At both trial sites as shown below there was sufficient rainfall during the three months after spraying to allow the rapid growth of weeds.

4 week periods after treatment application.	Trial I Ruiru	Trial 2 Koru
1st	9.16 in.	12.09 in.
2nd	8.03 in.	7.84 in.
3rd	2.15 in.	4.16 in.
12 week total	19.34 in.	24.09 in.

After spraying each plot was inspected regularly and scored visually for weed growth, using a scale of 0 to 5 where a score of 5 indicated the same amount of weed growth as on the untreated ground. Monocotyledons, dicotyledons and Cyperus spp. were scored separately for each plot.

RESULTS

Trial 1. On 19th July weeds were cut, dried and weighed from an area 9ft x 27ft in the centre of each plot. The total yields of weed dry matter from all plots of each treatment are given in Table IV, but the treatments not significantly different from 'control' have been excluded.

It is evident from Table III that in overall weed suppressing effect the urea derivatives diuron, linuron and monuron, and the triazones prometone and prometryne were highly effective. The performance of paraquat was particularly interesting for this chemical, which is stated to be entirely a contact herbicide, gave a considerable degree of weed control for the full three month period of the trial. (treatments 30 and 31). The addition of paraquat to diuron greatly improved the effectiveness of the latter during the first month of the trial, but did not have an important influence on the overall effectiveness of the urea derivative.

The linuron treatment (24) which was applied late in April was among the most effective. This would indicate that the chemical has a considerable effect on half grown weeds and is not entirely dependent on root uptake at the seedling stage. Prometryne gave good general weed control except for Cyperus rotundus L. and C. blysmoides Hochst., which were evident in considerable quantity on all six plots treated with this herbicide (treatments 11 and 12). The general effect of all the triazine herbicides was to control the dicotyledon but not the monocotyledon species of which the most common were Digitaria gazensis, Rendle, D. velutina, Beauv., Setaria verticillata, Beauv. and Dactyloctenium aegyptium, Beauv. The weight of weeds from plots treated with 3,4-dichloropropionanilide (FW 734) was surprisingly low since visual scores had not indicated that this herbicide had had much effect on weed growth. The addition of amitrole to simazine and atrazine appeared to reduce their overall effectiveness slightly.

TABLE III. TRIAL I. COFFEE RESEARCH STATION, RUIRU. DRY WEIGHT OF WEEDS SIGNIFICANTLY LESS THAN CONTROL YIELD OF 16.17 KG./81 SQ YD

P = 0.001

Treatment number		lb/ac active	kg.
26	Diuron Paraquat	2.96) 2.25)	0.51
21	Diuron	2.96	0.90
22	Diuron Paraquat	2.96) 0.91)	1.16
23	Diuron Paraquat	2.96) 1.71)	1.35
25	Diuron Linuron	2.96) 1.00)	2.07
24	Linuron	2.95	2.52
9	Prometon	4.90	2.68
19	Monuron	2.96	3.16
12	Prometryne	2.95	3.27
11	Prometryne	1.95	3.40
Least significant difference			12.71

P = 0.01

Treatment number		lb/ac active	kg.
2	Simazine	1.95	3.64
28	FW 734	3.96	3.78
5	Atrazine	1.95	4.67
31	Paraquat	1.59	5.28
4	Simazine	2.95	5.48
Least significant difference			9.77

P = 0.05

Treatment number		lb/ac active	kg.
29	FW 734	5.97	6.97
6	Atrazine Amitrole	1.95) 1.00)	6.97
30	Paraquat	0.80	7.38
27	FW 734	2.01	7.93
15	Amitrole Dalapon	1.18) 1.81)	8.06
3	Simazine Amitrole	1.95) 1.00)	8.28
Least significant difference			7.35

Trial 2. Within the first month from application it was obvious that some treatments entirely failed to reduce weed growth (Treatments 8, 9, 10, 11, 12, 15, 18, 21). Simazine treatments and atrazine without paraquat as well as the low rates of atraton, prometon and prometryne were excluded from later observations as these treatments were evidently unsuitable for the local conditions of

high rainfall and vigorous grass growth. Visual scores were made weekly until 28 July, by which time no treatment was satisfactory, but it was possible to place the nineteen remaining treatments in the order of overall effectiveness shown in Table IV.

TABLE IV. TRIAL 2. COFFEE RESEARCH SUB-STATION, KORU. SUMMARY OF VISUAL SCORES 1 AND 3 MONTHS AFTER TREATMENTS. (MAXIMUM SCORE 10 FOR EACH CLASS OF WEEDS.)

Treatment number	lb/ac active	1 June 1962				28 July 1962			
		Monocots	Dicots	*Cyperus* spp	Total	Monocots	Dicots	*Cyperus* spp	Total
5 Diuron	3.20	6	3	1	10	9	2	2	13
2 Monuron	3.20	8	4	2	14	10	2	3	15
7 Diuron Paraquat	1.60 0.68	7	2	2	11	9	5	4	18
13 Atrazine Paraquat	1.00 0.68	9	4	4	17	10	2	5	15
4 Monuron Paraquat	1.60 0.68	10	7	3	20	10	2	3	15
6 Diuron	1.60	6	5	3	14	9	8	5	22
27 Amitrole 2,4-D	1.50 1.50	10	5	5	20	10	5	5	20
26 Amitrole 2,4-D	2.50 1.00	5	7	5	17	10	9	5	24
3 Monuron	1.60	9	6	8	23	10	3	8	21
16 Atraton Paraquat	1.00 0.68	8	7	7	22	10	6	7	23
23 Dalapon 2,4-D	3.70 1.00	7	8	6	21	7	10	7	24
28 Amitrole 2,4-D	1.50 1.00	9	7	6	22	10	7	7	24
17 Prometon	2.50	9	8	8	25	10	4	8	22
24 Dalapon 2,4-D	2.22 1.50	7	8	7	22	10	7	8	25
20 Prometryne	2.50	9	6	8	23	10	7	8	25
22 Prometryne Paraquat	1.50 0.68	8	7	7	22	10	8	8	26
14 Atraton	2.00	9	9	9	27	10	3	9	22
19 Prometon Paraquat	1.50 0.68	8	7	9	24	10	5	10	25
25 Dalapon 2,4-D	2.22 1.00	9	9	6	24	9	10	9	28

The diuron treatment (5) was consistently the best throughout the trial but at the end of three months these plots had become invaded by Cynodon dactylon. Pers., large clumps of Cyperus rigidifolius, Stevd. had grown in the plots and there were some seedlings of Galinsoga parviflora on all plots. On one of the diuron plots Digitaria scalarum, Chiov. spread rapidly during the last month of the trial.

The differences between the treatments excluding diuron were slight since on all plots grasses were dominant with the following species most common:- Chloris pycnothrix Trin., Cynodon plectostachyus, Pilger, Panicum maximum, Jacq. and Sorghum verticilliflorum, Stapf. The untreated plots included these grasses but also a number of dicotyledon species such as Bidons pilosa and Galinsoga parviflora.

DISCUSSION

In Trial 1 no less than ten treatments were highly successful, whereas in previous trials at the same station it has been unusual for any herbicide acting through the soil to give a satisfactory degree of weed control. It is suggested that this difference is attributable to the time of application. In previous seasons the herbicides were applied just before the rains were expected, but in the present trial the treatments were withheld until the rains had broken, when the soil was moist and the weed seeds just germinating.

In Trial 2 the application of treatments was delayed too long, so that it was necessary to slash down existing weeds before spraying. Some of the subsequent grass growth developed from plants present at the time of spraying, though this was not generally the case. It will be necessary to repeat some of the best treatments with the applications made to recently cultivated ground early in March. These may well prove effective, but at Koru it is rarely possible to ensure weed free conditions at any time of the year, therefore herbicides should be used which have some effect through weed leaves as well as roots.

Of the various herbicides used in both trials, only fenac was observed to have any phytotoxic effect on the coffee. The characteristic symptoms which have already been described (Wallis, 1962) were first noticed three weeks after treatments had been applied in Trial 1.

REFERENCES

JONES, P.A. and WALLIS, J.A.N. (in press). A tillage study in Kenya coffee Part III Emp J exp Agric

JONES, P.A., ROBINSON, J.B.D. and WALLIS, J.A.N. (1960). Fertilizers, manure and mulch in Kenya coffee growing. Emp J exp Agric 28 335 - 352.

PEREIRA, H.C. and JONES, P.A. (1954). A tillage study in Kenya coffee Part I Emp J exp Agric 22 231-240.

WALLIS, J.A.N. (1958). Herbicides in Kenya Coffee. Pesticides Abstracts and News Summary C. 4 146 - 151.

WALLIS, J.A.N. (1960). Grass control in Kenya coffee. Down to Earth 16 7 - 9.

WALLIS, J.A.N. (1961). The place of herbicides in the management of Kenya coffee. Kenya Coffee 26 77 - 82.

WALLIS, J.A.N. (1962). Investigations of the use of pre-weed-emergence herbicides in coffee. Pesticides Abstracts and New Summary C. 8 195 - 199.

Research Report

PRE-EMERGENCE WEED CONTROL IN BULBS WITH BIPYRIDYLIUM HERBICIDES

C.R. Beech, S.H. Crowdy, G. Douglas

Plant Protection Ltd., Jealott's Hill Research Station, Bracknell, Berks.

Summary: Diquat 0.75 lb/ac. and paraquat 0.68 lb/ac. gave effective pre-emergence weed control in narcissus, daffodils and tulips. Application in 50 gal/ac. of water showed no advantage over application in 20 gal/ac. There was no advantage in spraying with a herbicide with some residual activity in addition to the bipyridyl when the weed flora was well developed at the time of spraying.

INTRODUCTION

Bulbs are a crop in which pre-emergence weed control is an accepted routine (Woodford 1958) and, prior to the ban on its use, sodium arsenite was the most commonly used herbicide. Diquat and paraquat are very effective contact pre-emergence herbicides whose lack of residual activity makes them very safe to use in a variety of crops. These two chemicals were tested in bulbs 1960-61.

MATERIALS AND METHODS

This report describes the results of two trials on tulips, one on narcissus and two on daffodils. All were centred on the Spalding area of Lincolnshire and were sprayed between the 25th November and 15th December 1960. In all these trials the treatments were applied to 1/200 ac plots in four randomised blocks with an Oxford Precision Sprayer. The diquat (1;1'-ethylene-2;2'-bipyridylium ion) was applied as the dibromide monohydrate salt and the paraquat (1;1'-dimethyl-4;4'-bipyridylium ion) as the di (methyl sulphate) salt. In the main series of treatments 0.1 per cent of the nonionic surface active agent 'Agral' 90 was added to the final spray. As additional treatments, diquat was tested without surface active agent and also in conjunction with chlorpropham to test the possible effect of a herbicide with residual activity. It was common practice to apply sodium arsenite sprays in 100 gal/ac of water. This volume is higher than is normally required for the bipyridylium herbicides and in most of the treatments these were applied in 50 gal/ac. In addition treatments at 20 gal/ac., the normal rate of application with these herbicides were included. The effect of treatment was assessed as the percentage of ground covered by the weeds.

EXPERIMENTAL RESULTS

Poa annua was the dominant weed in the narcissus experiment while in the remaining trials the dominant weeds were dicotyledons including *Stellaria media*, *Matricaria* spp., *Veronica* spp., *Senecio vulgaris* and *Capsella bursa-pastoris*. The effect of spraying was very similar in all the trials except the one in which *P.annua* was the dominant weed and Table I summarises the results of all the treatments in these trials.

TABLE I PER CENT OF GROUND COVERED BY WEEDS IN BULBS 13-16 WEEKS AFTER PRE-EMERGENCE TREATMENT. SPRAYED 25-28/11/60.

Chemical	Dose lb/ac ion	Vol water gal/ac	Per cent 'Agral' 90 in spray	Per cent of ground covered by weeds 13-16 weeks after spray	
				Grass dominant	Dicotyledons dominant
Diquat	0.75	50	0	61	1.7
"	0.75	50	0.1	31	1.2
"	1.0	50	0	50	1.2
"	1.0	20	0	51	2.2
"	1.0	50	0.1	14	1.0
"	1.0	20	0.1	15	1.2
Paraquat	0.68	50	0.1	1	2.5
	0.91	50	0.1	1	1.2
Diquat + chlorpropham	) 1.0)) 2.0	Separate sprays		46	1.0
Control Unsprayed				91	40.5

It is clear from this table that there is little advantage in using the higher dose of either diquat or paraquat except when diquat was used where grasses predominate. The addition of a surface active agent enhanced the weed control particularly on grasses, and when the spray was applied at a low volume. The actual development of the weed flora after spraying is illustrated in Tables II and III. These tables contain only the data from typical treatments.

TABLE II PRE-EMERGENCE WEED CONTROL IN NARCISSUS AND DAFFODILS. 0.1 PER CENT 'AGRAL' 90 INCLUDED IN SPRAY: SPRAYED 25-28/11/60

Chemical	Dose lb/ac	Per cent of ground covered by weeds varying number of weeks after treatment									
		Broad-leaved weeds					Grasses				
Narcissus: 1 trial		Before	3	7	16	21	Before	3	7	16	21
Diquat	0.75	5	5	0	0	2	60	23	19	31	76
Paraquat	0.68	4	3	1	1	2	57	39	16	2	6
Diquat and chlorpropham	1.0) 2.0)	3	2	0	0	0	59	40	47	46	88
Control		9	9	9	5	8	64	58	75	86	90
Daffodils: 2 trials											
Diquat	0.75	65	3	0	0	15	0	0	0	0	7
Paraquat	0.68	67	5	1	1	17	5	0	0	0	0
Diquat and chlorproham	1.0) 2.0)	61	1	0	0	13	1	0	1	1	8
Control		60	50	50	56	74	0	0	0	1	3

TABLE III PRE-EMERGENCE WEED CONTROL IN TULIPS: 0.I PER CENT 'AGRAL' 90 INCLUDED IN THE SPRAY. AVERAGE RESULTS OF TWO TRIALS: SPRAYED 15/12/60

Chemical	Dose lb/ac	Per cent ground covered by broad-leaved weeds* a varying number of weeks after treatment			
		Before	4	13	19
Diquat	0.75	8	1	2	26
Paraquat	0.68	8	1	4	19
Diquat and chlorproham	1.0) 2.0)	8	1	1	4
Control		8	6	25	59

* The incidence of grass weeds was insignificant.

The narcissi and daffodils (Table II) had been in the ground for more than a year and the weeds were well germinated at the time of spraying. Spraying with a bipyridylium herbicide gave a good control of the weeds that were present and their further development remained insignificant until the end of April when the crop had been picked and observations were ended. In these circumstances the additional spray with a herbicide with residual activity such as chlorpropham did not improve the effectiveness of the treatment. Since the bipyridyls have no residual effect, the failure of weeds to develop must be attributed to cold environmental conditions and an undisturbed soil which stopped new weed germination following the kill obtained by these herbidies. Table 2 also illustrates the marked superiority of paraquat for controlling grasses. The tulips (Table III) were planted during the autumn before spraying. The weeds had developed only slowly after planting and were relatively sparse at the time of spraying. In these circumstances, the residual activity of chlorpropham offered some advantage though, even in the absence of a chemical with residual effect, the weed control provided by the diquat and paraquat persisted for a considerable time.

DISCUSSION

0.75 lb/ac. of diquat in 20 gal/ac of water provided very effective pre-emergence weed control in bulbs, except when grasses were the dominant weeds. Paraquat at 0.68 lb/ac was very effective against grasses and also gave a good control of broad-leaved weeds; 0.1 per cent 'Agral' 90 was required with both chemicals. When the weed flora was well developed at the time of spraying and the treatment was followed by conditions unfavourable for the germination of weeds, there was no advantage in including a herbicide with residual activity in the spray programme. Diquat and paraquat will damage any green tissue with which they come in contact and their use when living parts of the plant are exposed above the soil will result in damage. If the leaves are sprayed while they are emerging, the damage appears to be confined to a tip scorch and is probably unimportant. However, if mature or dying leaves are sprayed, the chemical can be translocated to the new bulb and the damage can be severe.

REFERENCE

WOODFORD E.K. (Ed) (1958) Weed Control Handbook, Blackwell Scientific Publications, Oxford.

Research Report

THE EFFECTS OF HERBICIDES ON WEEDS AND NARCISSUS

P. D. Lees and L. W. Wallis
Rosewarne Experimental Horticulture Station,
Camborne, Cornwall.

Summary The results from the screening of 52 herbicides are recorded. The effects on weeds and narcissus are noted; both immediate and long term effects on the crop being included. Some methods of killing narcissus groundkeepers are also discussed.

INTRODUCTION

In 1959 a study was started on the effects of 52 herbicides upon weeds and bulbs in a crop of Narcissus King Alfred. Information was required which would lead to the development of selective weed control treatments for narcissus and of methods of controlling "groundkeepers". These are bulbs which are not picked up during harvesting. They can persist, in diminishing numbers for many years and can spoil subsequent narcissus crops by contaminating them with rogue varieties or with stem and bulb eelworm. If chemicals could be used to kill groundkeepers it would be possible to shorten rotations including narcissus.

METHODS AND MATERIALS

Time of application There were three dates of application, pre-emergence (mid Nov), post-emergence (mid Jan) when plants were 4 - 5 in. high and senescence (mid June) when the bulb foliage was yellow and dying.

Rates of application Each chemical, except proprietary white spirit and tractor kerosene, was applied at three does in 100/gal ac of water. In the table these are referred to as:-

1 - Normal or recommended dose
11 - 2 x normal or recommended dose
1V - 4 x normal or recommended dose

The bulbs were planted in September and they were not weeded before spraying. At the time of the first spray weeds were i in. high, at the post-emergence spray they were 3 - 4 in. high, and at the time of the senescence spray the weeds were tall and dense. The weeds present included self sown barley and potatoes, Stellaria media, Poa annua, Veronica spp., Fumaria spp., Senecio vulgaris and Solanum nigrum.

RESULTS

The effects of the range of chemicals tested on bulbs and weeds are shown in Table I. Treatments which gave a complete control of weeds at any one date of assessment are indicated together with the number of months for which control was maintained. Damage to the crop foliage was noted at each date of assessment in the first season and in the following year the bulb weights were recorded. Effects on foliage, flowers and bulb increase are indicated in the table.

DISCUSSION

Weed control treatments Weeds were controlled most effectively by pre-emergence contact sprays applied when the weeds were small. Later, at the post-emergence stage when the weeds were larger the bulb foliage was frequently damaged as severely as the weeds. Some of the contact herbicides were also effective in controlling weeds at the senescence stage. Although the auxin type herbicides greatly reduced the growth of weeds they failed to give an adequate degree of control. Several contact pre-emergence treatments such as diquat, PCP and mineral oils gave an effective but usually temporary control of weeds. Others such as dinoseb, endothal and sodium arsenite were satisfactory but their high mammalian toxicity is likely to limit their use.

Residual herbicides such as atrazine, simazine and diuron, applied over existing weeds, were only effective at high rates of application but at these rates their residual effect was persistent. Since most contact herbicides applied after emergence can damage narcissus foliage the best control of weeds is likely to be obtained by combining a late pre-emergence application of a contact herbicide with one of the residual chemicals. Control of weeds is required for 6 months after emergence and to obtain this length of control it may be necessary to apply the residual chemical as late as possible after the emergence of the narcissus foliage.

Methods of controlling Narcissus groundkeepers. It is shown in Table I that some chemicals such as dalapon, TCA and aminotriazole cause considerable damage to bulbs in the year after application, the effect of the post-emergence and senescence treatments being particularly damaging. Earlier work at Rosewarne (Anon 1962) has shown that, under certain conditions, sprays of tractor kerosene, TCA, dalapon and aminotriazole could kill a large proportion of the bulbs by the following year. The present study helps to confirm these findings and observations on Narcissus King Alfred in 1959 indicated that the sprays were far more effective when applied in March than in February.

Preliminary results from later trials suggests that TCA at rates of 30 - 40 lb/ac is the most effective chemical on groundkeepers and that March or April applications give the best results. There is evidence of varietal differences in susceptibility, Helios and Magnificence being more susceptible than Actaea, King Alfred or Soleil d'Or. The two most resistant varieties, King Alfred and Soleil d'Or have a relatively tough, water repellent foliage and might be rendered more susceptible by adding a wetting agent to the spray.

To be an effective bulb-killer a chemical must be absorbed rapidly, as the time during which a spray can be applied is limited by cropping requirements. The narcissus must absorb a lethal dose of chemical in the short time available between the peak of growth (at or just after flowering) and spring cultivations. Often the spray must be applied to groundkeepers exposed after cutting spring cabbage, and spraying must be completed before cultivations for spring potatoes or other spring crops take place.

An effective chemical for groundkeeper control must therefore be translocated rapidly to the bulb and must not leave toxic residues in the soil which would prevent immediate planting of other crops. TCA is a suitable chemical from the point of view of effectiveness but the rates required are likely to interfere with the growth of succeeding crops for an appreciable time so that there is still a need for a less persistent material.

REFERENCES

Anon (1962) 7th Ann Rep Rosewarne Exp Hort Sta for 1961.

TABLE I. THE EFFECTS OF A RANGE OF HERBICIDES ON WEEDS AND NARCISSUS

Key

\+ = Effective weed control in first season. In brackets number of months for which control was given.

0 = Unsatisfactory weed control.

R = No injury to crop (Resistant).

Herbicide	Dose 1 lb/ac	Time of				
		Pre-emergence			Post-	
Inorganic Chemicals		I	II	IV	I	II
1. Ammonium sulphamate	218	0 S(b)	+(4) S(b)	+(4) S(b)	0 R	0 S(b)
2. Calcium cyanamide	336	+(4) R	+(4) R	+(4) R	+(4) S(b)	0 S(b,f)
3. Copper sulphate	30	+(2) S(b)	+(4) S(b)	+(4) S(b)	0 S(b)	0 S(b)
4. Iron sulphate	151	+(4) R	+(4) R	+(4) R	0 S(1,b)	0 S(1,b)
5. Mercurous chloride	11	0 R	0 R	0 R	0 R	0 R
6. Potassium cyanate	5	+(2) R	+(4) R	+(4) R	0 S(1)	0 S(1)
7. Potassium permanganate	300	0 S(b)	0 S(b)	0 S(b)	0 S(b)	0 S(b)
8. Sodium arsenite	8	+(4) R	+(4) R	+(6) R	0 R	+(4) R
9. Borax	500	+(4) S(1)	+(4) S(1)	+(4) S(1)	0 S(1)	0 S(1,b,f)
10. Sodium chlorate	32	+(4) R	+(6) R	+(6) S(b)	+(2) S(1,b)	+(2) S(1,b)

S = Crop injured (Susceptible).

S(l) = Injury to leaves.

S(f) = Injury to flowers or reduction in flower size or number in the year after spraying.

S(b) = Reduction in growth of bulbs.

Application				Remarks
emergence	Senescence			
IV	I	II	IV	
0 S(b,f)	+(l) R	+(l) R	+(l) S(b)	
0 S(b,f)	0 R	0 R	0 S(b)	
0 S(b)	0 S(b)	0 S(b)	+(l) S(b)	
0 S(1,b)	0 S(b)	0 S(b)	0 S(b)	Tips of foliage scorched by post-emergence sprays.
0 R	0 R	0 R	0 R	
0 S(l)	0 R	0 R	0 R	Slight scorch from post-emergence sprays.
0 S(b)	0 S(b)	0 S(b)	0 S(b)	Early flowering.
+(4) R	+(l) R	+(l) S(f)	+(l) S(f)	Slight damage to tips of foliage 2 months after post-emergence spray. Slight curling of petals in 2nd year.
0 S(l,b,f)	0 S(b)	0 S(b)	0 S(b)	Foliage semi-prostrate then streaked and scorched following pre- and post-emergence sprays.
+(4) S(l,b)	+(l) R	+(l) R	+(l) R	Tips of foliage scorched after post-emergence sprays.

TABLE I (contd)

Herbicide	Dose 1 lb/ac	Time of				
		Pre-emergence			Post-	
		I	II	IV	I	II
11. Sodium nitrate	280	0 R	0 R	0 R	0 S(1)	0 S(1)
12. Sulphuric Acid	12 gal per cont	+(4) R	+(4) R	+(6) R	0 R	0 R
13. Tractor Kerosene	40 gal	+(4) R	+(6) R	+(6) R	0 S(b)	+(2) S(b,f)
14. Proprietary White Spirit (Shell W)	40 gal	+(4) R	+(6) R	+(6) R	0 S(1,b)	0 S(1,b,f)
Phenoxyacetic Acids						
15. 4 - CPA	0.5	+(4) R	+(4) R	+(4) R	0 S(1)	0 S(1)
16. MCPA (Sodium salt)	0.5	0 R	0 R	0 S(1)	0 S(1)	0 S(1)
17. MCPA (amine)	0.5	0 R	0 R	0 R	0 R	0 R
18. MCPA + MCPB ("Tropotox")	1	0 R	0 R	0 R	0 R	0 R
19. MCPA + 2,3,6 - TBA	0.75 0.25	0 R	0 R	0 R	0 R	0 R
20. 2,4-D (amine)	0.5	0 R	0 R	0 R	0 R	0 R
21. 2,4-D + 2,4,5 - T ("Spontox")	1	0 R	0 S(b)	0 S(b)	0 S(b)	0 S(b)
22. 2,4,5 - T (ester)	0.5	+(6) R	+(6) R	+(6) R	+(2) S(1,b,f)	+(2) S(1,b,f)

Application				Remarks
emergence	Senescence			
IV	I	II	IV	
0 S(1)	0 R	0 R	0 R	Foliage scorched, later semi-prostrate.
0 R	+(1) R	+(1) R	+(1) R	
+(4) S(1,b,f)	+(1) S(b)	+(1) S(b)	+(1) S(b,f)	
0 S(1,b,f)	+(1) R	+(1) R	+(1) S(f)	Foliage severely damaged by post-emergence IV treatment
0 S(1,b,f)	+(1) R	+(1) S(b)	+(1) S(b)	Foliage twisted following post-emergence treatments.
0 S(1)	0 R	0 R	0 R	Foliage semi-prostrate after spraying.
0 R	0 S(b)	0 S(b)	0 S(b)	
0 R	0 S(b)	0 S(b)	0 S(b)	
+(4) R	0 R	0 R	0 R	
0 R	0 R	0 R	0 R	
0 S(b)	0 R	0 S(b)	0 S(b)	
+(2) S(1,b,f)	0 R	0 S(b,f)	0 S(b,f)	Foliage prostrate and yellow-white 2 months after spraying at higher doses.

TABLE I (contd)

Herbicide	Dose 1 lb/ac	Time of				
		Pre-emergence			Post-	
		I	II	IV	I	II
23. 2,4-DES	2	0 R	0 R	0 S(l)	0 S(l)	0 S(l)
Phenoxypropionic Acids 24. Mecoprop	1	0 S(b)	0 S(b)	0 S(b)	0 R	0 R
Phenoxybutyric Acids 25. MCPB	1	0 S(l)	0 S(l)	0 S(l)	0 R	0 R
26. 2,4 - DB	1	0 R	0 R	0 R	0 R	0 R
Halogenated Aliphatic Acids 27. Sodium monochloroacetate	8	0 R	0 R	0 R	0 R	0 R
28. TCA	20	+(4) S(f)	+(4) S(b,f,)	+(4) S(b,f)	+(2) S(b,f)	+(2) S(l,b,f)
29. Dalapon	4	+(2) R	+(4) R	+(4) R	0 R	0 R
Carbamates 30. Chlorpropham	2	+(4) R	+(4) R	+(6) R	0 R	0 R
31. EPTC	2	0 R	0 R	0 R	0 R	0 R
32. Metham-sodium	50	0 S(b)	0 S(b)	+(4) S(b)	0 S(b)	+(4) S(l,b,f)

Application				Remarks
emergence	Senescence			
IV	I	II	IV	
0 S(1)	0 R	0 R	0 R	Foliage curled temporarily after pre- and post-emergence spraying.
0 R	0 R	0 R	0 R	
0 R	0 R	0 R	0 R	Yellow mottling of foliage 4 months after pre-emergence spraying.
0 R	0 R	0 R	0 R	
0 S(1)	0 R	0 R	0 R	Foliage scorched and later prostrate following post-emergence spray at dose IV.
+(2) S(1,b,f)	0 S(b,f)	0 S(b,f)	0 S(b,f)	TCA damage i.e. flower parts sticking together.
0 S(f)	0 S(b,f)	0 S(b,f)	0 S(b,f)	Flower damage similar to TCA damage.
0 S(b)	0 R	0 R	0 R	
0 R	0 R	0 R	0 R	
+(4) S(1,b,f)	0 R	0 R	0 R	Flower damage - curling of petals (2nd year). Foliage scorched and flattened after post-emergence sprays.

TABLE I (contd)

Herbicide	Dose 1 lb/ac	Time of				
		Pre-emergence			Post-	
Acetamides		I	II	IV	I	II
33. CDAA	2	0 R	0 R	+(4) R	0 R	0 R
Ureas						
34. DCU	4	0 S(b)	0 S(b)	0 S(b)	0 R	0 R
35. Monuron	1	+(4) R	+(4) R	+(4) R	0 R	+(2) R
36. Borate + Monuron	200 + 20	+(6) S(l,b,f)	+(6) S(l,b,f)	+(6) S(l,b,f)	+(4) S(l,b,f)	+(4) S(l,b,f)
37. Diuron	1	+(6) R	+(6) R	+(6) R	0 R	+(4) R
38. Neburon	2	0 R	0 R	0 R	0 S(b)	0 S(b)
39. Fenuron	1	+(4) R	+(4) R	+(4) R	0 R	0 R
Triazines						
40. Simazine	1	+(4) R	+(4) R	+(4) S(b)	0 R	+(4) R
41. Propazine	1	+(4) R	+(4) R	+(4) R	0 R	0 R
42. Trietazine	1	+(4) R	+(4) R	+(4) R	0 R	0 R
43. Atrazine	1	+(4) R	+(4) R	+(6) R	0 R	+(2) R
44. Prometon	1	+(4) R	+(4) R	+(4) R	0 R	0 R

Application				Remarks
emergence	Senescence			
IV	I	II	IV	
0 R	0 R	0 R	0 R	
0 S(f)	0 R	0 R	0 R	Flower damage similar to TCA damage.
+(4) S(l)	0 R	0 R	0 R	Occasional leaf-scorch 2 months after post-emergence spray IV.
+(4) S(l,b,f)	+(l) S(b,f)	+(l) S(b,f)	+(l) S(b,f)	Premature death of foliage following all pre- and post-emergence treatments.
+(4) R	0 R	0 R	0 R	
0 S(b)	0 R	0 R	0 R	
+(2) R	0 R	0 R	0 S(b)	
+(4) R	0 R	0 R	0 S(b)	Slight curling of petals after senescence IV spray.
0 R	0 R	0 S(b)	0 S(b)	Slight blotching of foliage after pre-emergence spray. Tip scorch after post-emergence spray.
0 R	0 R	0 R	0 R	
+(2) R	0 R	0 R	0 R	
0 R	0 R	0 R	0 R	

TABLE I (Contd)

Herbicide	Dose 1 lb/ac	Time of				
		Pre-emergence			Post-	
Substituted Phenols		I	II	IV	I	II
45. DNOC	4	+(4) R	+(4) R	+(4) R	+(2) R	+(2) R
46. Dinoseb	1	+(4) R	+(4) R	+(4) R	0 S(1)	+(4) S(1)
47. PCP	3	+(4) R	+(4) R	+(6) R	0 S(1)	0 S(1,b,f)
Miscellaneous						
48. Aminotriazole	4	+(4) R	+(4) S(1)	+(6) S(1,b)	+(4) S(1,b)	+(4) S(1,b)
49. Endothal	2	+(4) R	+(4) R	+(4) R	0 S(b)	0 S(1,b)
50. Diquat	1	+(4) R	+(4) R	+(4) R	+(2) S(1,b)	+(2) S(1,b,f)
51. Maleic hydrazide	4	0 R	0 S(b)	0 S(b)	0 R	0 S(b,f)
52. Naptalam	2	0 R	0 R	0 R	0 R	0 R

Application				Remarks
emergence	Senescence			
IV	I	II	IV	
+(2) R	0 R	0 R	0 R	
+(4) S(1)	0 R	0 R	0 R	Foliage tending to be prostrate after post-emergence sprays.
+(4) S(1,b,f)	+(1) R	+(1) R	+(1) R	Severe foliage damage up to 3 months after post-emergence IV spray.
+(4) S(1,b,f)	+(1) S(b,f)	+(1) S(b,f)	+(1) S(b,f)	Yellowing of foliage following all doses post-emergence.
0 S(1,b)	0 R	0 R	+(1) R	Foliage semi-prostrate 3 months after post-emergence spray.
+(2) S(1,b,f)	+(1) R	+(1) R	+(1) S(b)	Foliage scorched and streaked after post-emergence spray, later semi-prostrate.
0 S(b,f)	0 R	0 S(f)	0 S(f)	Flower damage - twisted petals, split trumpets.
0 R	0 R	0 R	0 R	

Research Report

TRIALS OF HERBICIDES ON NARCISSUS AND TULIP

Elizabeth D. Turquand

Kirton Experimental Husbandry Farm, Boston, Lincs.

Summary: Residual herbicides were applied to tulip and narcissus beds in two seasons of contrasting weather conditions. Simazine at 1 lb/ac reduced the bulb yield of tulip and narcissus in both years, compared with other herbicides used. Several herbicides belonging to the urea group were added to chlorpropham and applied pre-emergence. Provided the dose was not too high, these mixtures appeared safe and gave an improved weed control. Damage was caused on tulip by post emergence applications of chlorpropham at 2 lb/ac at certain stages of growth.

INTRODUCTION

The use of herbicides on bulb crops is an established commercial practice, but there is a wide field for experimentation on the safety of various herbicides in fairly common use on other crops. J. Wood et al, (1960) and J. Wood (1960) showed that chlorpropham 4 lb/ac applied to tulip and narcissus pre-emergence gave a reasonable degree of weed control with an adequate margin of safety. Some weeds, for example Senecio vulgaris and Matricaria spp., were not controlled, however, and weed control tended to break down in early summer. The addition of diuron or fenuron to chlorpropham improved weed control, and in further experiments an endeavour was made to assess the safety of these and other possible additives. Work on the effect of post emergence applications of chlorpropham on tulips (J. Wood et al 1960) was continued and extended because, owing to weather conditions, growers cannot always avoid post emergence applications of herbicides.

METHODS AND MATERIALS

Experiments were carried out on both tulips and narcissus and replicated treatment plots were arranged in randomised blocks or latin squares. Planting weight and size of bulb per plot were uniform throughout an experiment. All bulb stocks were grown on the farm at Kirton. Narcissus were lifted annually and hot water treated at 110°F for 3 hours before replanting. Plot size was 10 ft x 4½ ft containing 250 bulbs in 5 rows 9 in. apart. This allowed sufficient bulbs from each treatment for forcing during the following winter, to test for any residual effect of the weedkillers.

All weedkillers were applied with an Oxford Precision Sprayer in 100 gal/ac of water using a screen to prevent spray drift. Most herbicides used were commercial formulations, and the rates of application given below refer to active ingredient. During the growing season visual damage to the crop was recorded and weed cover assessed by scoring. After lifting, plot weights and numbers of bulbs in each grade were recorded.

Experiments with residual herbicides on narcissus and tulip

RESULTS Table I and II show the effects of a range of herbicides on bulb yield of narcissus (King Alfred 1960/61, Golden Harvest in 1961/62) and tulip (Rose Copland) applied in 1960 (16 November) and 1961 (15 November).

TABLE I EFFECT OF RESIDUAL HERBICIDES ON YIELD OF TULIP AND NARCISSUS 1960/61 SEASON

Treatment	Mean yield in ounces	
	Tulip Rose Copland	Narcissus King Alfred
1. Simazine 1 lb/ac	286	663
2. Chlorpropham 3 lb/ac	329	690
3. Chlorpropham 2 + neburon 0.5 lb/ac	330	708
4. Chlorpropham 2 + fenuron 0.5 lb/ac	323	700
5. Chlorpropham 2 + diuron 0.4 lb/ac	325	701
6. Chlorpropham 2 + diuron 0.4 lb/ac repeated 2 December	320	687
7. Diuron 0.4 lb/ac	301 ∅	694 ∅
8. Diuron 0.8 lb/ac	340 ∅	710 ∅
9. Cultivated	345	714
10. Unweeded control	308	684
General mean	321	695
Standard error per plot	± 9.4	± 21.98
Standard error as per cent of general mean	2.5	3.2
Significance of F test	1 per cent	N.S.
Least sig diff (P = 5 per cent)	14	32

∅ Some large weeds were removed from these plots.

TABLE II EFFECT OF RESIDUAL HERBICIDES ON YIELD OF TULIP AND NARCISSUS 1961/62 SEASON

chloroxuron*

Treatment	Mean yield in ounces	
	Tulip Rose Copland	Narcissus Golden harvest
1. Simazine 1 lb/ac	203	724
2. Chlorpropham 2 + simazine 0.5 lb/ac	241	741
3. Chlorpropham 2 + neburon 0.5 lb/ac	231	757
4. Chlorpropham 2 + fenuron 0.5 lb/ac	226	755
5. Chlorpropham 2 + diuron 0.4 lb/ac	241	768
6. Chlorpropham 2 + diuron 0.4 lb/ac repeated 14 December	221	746
7. Chlorpropham 2 + diuron 0.8 lb/ac	228	752
8. Chlorpropham 2 + diuron 0.8 lb/ac repeated 14 December	208	742
9. Chlorpropham 4 lb/ac	243	752
10. Chlorpropham 2 + CIBA 1983 2 lb/ac	237	763 *
11. Cultivated	241	714
12. Untouched control	246	705
General mean	230	743
Standard error per plot	± 24.8	± 22.5
Standard error as per cent of general mean	10.8	3
Significance of F test	N.S.	1 per cent
Least significant difference (P = 5 per cent)	36	32

DISCUSSION

The 1960/61 season had a very high rainfall during November, December and January, which caused some flooding and severe surface capping on Kirton soil. The following Spring was dry and exceptionally mild, giving an early season. The surface capping prevented excessive weed growth, although late germination of Papaver rhoeas gave a fairly dense weed cover on some plots. Weed control was poorest with chlorpropham 3 lb/ac, chlorpropham/fenuron and chlorpropham/neburon mixtures. Diuron alone gave such a poor control of Veronica spp. that the largest plants were removed by hand to avoid reduction in yield from weed competition. Simazine and the chlorpropham/diuron mixture gave the best weed control. The 1961/62 season was very cold and dry during the winter months, followed by a cold dry spring. Growth was slow and all herbicide treatments gave good weed control in spite of an excellent frost tilth and considerable surface cracking.

The only visual signs of crop damage noted were during March and April 1961, when the leaves of tulip looked flabby and greyish on plots which had received the double application of the chlorpropham/diuron mixture. These symptoms disappeared later in the season and were not observed in 1962. The yield was not significantly reduced by this treatment in either year, but there was a tendency towards yield reduction in both seasons.

In spite of the absence of visual damage the yields of tulip and narcissus were reduced by an application of simazine at 1 lb/ac, reduction being significant in 1960/1 for tulip and in 1961/2 for narcissus. The single application of the chlorpropham/diuron mixture gave good weed control in both seasons without adverse effect on yield. The chlorpropham/fenuron mixture was not so effective as a herbicide. Results with the mixtures tested for one year only suggest that chlorpropham/simazine, chlorpropham/CIBA 1983 and chlorpropham with the higher rate of diuron have no adverse effect on crop yield, but there is a tendency for tulip yield to be reduced with two applications of the chlorpropham/higher rate of diuron mixture.

When bulbs from the 1960/61 experiments were forced in early Spring 1962 no obvious ill effects on flower quality were noted from any of the treatments.

Post emergence applications of chlorpropham on tulip

RESULTS

Tulip Carrara was planted in September 1960 in a trial of latin square design with 50 bulbs per plot. To prevent weed growth confusing the picture all plots received a pre-emergence application of chlorpropham at 2 lb/ac on 16 November. Post-emergence treatments consisted of four dates of application of chlorpropham at 2 lb/ac compared with pre-emergence treatment only. In the 1962 trial the plot size was increased to 10 ft x $4\frac{1}{2}$ ft with 250 bulbs per plot to produce sufficient bulbs for forcing. The variety was changed to William Pitt. Since the application of chlorpropham 2 lb/ac at the post flowering stage had not affected the growth of tulip in the 1960 or 1961 experiments, this treatment was omitted and replaced by an application of a chlorpropham/diuron mixture at the rolled leaf stage (a time when growers might wish to make an application). A pre-emergence application of chlorpropham at 2 lb/ac was given to all plots on 10/12/61. The effects of these treatments on the crops are shown in Table III.

TABLE III EFFECTS OF VARIOUS POST-EMERGENCE TREATMENTS ON FLOWER STALK LENGTH AND BULB YIELD OF TULIP IN 1961 AND 1962

Treatment	Growth stage and dates of application	Tulip Carrara 1960/61 season		Tulip Wm. Pitt 1961/62 season	
		Mean flower stalk length (in)	Mean yield (oz)	Mean flower stalk length (in)	Mean yield (oz)
Chlorpropham 2 lb/ac	Rolled leaf 14/2/61, 20/2/62	16.6	94.4	22.5	421
Chlorpropham 2 lb/ac	Cup leaf 20/2/61, 21/3/62	16.2	87.2	22.1	407
Chlorpropham 2 lb/ac	Full leaf, coming up to flower 10/4/61, 1/5/62	14.4	95.0	19.6	440
Chlorpropham 2 lb/ac	After flowering 10/5/61	16.7	93.8	-	-
Chlorpropham 2 + diuron 0.8 lb/ac	Rolled leaf 20/2/62	-	-	22.6	421
Unsprayed post-emergence		16.5	101.6	22.6	446
General mean		16.1	94.4	21.9	427
Standard error per plot		± 0.41	± 7.4	± 0.28	± 13.8
Standard error as per cent of general mean		3	8	1.3	3.2
Significance of F test		1 per cent	N.S.	1 per cent	1 per cent
Least significant difference (P = 5 per cent)		0.56	10.2	0.39	19.1

DISCUSSION

The weather in spring 1961 was warm and all sprays were applied when the soil was moist and growth vigorous. The spring of 1962 was cold and dry and growth slow. In both these contrasting seasons, there was a slight reduction in flower stalk length when chloropropham at 2 lb/ac was applied at the cup leaf stage and a very noticeable reduction in stalk length when the same treatment was applied at the full leaf stage. There was an indication of reduced yield with all post-emergence treatments compared with control in both years, and this reduction in yield was significant when chlorpropham 2 lb/ac was applied at the cup leaf stage.

Acknowledgements

The author is greatly indebted to Mr. J. Wood (late Assistant Director Kirton E.H.F.) for his help and guidance with these experiments. The author also wishes to thank the A.R.C. Weed Research Organisation, manufacturers who have supplied material and information, and Mrs. Hardy and B. Skillings, Scientific Assistants at Kirton E.H.F.

REFERENCES

J. WOOD *et al* (1960), Proc 5th British Weed Control Conference, 425-431

J. WOOD (1960). Review of Bulb Experiments Kirton E.H.G. 1960, 5 - 9.

Research Report

OBSERVATIONS ON WEED CONTROL IN ROSE TREE NURSERIES

A. W. Smith and L. W. Wallis,

National Agricultural Advisory Service, Nottingham

Summary: Programmes of herbicide treatments are described which were planned to fit in with the cultural methods used in East Midland rose nurseries. A two year programme of sprays consisting of chlorpropham, 2,4-DES and fenuron caused slight visual damage symptoms. The control of weeds was good but not complete. In a second two year programme, simazine was compared with the above treatments. 4 - 5 lb/ac of simazine applied over two seasons controlled weeds effectively and the crop was not damaged. Sprays of 2,4-DES 4 + fenuron 0.5 lb/ac and simazine 1 and 2 lb/ac did not affect bud union. The adaptation of these results to nursery practice is discussed.

INTRODUCTION

Roses occupy the same site on the nursery for two years (Smith and Wallis 1959). The weed problem thus requires a spray programme to cover both the rootstock year in which the rootstock is planted and budded and the maiden year in which the rootstock is cut back and the scion bud develops to form the maiden tree which is lifted at the end of that season. During these two years there are three occasions when the soil is clean following cultivations required for cultural reasons not connected with weed control. After planting, after budding (the rootstocks are earthed up after planting and this ridge of soil must be pulled down to expose the stem before budding), and after clearing the soil from the buds in the spring. This follows the cutting back of the rootstock to the scion bud. To maintain the soil in a clean condition herbicides are therefore best applied at these times.

METHODS AND MATERIALS

The following investigations were done with varieties grown on *Rosa canina* and *R. laxa* rootstocks. These stocks are in general use in the East Midlands for the production of bush trees and climbers. *R. rugosa*, generally used for standards, was not included. The soil types on which the bushes were growing ranged from fine sandy loams to clay loams.

All sprays were applied in 100 gal/ac of water. They were applied overhead but were directed sufficiently to get a good cover over the entire soil surface. All plots, including controls, were hoed just before the sprays were applied. Weed assessments therefore show the development of seedling weeds since the previous treatment.

RESULTS

1958 - Sprays on maiden bushes. Some preliminary observations were made in 1958 on the effects of chlorpropham 2 + fenuron 0.5 lb/ac, 2,4-DES 4 + fenuron 0.5 lb/ac and 2,4-DES 6 lb/ac. The varieties treated were Ena Harkness, Fantastique, Cinnabar Improved and Independence growing on R. laxa. The mixtures when applied in April-May caused a temporary growth check but later in the year no effect on growth was visible. 2,4-DES used shortly before a period of heavy rain, however, caused severe hormone type damage to variety Ena Harkness and less severe damage to other varieties.

Spring treatments in dry weather gave a moderate control of weeds. With later applications made during a wet summer the control of weeds improved.

Two year spray programmes covering rootstock and maiden years. In 1958 a two year trial was started on the following rootstocks: R. laxa seedlings, R. canina seedlings and R. canina Pollmeriana seedlings, later budded with the following varieties:

Alain	Irene of Denmark	Perfecta
Ena Harkness	Masquerade	Spek's Yellow
Fashion	McGredy's Yellow	Souvenir de Jacques
Frensham	Monique	Verschuren
Goldilocks	Montezuma	Virgo
Hamburger Phoenix	Mojave	

The rootstocks were planted in February and March and were budded in July and August 1958 before the third sprays were applied. The treatments applied are shown in Table I.

TABLE I. TREATMENTS APPLIED TO ROSES IN 1958/59 TRIAL

C + f = Chlorpropham 2 + fenuron 0.5 lb/ac

D + f = 2,4-DES 4 + fenuron 0.5 lb/ac

D(6) = 2,4-DES 6 lb/ac

Treatment No.	Date of Spraying					
	April 1958	May 1958	August 1958	December 1958	February 1959	June 1959
1	Control					
2	-	-	-	C + f	-	-
3	D + f	-	D + f	-	C + f	D(6)
4	-	D + f	D + f	C + f	-	D(6)
5	C + f	-	D + f	C + f	C + f	D + f

The mixtures used in April and May of the rootstock year caused a slight growth check while in the second (maiden) year the chlorpropham mixture slightly delayed bud break. Under the drought conditions of 1959 no damage from 2,4-DES was seen. Bushes from treatment 5, which had the maximum total number of sprays showed slight signs of injury from fenuron (chlorotic margins to the leaves) but the bushes were only slightly smaller than those from the control plot when lifted. The combinations of treatments with a chlorpropham/fenuron mixture in winter and a 2,4-DES/fenuron mixture in summer gave a satisfactory degree of weed control throughout the trial. A second two year trial was started in 1960 on stocks of R. canina Pollmeriana planted in March and budded in August with Super Star, Virgo, Sir Winston Churchill and Souvenir de Jacques, Verschuren. The programme of treatments is given in Table II together with assessments of weeds on various occasions during the two years.

TABLE II TREATMENTS APPLIED TO ROSES IN 1960/61 TRIAL AND ASSESSMENTS OF WEEDS AT VARIOUS DATES

Key

S(1) = Simazine 1 lb/ac

S(2) = Simazine 2 lb/ac

D + f = 2,4-DES 4 + fenuron 0.5 lb/ac

C + f = Chlorpropham 2 + fenuron 0.5 lb/ac

Date of application				Estimated per cent weed cover			
16.5.60	21.9.60	19.1.61	8.6.61	28.6.60	4.11.60	13.4.61	1.9.61
S(1)	-	-	-	60	30	40	90
S(2)	-	-	-	30	0	0	8
-	-	-	S(1)	99	50	75	30
-	-	-	S(2)	90	50	85	10
S(1)	S(1)	-	-	90	1	1	40
S(2)	S(2)	-	-	35	0	0	5
S(1)	-	S(1)	-	90	40	1	15
S(2)	-	S(2)	-	40	0	0	0
S(1)	-	-	S(1)	95	30	70	10
S(2)	-	-	S(2)	70	40	85	3
-	S(1)	-	S(1)	95	3	3	5
-	S(2)	-	S(2)	95	1	3	0
-	-	S(1)	S(1)	90	45	12	3
-	-	S(2)	S(2)	80	60	10	1
S(1)	S(1)	S(1)	-	80	1	0	3
S(2)	S(2)	S(2)	-	35	0	0	0
-	S(1)	S(1)	S(1)	90	8	1	1
-	S(2)	S(2)	S(2)	80	1	0	0
S(1)	S(1)	S(1)	S(1)	40	1	0	1
S(2)	S(2)	S(2)	S(2)	20	0	0	0
D + f	D + f	C + f	D + f	45	10	3	10
S(1)	D + f	S(1)	D + f	15	3	1	1
S(2)	D + f	S(2)	D + f	6	0	1	1
S(1)	S(1)	C + f	D + f	8	1	0	10
S(2)	S(2)	C + f	D + f	8	0	0	1
D + f	S(1)	C + f	S(1)	70	1	0	1
D + f	S(2)	C + f	S(2)	30	0	0	1

TABLE II - (Contd.)

Date of application				Estimated per cent weed cover			
16.5.60	21.9.60	19.1.61	8.6.61	28.6.60	4.11.60	13.4.61	1.9.61
D + f	D + f	S(1)	S(1)	30	15	5	0
D + f	D + f	S(2)	S(2)	20	8	1	0
	Control	1.		90	75	80	95
	Control	2.		90	60	60	90

The spring of 1960 was very dry and the sprays applied in May did not give effective control of weeds. Sprays applied later in the year under wetter conditions were much more effective. The assessment of weeds in April 1961 shows that the control of weeds was proportional to the amount of herbicide applied during the previous year. Simazine at 1 or 2 lb/ac was more effective than the 2,4-DES/fenuron or chlorpropham/fenuron mixtures. Crop growth was normal on all simazine plots. Where treatments containing fenuron were used some effects on the foliage were noted in the spring of both years.

Effect of herbicides on bud union. It has been suggested that the percentage of successful unions or "take" of buds might be affected by spraying soon after budding. Results from the two year investigation completed in 1959, however, indicated that the union of buds was not affected by spraying with a mixture of 2,4-DES 4 and fenuron 0.5 lb/ac within a few days of budding. In 1959 (a dry year) a series of treatments with the same mixture were applied to four varieties at intervals of 2 - 30 days after budding on *R. laxa* seedling rootstocks. The percentage take was estimated in April 1960 and the estimates are given in Table III which shows that, under the conditions of this trial, the herbicide treatment had no effect on the take of buds.

TABLE III. EFFECT OF TREATMENT WITH A 2,4-DES/FENURON MIXTURE ON THE TAKE OF FOUR ROSE VARIETIES BUDDED ON *R. LAXA*

Variety	Date of Budding	Estimated per cent take: Number of days after budding that herbicide was applied				Per cent take of controls
		2-7	8-14	15-21	22-28	
Monique	24.6.59	78	86	82	74	72
Message	11.7.59	64	60	69		66
Burnaby	11.7.59	56	75	68		68
Buccaneer	10.7.59		79	80		75

In 1960 simazine at rates of 1 and 2 lb/ac was applied at intervals of 2-12 days after budding *R. canina Pollmeriana* rootstocks with the variety Wendy Cussons. There was heavy rainfall during this period but, again. this year the take was not affected.

DISCUSSION

Susceptibility of rootstocks. These investigations were limited to *R. canina* and *R. laxa* rootstocks, but there was no difference between the susceptibilities of trees grown on these two stocks. Both were slightly damaged by fenuron but not by simazine at the doses employed. The resistance to simazine is in accordance with the findings of Geigy Ltd., (Geigy 1959) which suggest that *R. canina* is more resistant than *R. laxa* which in turn is more resistant than *R. rugosa* and *R. multiflora*. The lower resistance of *R. rugosa* may be connected with the fact that it is shallower rooting than the others.

Susceptibility of varieties. The variety Ena Harkness was apparently especially susceptible to 2,4-DES damage. There have been reports from commercial usage of this chemical of slight damage on several other varieties, especially on reds. Gast (1960) reported marked variations in resistance to simazine of different varieties on the same rootstock but this effect was not observed in our investigations, presumably because rather lower doses were employed.

Efficiency of weed control. The two year spray programme with chlorpropham/fenuron and 2,4-DES/fenuron mixtures effected a reasonable but not complete control of weeds with the risk of slight damage by the fenuron and 2,4-DES components. Simazine gave virtually complete control of weeds by the second year when used at doses totalling 4-5 lb/ac over the two year period and those treatments caused no visible damage.

It was noted in several years that when large weeds had been disturbed by hoeing, their re-establishment was inhibited by spraying with a mixture of 2,4-DES + fenuron or with simazine. This effect was observed during wet summers when similarly disturbed weeds on control plots re-established readily.

Timing of sprays. There is no evidence that sprays of simazine are harmful to newly planted rootstocks but it is generally considered advisable to allow a short time for establishment before spraying. With early planted rootstocks good results are generally obtained by applying the spray a few weeks after planting. In the East Midlands, however, planting is frequently rather late, often being delayed until the onset of a spell of dry, spring weather. During such conditions simazine is less effective and it is better to postpone the application until rain falls, but when the first substantial rain does not fall until shortly before budding, spraying would be wasteful as the soil has to be moved just before budding.

In most seasons the weather after budding (July - September) is wet and conditions for the use of simazine are optimal. It is therefore suggested that the best time for applying simazine is after budding while the soil is still clean. An application of simazine 1.5 - 2 lb/ac at this stage will prevent the growth of most weed seedlings until the following spring. If this is followed by a similar spray in February or March after cleaning up, little further spraying is required until lifting unless the soil is disturbed by cultivation.

Growth of roses in an uncultivated soil. During the course of these investigations many plots kept virtually weed-free by the use of herbicides had little or no cultivation throughout the life of the crop. Under these conditions there was considerable capping of the soil surface, with bad cracking during dry weather and tendency for erosion to occur in the winter but the growth of the roses did not appear to be affected. Even in trials on Keuper marl, a soil with a poor structure which can inhibit the growth of most vegetable and other crops when badly managed, the loss of surface structure did not appear to affect the growth of rose trees.

REFERENCES

GAST, A. (1960) Proc 5th British Weed Control Conference, 433-437

GEIGY (1959) Simazine, woody plants. Information Bulletin of J.R.Geigy S.A., Basle. 20.5.59.

SMITH, A.W. and WALLIS, L.W. (1959) N.A.A.S. Quarterly Rev No 43 10 132-138.

Discussion on preceding eight papers

Mr. C. W. Robshaw I should like to make two comments on Mr. Wallis's paper. Firstly, in trials in coffee growing under shade in Costa Rica where the annual rainfall is in excess of 100 in. we have found that 2 lb/ac of paraquat ion gives good control of grasses and broad-leaved weeds, for a period of 3 months. Secondly, we have noted that rain following immediately after the application of paraquat to weeds in coffee, did not affect its action.

Mr. P. Bracey I should like to make the comment that diquat and paraquat will not control perennial dicotyledon weeds such as bindweed, nettle, docks, mallow etc.

Dr. S. H. Crowdy We do not claim that paraquat does more than burn the tops off deep rooted perennial weeds: regrowth will occur and its extent will depend on the particular weeds present and the conditions. Paraquat will control a number of perennial grasses.

Mr. W. T. Cowan In practice is there any real advantage in obtaining complete elimination of annual weeds throughout the season? Does it really matter if a few seedlings develop after harvest? In my own trials on raspberries, blackcurrants and gooseberries, where simazine and diuron were compared pound for pound of active ingredient, the plots were equally clean up to the time of picking. Undoubtedly simazine is more persistent than diuron and will prevent the growth of weeds like groundsel and speedwell for a longer period, but bearing in mind the 30 per cent differential in price (in favour of diuron) is this necessarily to the grower's advantage? A few weeds late in the season are not going to affect yields and after the compaction and treading from harvesting and other operations he probably wants to cultivate anyhow. Would the grower be just as well advised to accept some of these weeds and in any case, is a carpet of weeds always a bad thing?

Dr. D. W. Robinson We do not think that a carpet of weeds is always necessarily a bad thing but by the use of chemicals all weeds can be removed. After applying herbicides for a period of about three years there would be no more germination of weeds and there would, therefore, be no more need to apply any herbicides except, possibly for occasional spot treatment.

Mr. F. T. Roach Regarding the cover of annual weeds in blackcurrants before the crop is picked, we do know that bare ground loses very much less moisture than ground covered with weeds and it has been shown at East Malling that there is a large increase in fruit, size and weight just before picking. With bare ground it is therefore probable that more moisture is available to the crop.

Mr. W. T. Cowan May I point out that in most cases a cover of annual weeds appears after picking and these are less likely to affect the growth of the crop. Perennials, of course, are in a different category and in many fruit plantations they are very important. Although long-term trials on fruit can only be carried out satisfactorily at research stations, conditions at such places often become unavoidably different from those of practical growing and there is room for more trials on commercial holdings, especially on such factors as perennial weeds which are less commonly encountered at research stations.

SESSION 9

Chairman: Mr. F. W. Morris

NEW HERBICIDES AND TECHNIQUES

CROP PRODUCTION IN A WEED FREE ENVIRONMENT

A report on the Proceedings of the B.W.C.C. Symposium October 2nd 1962

E.K. Woodford

A.R.C. Weed Research Organization

The British Weed Control Council, apart from organising biennial conferences such as the one we are attending, arranges for symposia to be held from time to time to discuss special topics which cannot be dealt with in sufficient detail at the biennial conferences.

The 3rd symposium on 'Crop Production in a Weed Free Environment' was held in London on October 2nd. This was the most successful of the three. Approximately 200 people attended, and the Proceedings, which are to be published by Messrs. Blackwell Scientific Publications Ltd., should be of interest to a much wider audience.

To many of you it may seem strange that the B.W.C.C. should be organising a symposium which envisages a state of affairs when all weed control men would be out of a job and which is primarily concerned with agronomy, but as Professor Rademacher pointed out in his introductory paper, and as has been emphasised by several speakers since, herbicides cannot be thought of in isolation, and it is important that they should be integrated into crop production methods.

The symposium was organised to give weed control specialists a chance to tell agronomists, soil scientists, plant physiologists and agricultural engineers how far herbicides were available to produce a weed-free environment and to ask them in turn (i) how much they knew about the benefits of cultivations in the absence of weeds and (ii) how best to grow the harvest plants to obtain maximum yield in the absence of weeds.

The symposium was I think successful because:

1) It brought together the various interested parties

2) It stimulated quite a lot of thinking about the possibilties of new cropping methods and the concept of a weed-free environment.

3) The discussions brought home to many people the difficulties of trying to assess the effects of cultivations <u>per se</u> and how little we really

know about measuring the effects of cultivation on the crop in terms of the physical characteristics of the soil.

Cultivation is still very much an art, and the difficulties of trying to put this art on a scientific basis are immense.

Even so, several speakers at this symposium asked for a simple method of measuring the effects of cultivation on the soil. I could not help feeling that this was rather a forlorn hope and that the farmer and grower would have to rely on "know-how" for quite a long time to come.

As far as devising new methods of husbandry to take advantage of the freedom offered by a weed free environment, I was left with the impression that some progressive farmers were further ahead than many of the scientists. Mr. Peter Smith told us how a constant demand for cheap food was forcing him and many farmers and growers to move ahead of official research. He was growing 150 acres of blackcurrants in an area where he had been told it was impossible to grow the crop, and he had for 18 months kept his plantations weed free without any cultivations. The other farmer, Mr. J. C. Green, was working more closely with official research in devising novel and profitable methods of growing carrots. His weed-free bed system with close planted rows had enabled him to bulk-top, dig and handle the carrots with great economy. In his experiments with potatoes he was obtaining higher yields of best shaped tubers by planting 12" square and using herbicides to replace cultivation.

Organisation

The symposium was arranged so that each delegate received a preprint of a review paper entitled 'Crop situations where cultivations for weed control may be eliminated by use of herbicides'. Armed with this information he would then listen to papers by experts dealing with:

1) The effects of cultivation or its absence on

    a) the soil

    b) the plant

2) Requirements for crop spacing and management in a weed free environment.

It was hoped in this way to obtain a balanced picture of the whole problem and to progress from scientific facts to useful conjecture on the possibilities of new methods of crop husbandry and management.

In fact, the symposium did not turn out quite as expected, as many of the speakers confined themselves to their own specialised interests and there was a lack of balance in the overall picture presented. It would have helped if, in addition to the review on the situations where herbicides were replacing cultivations, we had had another review dealing with the work that had been done in the past to measure the effects of cultivation on crop growth where weeds have not been a complicating factor.

There were six papers dealing with the physical aspects of the soil:-

a) Oxygenation

b) Water Acceptance

c) Fertilizer Availability

d) Root Penetration

e) Compaction

f) Erosion

Time does not permit reference to these papers individually. Instead I will mention some of the practical problems on which the facts presented threw some light. But before doing so it is important to have clearly in our minds the different types of crop situations that have to be considered.

Obviously the potential importance of cultivations will be quite different for perennial and annual crops. The established perennial may not need cultivation at all, but an annual crop is only in the ground for a few months and we have to consider:

a) cultivations prior to planting and sowing

b) cultivations while the crop is growing

c) cultivations at and after harvest

Perennials Dr. Robinson in his review paper on horticultural crops referred to many fruit crops where non-cultivation is an established practice. There is nothing very new about perennial crops being able to live quite happily in the absence of cultivation. A forester would never think of cultivating an established forest. There does not seem to be much doubt that non-cultivation practices will increase as a system of management for fruit crops in this country.

Annuals As far as annual crops are concerned, there are several where herbicides can eliminate weeds during the time the crop is in the ground. Maize, cereals, peas, vegetables, etc., were listed in the review paper by Messrs. Elliott and Boyle. In several it has been accepted that there is no need for cultivation while the crop is in the ground, but for others such as maize and some vegetable crops some inter-row cultivation is still claimed to be necessary. Cultivations carried out before planting or sowing are mainly for the preparation of a seedbed and the incorporation of fertilizers and herbicides. Weed control is often an ancillory requirement and where water is in short supply herbicides may permit special techniques as have been developed by Professor Jones for maize in North America. Cultivations at and after harvesting are more generally associated with weed control and the burying of trash. We are familiar with the stubble cultivations recommended after cereal harvest and in a weed-free environment it would probably be necessary to revise some of the principles laid down by Professor Sanders in his textbook on British Crop Husbandry.

Turning to some of the practical points arising from the papers, on the physical effects of non-cultivation:

Capping - caps form on many soils because of the action of rain, irrigation and treading. Such caps are regarded as undesirable by most horticulturists and a very definite reason for cultivation. Most of the findings presented at the symposium, however, suggested that the importance of the cap has been overemphasised and that it is rarely detrimental, except at the time of seed emergence.

Winter told us that at Lüddington he had failed to measure any harmful effects from capping once lettuce seeds had established. Troughton and Robinson also stated that cap formation seemed to have little effect on the growth of plants. Hawkins had measured the movement of oxygen through artificially induced caps and had found that this was usually unimpaired. He had to puddle clay very vigorously before he could form a cap that decreased the movement of oxygen.

Obviously this is an important problem which needs much more research.

Erosion - the formation of a cap will, however, decrease water acceptance and increase the dangers from erosion. There seems little doubt that erosion will be one of the main problems of a weed-free environment, and that on sloping soils some form of mulch will be required.

Mulch - the difficulties with mulches are that they are expensive and may be a fire hazard. However, as Dr. Robinson pointed out, in a weed-free environment with no cultivation a single application of a straw mulch should last several years. A mulch also has the disadvantage that it increases the frost hazard.

Frost hazard - on the balance side, however, it has been shown that the smooth soil surface formed by non-cultivation increases heat acceptance and loss by soils, and therefore decreases the frost hazard.

Incorporation - Cooke dealt with the incorporation of fertilizers and told us that nitrogen was mobile enough not to require incorporation, but that on some soils deficient in potash and phosphate incorporation of these fertilizers might be required. It may also be necessary, of course, to incorporate certain herbicides, but again the advantage of a clean uncultivated soil surface is that herbicides penetrate it more easily and uniformly.

Compaction - as far as compaction was concerned, I was interested to learn that this could often be overcome by the application of nitrogenous fertilizers.

Biological effects

The effects of cultivation on weeds and the damage of cultivation implements to the above-ground parts of the plants was discussed. Everybody seemed to be agreed that root pruning was detrimental and there was no evidence that it stimulated growth of the roots deeper in the soil.

Buried Weed Seeds - The nearer we approach to a weed-free environment, the more important does the number of weed seeds in the soil become. Mr. Roberts told us that very few people had worked in this field, probably because of the difficulties of assessing the total number of weeds in soil samples. The results that had been obtained indicated that the total number in soils usually varied from 10-100 million per acre. In one soil at Wellesbourne he had obtained a count of 220 million per acre. The rate of disappearance of these weed seeds if the ground was kept weed-free, he had ascertained, would be approximately 50% per annum or a half life of one year. With the traditional seven-year cultivations, one would then expect a buried weed seed infestation to be reduced by 99%, but even so, if the soil had originally contained 50 million seeds per acre the 1% left would still amount to 100 seeds per square yard.

It has been found in practice that the amount of soil-applied herbicide required to keep the ground clean, decreases rapidly from year to year provided the soil is not disturbed. A single cultivation will however, undo much of the good that has been done and it is important that we understand the factors controlling the number of seeds viable in the soil.

Soil Aeration

Professor Williams presented a very stimulating and interesting paper on why plants die from the lack of oxygen. Unfortunately, he had to conclude that nobody knew why they died. The best hypothesis was that they died from pathogen attack, perhaps due to the fact that oxygen was required for the formation of cork and cuticle which normally protect the plant. He concluded:

"It remains only to assess the likelihood that damage due to the indirect effects of oxygen deficiency will arise in practice.

Waterlogging invariably results in a rapid and virtually complete exclusion of oxygen, and the consequent damage is likely to take the form of enhanced bacterial attack; but this is not the central problem of the symposium. Under normal conditions, difficulty is likely to be experienced only if, in the absence of cultivation, the soil compacts readily and forms surface crusts impermeable to air. Although soils forming such completely impermeable crusts are on record in the literature, it does not follow they are common, and it seems likely that in most soils the roots will obtain sufficient oxygen without the need for cultivation".

The main purpose of the symposium was to discuss the kind of changes that might take place in the methods of husbandry when there is no longer any need to consider the importance of weeds. The chief limitation imposed by the necessity to cultivate is that of arranging plants in lines so that weeding can be done mechanically. We have become so accustomed to this arrangement of plants in the field that we tend to forget that it is perhaps not the best arrangement for maximum crop production.

It was, therefore, very interesting to have Dr. Bleasdale remind us that when labour was cheap and plentiful in the 18th and 19th centuries, market gardeners grew their crops not in rows but in beds four to five feet wide, and then singled to a spacing distance most suitable for maximum crop growth. This system of management was changed when labour became scarce and more expensive and when Jethro Tull published his book on "New Horse Hoeing Husbandry". The wheel has now turned full circle and we are contemplating returning to those methods which were common practice in the 18th century.

The problem now is how to accomplish with machines and herbicides what our forefathers did with their hands and there is a growing need for a new book entitled "Hoeless Herbicide Husbandry"

Dr. Bleasdale has for many years been considering how best to grow carrots, peas and other vegetable crops in a weed-free environment. His pioneering work in this field has done a lot to stimulate growers. His paper dealt in detail with the results of his elegant spacing experiments which have broken new ground in design and analysis. It would seem logical that plants should be distributed at random and that the distance between them should be such as to ensure early ground cover and enough room to grow as required.

Mr. Green's results with carrots have shown how such principles can be put into practice. However, there are many practical problems awaiting attention, and the agricultural engineers will have to consider the requirements for new drills and new harvesting machinery. But as Dr. Bleasdale pointed out, the biologists are still not in a position to provide the engineers with all the facts they require. If singling is to be eliminated a lot more needs to be determined about seed viability and germination capacity.

At this Conference we have heard several references to the requirement for good husbandry. I have felt that often good husbandry is associated in the speakers' minds with the good old days of the past. What we require surely is not just good husbandry but the best husbandry, and for this purpose we shall have to make the most efficient use of herbicides.

SYMPOSIUM PROGRAMME

CROP PRODUCTION IN A WEED-FREE ENVIRONMENT

October 2nd, 1962

Symposium Chairman - Professor A. H. Bunting, The University of Reading

Morning Session

10.00 a.m. Chairman's Introduction

10.15 a.m. The problem of weed seeds in the soil
H. A. Roberts, National Vegetable Research Station

DISCUSSION

Cultivations in the absence of weeds

10.35 a.m. (i) Physical

Session Organizer - A.J.Low, Jealott's Hill Research Station

15-minute papers:

(a) Oxygenation - J.C.Hawkins, National Institute of Agricultural Engineering

(b) Water Acceptance - E.J.Winter, National Vegetable Research Station

(c) Fertilizer Availability - Dr. G.W.Cooke, Rothamsted Experimental Station

(d) Root Penetration - Dr. A. Troughton, Welsh Plant Breeding Station

(e) Compaction - Dr. J.Pringle and F. Hunter, King's College, Newcastle

(f) Erosion - A.J. Low

DISCUSSION

Afternoon Session The effects of cultivation in the absence of weeds

2.15 p.m. (ii) Biological

Professor W.T.Williams - The University of Southampton

3.00 p.m. Crop spacing and management under weed-free conditions
Dr. J.K.A. Bleasdale - National Vegetable Research Station

3.45 p.m. Summary of review paper:

'Crop situations where cultivations for weed control may be eliminated by use of herbicides'