dispersed by shaking, and counted at 50C for 30 min (or to a count of 100,000 if this was reached first.)

C^{14} standard solutions and scintillation blanks were used, and the counting efficiency (which was determined for each counting run) varied from 54 per cent to 57 per cent.

Although other workers have reported that dalapon is easily leached from plant tissue, the sample preparation procedure was checked to determine whether or not a disproportionate amount of dalapon-2-C^{14} remained in the solid portion. By successive extractions, it was determined that the dalapon-2-C^{14} was readily equilibrated in the system.

It was also considered possible that the added wetting agent might affect the absorption of dalapon by the lanolin used to wall the application areas. This was checked, and found not to be a factor.

RESULTS AND DISCUSSION

Applications of the dalapon and surfactant formulations were made to the third leaf of quackgrass plants in the 6-leaf stage. After 5 days, the various plant parts were examined by liquid scintillation counting. The results obtained with dalapon alone are shown in Table I.

TABLE I. THE NET COUNTS PER MINUTE OBTAINED FROM VARIOUS PARTS OF QUACKGRASS PLANTS TREATED WITH C^{14} LABELLED DALAPON IN WATER WITH NO ADDED WETTING AGENT.

(Background count = 28.3 cpm.)

Replicate	First leaf	Second Leaf	Third Leaf*	Fourth Leaf	Fifth Leaf	Sixth Leaf
1	26	37	8684	163	327	346
2	20	38	7872	216	355	337
3	25	37	7432	206	329	295
4	24	31	8425	189	273	332
5	27	40	6915	174	285	380
6	20	28	8439	225	286	256
average	23.7	35.2	7978	195	309	324
standard deviation	3.1	4.2	679	24	32	43
C.V. (per cent)	13.1	11.9	8.5	12.3	10.4	13.3

* Application made to third leaf

TABLE 1. (Contd.)

Replicate	Stem	Untreated shoot	Old rhizome section	New rhizome	Roots
1	36	409	20	82	24
2	26	470	17	76	18
3	30	456	21	60	22
4	33	439	26	69	27
5	29	552	24	67	19
6	33	472	16	70	23
average	32.2	466	20.7	70.7	22.2
standard deviation	3.3	48	3.9	7.6	3.3
C.V. (per cent)	10.2	10.3	18.9	10.8	14.9

The variation between replicates as shown in Table I is typical of that obtained with the other treatments. The results obtained using dalapon with two non-ionic wetting agents each in three different concentrations were compared with those shown for dalapon alone by calculating the per cent of applied dalapon-2-C^{14} which was found in each of the several plant parts.

A number of comparisons are possible in this manner, some obviously of more interest than others. Translocation into new rhizomes and through old rhizomes into untreated shoots is of considerable importance in obtaining control of quackgrass. The effectiveness of the wetting agents in influencing movement into these parts is shown in Table II.

TABLE II. THE PER CENT OF APPLIED RADIO-DALAPON WHICH WAS FOUND IN THE RHIZOMES, ROOTS, AND UNTREATED SHOOTS.

(Application made on third leaf of 6 leaf plants of quackgrass)

		New rhizome	Old rhizome	Untreated shoot	Roots
Dalapon alone		0.74	0.22	4.9	0.26
Dalapon with P-26-2.	0.05 per cent	1.35	0.53	7.3	0.28
	0.1 " "	1.92	0.67	8.4	0.17
	0.2 " "	2.94	0.81	10.5	0.24
Dalapon with Tergitol TMN	0.05 per cent	1.43	0.49	6.9	0.22
	0.1 " "	2.05	0.73	7.7	0.26
	0.2 " "	3.65	0.94	9.4	0.31

These experiments clearly showed that the addition of selected non-ionic wetting agents to the formulation resulted in increased movement of dalapon into the rhizomes, and that the results obtained with the two wetting agents were quite similar.

The accumulation of dalapon in young tissue was also markedly increased by the addition of non-ionic wetting agents, and such increases are shown in Table III.

TABLE III. THE PER CENT OF APPLIED C^{14} DALAPON WHICH WAS FOUND IN THE LEAVES ABOVE THE TREATED (THIRD) LEAF

		4th leaf	5th leaf	6th leaf
Dalapon alone		2.0	3.2	3.4
Dalapon plus P-26-2	0.05 per cent	2.4	3.9	11.7
	0.1 " "	3.9	5.6	16.5
	0.2 " "	6.3	8.2	24.4
Dalapon plus Tergitol TMN	0.05 per cent	2.2	2.6	9.2
	0.1 " "	6.0	6.6.	16.1
	0.2 " "	10.8	11.9	26.2

Here, as shown before, the use of the wetting agents resulted in increased accumulation of dalapon-2-C^{14}.

The comparisons for lower leaves, stems and roots were also made, and in each instance the addition of wetting agent increased the amount of radio-activity. The differences were quite large in some cases, probably because the amount of radioactivity found in these plant parts was quite low when no wetting agent was used. In every instance, the amount of radioactivity which remained in the treated leaf was less when wetting agents were added than when dalapon alone was used.

These data show clearly that the addition of a non-ionic wetting agent to the formulation used in this experiment markedly increased the uptake and translocation of dalapon-2-C^{14}.

The amount of dalapon-2-C^{14} translocated above and below the treated leaf was determined by computing the net count per minute for the appropriate plant parts (sample average net count per minute times the dilution factor used in preparing the sample) then comparing the count beyond the treated leaf with the total count. The per cent of applied dalapon translocated above the treated leaf and the per cent translocated below the treated leaf are shown in Table IV.

TABLE IV. THE TRANSLOCATION OF C^{14} LABELLED DALAPON IN FORMULATIONS WITH AND WITHOUT ADDED WETTING AGENTS.

	Dalapon alone	Dalapon with P-26-2			Dalapon with Tergitol TMN		
		0.05 per cent	0.1 per cent	0.2 per cent	0.05 per cent	0.1 per cent	0.2 per cent
The per cent of applied dalapon translocated above the treated leaf.	8.7	17.4	26.1	38.5	14.0	27.5	49.7
The per cent of applied dalapon translocated below the treated leaf	7.1	13.4	19.0	28.9	10.4	18.0	29.2

These data show several things in addition to the obvious influence of added wetting agent. First, although both non-ionic wetting agents performed similarly; when formulations containing the low rate of wetting agent were used, the use of Poyglycol 26-2 resulted in greater accumulation of C^{14} dalapon in the various plant parts than did the use of Tergitol TMN. The reverse was true at the high rate. It would probably be difficult to establish the significance of this on the basis of these data alone, but the same trend existed in several preliminary tests using a number of different concentrations of both wetting agents. Surface tension measurements showed that at 0.2 per cent in the formulation, Tergitol TMN reduced surface tension more than did Polyglycol 26-2, while at concentrations of 0.05 per cent and less, the reverse was true.

This may indicate that penetration (as affected by surface tension) is a major factor influencing the results obtained.

A study of the amount of dalapon translocated into the new rhizomes shows that although the amounts accumulated increased with added wetting agent, there was a slight decrease in the percentage of translocated dalapon which moved to the rhizomes. This also would tend to support the hypothesis that the surface active agent influenced penetration more than translocation, and that whatever conditions limit the transport of dalapon-2-C^{14} into the rhizome still appeared to be limiting when wetting agents are used in the formulation.

Second, significant amounts of dalapon-2-C^{14} were translocated through the rhizome to untreated shoots. Not all shoots can be equally well covered by a field spray, and a number of quackgrass shoots are normally connected by rhizomes. The transport of dalapon from one shoot to another through the rhizome section may tend to equalize a less than perfect spray application. In these experiments, as little as 0.05 per cent of a non-ionic wetting agent in the formulation increased the movement of dalapon-2-C^{14} into an untreated shoot by nearly 50 per cent, while 0.2 per cent in the formulation increased movement into an untreated shoot by nearly 100 per cent.

Movement into new rhizomes followed the same pattern, with the addition of 0.05 per cent wetting agent resulting in more than 80 per cent increase in accumulation of C^{14}-dalapon while the addition of 0.2 wetting agent resulted in at least four times the accumulation of radioactivity obtained with formulations containing no wetting agent.

Movement of dalapon-2-C^{14} into the leaves was increased more by the addition of wetting agents than movement into and through the rhizomes, but it is felt that these movements (into rhizomes and through rhizomes to untreated shoots) are critical in evaluating the herbicidal effectiveness of dalapon on quackgrass.

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DALAPON FOR THE CONTROL OF "COUCH" (AGROPYRON REPENS, AGROSTIS GIGANTEA AND AGROSTIS STOLONIFERA)

(A Summary of Some N.A.A.S. Trials 1957-1959)

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Summary. Seventeen trials, in which treatment of couch or bent (Agropyron repens, Agrostis Gigantia and A. stolonifera) with dalapon, at doses falling within the range of 4-20 lb per acre, applied in all on 26 occasions, were carried out on farms by the N.A.A.S. in 1957-1959. Difficulty was encountered in making satisfactory assessments of the degree of control of grasses produced by chemical treatment. Results showed dalapon to be unreliable in its effects under the practical farm conditions encountered in the trials. The trials are not capable of indicating the reasons for the variable results. A little evidence on split applications of dalapon, pre-spraying treatment with nitrogen, and rolling pre- or post-spraying suggests that none of these techniques materially assists in the control of couch or bent with dalapon.

INTRODUCTION

This report summarises various trials carried out on farms by members of the N.A.A.S. to investigate the efficiency of dalapon, at a range of doses and under varying conditions, in controlling couch and bent grasses (Agropyron repens, Agrostis stolonifera and Agrostis gigantea).

METHODS AND MATERIALS

The trials, carried out from 1957 to 1959 were not standardised in treatments, layout or assessment. A sodium salt of dalapon containing 74 per cent a.e. and a wetting agent* was used in all trials. Two, three or four doses, between 4 and 20 lb of dalapon/ac, were included in each trial. Times of spraying ranged throughout the year and there was one or more dates of spraying in each trial. In addition, there were trials in which a single application of dalapon was compared with a split application of the same dose and trials to investigate the effect of treatment of "couch", by rolling or top dressing with nitrogen, on the degree of control achieved.

The layouts of the trials were, in each case, randomised blocks with usually three replicates. Plot size varied from 1/200 ac to 1/20 ac. Sites were usually selected where the infestation of couch or bent was heavy.

*The commercial product "Dowpon"

The varied type and timing of cultivations following spraying and the different cropping systems made standardised assessments for the trials impossible. One or more of four methods of assessment were carried out at convenient times following spraying. The methods were:

I. Score for the amount of foliage present on the scale 0-10 where 0 = no foliage present and 10 = maximum amount of foliage.

II. Counts of shoots per unit area.

III. Estimate of the percentage of ground area covered by "couch" foliage.

IV. Fresh weight of samples of rhizomes plus foliage.

Wherever possible assessments were continued into the second year. Details of each site are shown in Table I.

RESULTS

In order to be able to present a mass detail in tabular form the results of all assessments have been transformed to the scale 0 - 100 with control plots as 100 in every case; the amount of grass in the control plots at the time of assessment is indicated where recorded (See Table I).

The three points that are immediately apparent in the results in Table I are (i) the higher the dose generally the better the control of the grasses (ii) the failure of treatment with dalapon in the majority of cases to eliminate, or reduce to less than 1/10 the amount on untreated areas, any species of "couch". Good results have generally been apparent only when the plots have been observed within a few months of spraying (iii) the variability of results from site to site (Figure 1 illustrates this). The three spray treatments that gave particularly poor control (Figure 1(a) "couch" at 60-70 compared with control at 100) were Cornwall (sprayed 3/1/58) Derby (sprayed 1/11/57) and Montgomery (sprayed 10/10/58). *Agrostis sp.* at Cornwall was regrowth after ploughing which was "not considerable" and results may be poor for this reason. At Montgomery rain fell four hours after spraying (the second spraying at Montgomery was followed by at least eight hours dry weather and gave a better but still poor control of couch) and the rainfall may have contributed to the poor control of *Agrostis stononifera*. The Derbyshire site on *Agrostis sp.* was sprayed fairly late in the autumn but whilst the couch was still green (the spraying carried out a month earlier gave somewhat better control of bent) and ploughing was not carried out until four months later.

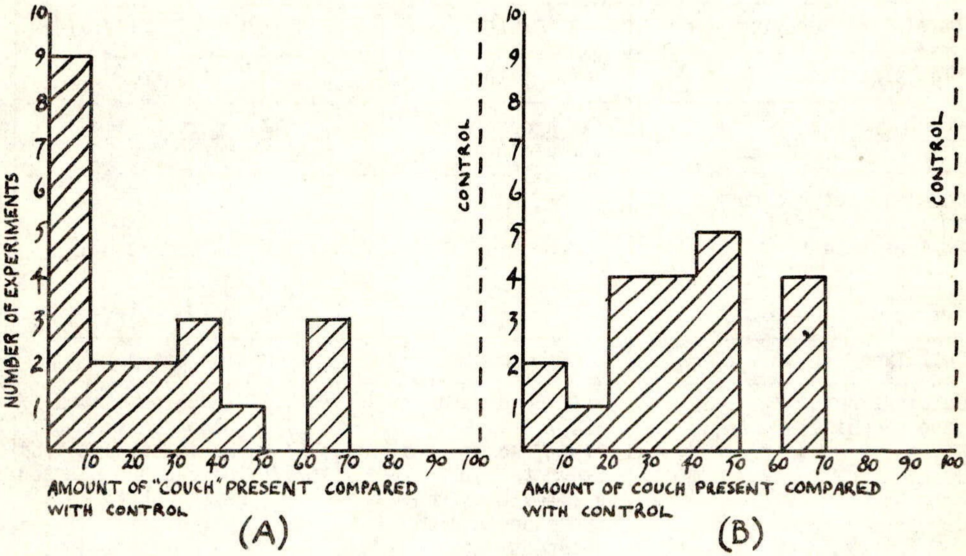

Fig. 1. The best (a) and poorest (b) control of couch recorded (at any time and by any method) from the same 20 treatments of not less than 13½ lb dalapon/ac.

TABLE I. DETAILS OF SITES AND SUMMARY OF CONTROL OF "COUCH" AND BENT

(Results of all assessments transformed to scale 0-100 with control plots as 100)

Site	1. Devon (I)		2. Flint			
Date(s) of Spraying	4/6/57		18/9/57		16/10/57	
Plot size (ac)	1/100		1/100			
Couch species	<u>Agrostis gigantea</u>		<u>Agropyron repens</u>			
Condition of "Couch"[x]	B		A		A	
Foliage height	4-6 in.		6 in.		7-8 in.	
Density	-		17 shoots/ sq ft		-	
Soil Type	culm shale		medium heavy loam			
Cultivations and cropping	-/12/56 plough 6/857 " -/9/57 worked and sown to kale spring/58 worked and planted with potatoes		-/11/57 twice rotovated -/1/58 ploughed -/4/58 heavy cultivations 16/4/58 ridged and planted with potatoes			
Dates of assessments	20.7.57	20.3.58	27.7.58		14.6.59	
Months after treatments	1½	9½	10	9	21	20
Type of assessment*	IV	IV	II	II	III	III
4-5 dalapon/ac	66	95	44	73	95	78
6 lb " "	64	53	38	51	86	63
9-10 lb" "	39	29	44	51	26	60
13½ - 15 lb dalapon/ac	33	8	0	22	44	29
20 lb " "	-	-	-	-	-	-
Infestation in control plots at time of assessment	1.2 lb rhizomes / sq ft	0.45 lb rhizomes /sq ft	30 shoots/ sq ft		45 per cent ground cover	

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizome.

[x] A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

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TABLE I (continued)

Site	3. Berks (I)		
Date(s) of spraying	19/9/57	6/11/57	6/3/58
Plot size (ac)	1/100		
"Couch" species	A.repens 75 per cent Agrostis spp. 25 "	60 per cent 40 " "	55 per cent 45 " "
Condition of "Couch"[x]	A	B	B
Foliage height	6-9 in.	4-5 in.	5-6 in.
Density	45 per cent ground cover	20 per cent ground cover	30 per cent ground cover
Soil type	gravel loam		
Cultivations and cropping	4/10/57 plough -/4/58 Seedbed prepared 12/4/58 Barley sown	8/9/57 plough	

Dates of assessments	26.3.58		16.10.58		
Months after treatments	6	5	13	12	7
Type of assessment*	II	II	IV	IV	IV
4-5 lb dalapon/ac	11	0	57	37	18
6 lb " "	-	-	-	-	-
9-10 lb dalapon/ac	9	0	32	48	9
13½-15 lb " "	-	-	-	-	-
20 lb " "	2	0	25	33	-
Infestation in control plots at time of assessment	28 shoots/ sq ft		0.95 lb rhizomes/ sq ft		

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizome

[x]A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

TABLE I (continued)

Site	4. W. Sussex					5. Cornwall			
Date(s) of spraying	20/9/57		13/2/58			1/10/57		30/1/58	
Plot size (ac)	1/20					1/25			
"Couch" species	A. repens 25 per cent Agrostis spp. 75 per cent		50 per cent 50 per cent			Agrostis spp.			
Condition of "Couch"[x]	A		B			A		B	
Foliage height	4-14 in.		3 in.			-		-	
Density	20-75 per cent ground cover		10-15 per cent ground cover			thick		regrowth not considerable	
Soil Type	sandy loam					light loam			
Cultivations and cropping	10/10/57 plough -/3/58 seedbed prepared 4/4/58 barley sown					-/10/57 ploughed		20/9/57 ploughed	
						7/4/58 worked and sown to barley			
Dates of assessments	4.4.58	16.9.58				12.11.58			
Months after treatments	6½	12		7		13		9½	
Type of assessment*	II	I	IV	I	IV	II	IV	II	IV
4-5 lb dalapon/ac	7	60	41	76	75	47	28	81	62
6 lb " "	-	-	-	-	-	-	-	-	-
9-10 lb " "	2	58	16	47	28	39	13	63	56
13½-15 lb "	-	-	-	-	-	-	-	-	-
20 lb "	1	46	24	20	10	48	36	70	62
Infestation in control plots at time of assessment	24 shoot/ sq ft	-	0.61b rhiz/ sq ft	-	0.61b rhiz/ sq ft	12 sh. sq ft	0.131b rhiz/ sq ft	62 sh. sq ft	0.131b rhiz/ sq ft

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizome

x A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

TABLE I (continued)

Site	6. Derby		7. Bucks		8. Northampton	
Date(s) spraying	14/10/57	30/1/58	15/10/57		21/10/57	12/11/57
Plot size (ac)	1/40		1/20		1/20	
Couch species	*Agrostis* spp.		*A. repens* 40 per cent *A. gigantea* 60 per cent		*Agrostis* spp.	
Condition of "Couch"[x]	A	A	A		A	A
Foliage height	-	-	4-7 in.		-	-
Density	-	-	60 per cent ground cover		-	-
Soil Type	sandy loam		gravel loam		medium loam	
Cultivations and cropping	-/3/58 plough		28/11/57 plough -/1/58 rotovate and harrow 25/2/58 sown to oats		ploughed and sown to oats in 1958	
Date of assessment	5/5/59		22.5.58	16.9.58	9.10.58	
Months after assessment	6½	6	7	11	12	11
Type of assessment*	I	I	III	III	I	I
4-5 lb dalapon/ac	60	60	40	72	40	30
6 lb " "	-	-	-	-	-	-
9-10 lb " "	40	95	20	29	30	20
13½-15 lb " "	50	70	-	-	40	20
20 lb " "	-	-	-	-	-	-
Infestation in control plots at time of treatments	-		75 per cent ground cover	73 per cent ground cover	65 per cent ground cover	

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizomes

[x] A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

TABLE I (continued)

Site	9. Staffs	10. Denbigh		11. Kent
Date(s) Spraying	23/10/57	5/4/58		29/4/58
Plot size (ac)	1/50	1/100		1/30
"Couch" species	<u>Agropyron repens</u>	<u>A.repens</u> 60 per cent <u>A.stolonifera</u> 40 per cent		<u>A.gigantea</u> <u>A.stononifera</u>
Condition of "Couch"[x] Foliage height Density	B 4-6 in.	B 5-6 in. 20 shoots per sq ft		B 1-5 in. 34 per cent ground cover
Soil type	sandy loam	medium/heavy loam		clay with flint
Cultivations and cropping	-/9/57 plough -/4/48 sown to ley	Barley 1957-stubble rotovated -/1/58 plough followed by further rotovation 16-20/8/58 plough and sown to rape 28/3/59 rotovated twice before plough & sowing to barley		30/5/58 plough 11/6/58 disc twice sown to kale
Date of assessment	Spring 1958	28.7.58	9.6.59	-.11.58
Months after assessment Type of assessment*	c.5 IV	3½ II	14 II	7 III
4-5 lb dalapon/ac 6 lb " " 9-10 lb " " 13½-15 lb " " 20 lb " "	41 - 32 30 -	7 - 3 0 -	22 - 0 7 -	20 - 12 - -
Infestation in control plots at time of treatments	0.06 lb rhizomes/ sq ft	16 shoots/ sq ft	4.5 shoots/ sq ft	83 per cent ground cover

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizomes

x A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

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TABLE I (continued)

Site	12. Lincs	13. Berks		14. Devon (II)						
Date(s) of spraying	5/5/58	14/5/58		8/6/58						
Plot size (ac)	1/50	1/200		1/200						
"Couch" species	A. repens 30 per cent Agrostis spp. 70 per cent	A. stononifera		A. repens 70 per cent Agrostis spp. 30 per cent						
Condition of "Couch"[x]	B	growing in peas		B						
Foliage height	-	-		5-6 in.						
Density	67 per cent ground cover	40 per cent ground cover		80 per cent ground cover						
Soil type	heavy boulder clay	chalk		-						
Cultivations and cropping	-/12/57 plough then untouched until assessment 25/8/58	-/11/57 plough -/4/57 cultivated & sown to peas		no crop 1958 20/9/58 plough						
Date of assessment	25.8.58	12.8.58	3.10.58	5.9.58				17.12.58		
Months after assessment	3½	3	4½	3				6		
Type of assessment*	III	I	I	I	II	III	IV	I	II	III
4-5 lb dalapon/ac	25	8	20	68	57	31	43	36	44	36
6 lb " "	-	7	12	-	-	-	-	-	-	-
9-10 lb " "	12	-	-	38	31	37	39	39	40	44
13½-15 lb " "	-	-	-	10	20	11	30	14	19	33
20 lb " "	0	-	-	-	-	-	-	-	-	-
Infestation in control plots at time of treatments	80 per cent ground cover	85 per cent ground cover		285 shoots/sq ft 87 per cent ground cover 2.5 lb rhiz/sq ft				10 shoots/sq ft 23 per cent ground cover		

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizomes

x A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

TABLE I (continued)

Site	15. Berks (III)									
Date(s) of spraying	23/6/58					14/8/58				
Plot size (ac)	1/30									
"Couch" species	*A. repens* 70 per cent *Agrostis* spp. 30 per cent									
Condition of "Couch"[x]	in clover ley					in clover ley				
Foliage height	4-6 in.					8-12 in.				
Density	-					-				
Soil type	sandy loam									
Cultivations and cropping	23/1/59 ploughed 24/3/59 worked and sown to barley									
Date of assessment	21.1.59		24.3.59		2.10.59		22.10.59			
Months after assessment	7	5	9	7	14½	12½	15		13	
Type of assessment*	I	I	III	III	I	I	III	IV	III	IV
4-5 lb dalapon/ac	29	11	9	25	66	66	65	52	46	58
6 lb " "	-	-	-	-	-	-	-	-	-	-
9-10 lb " "	26	9	10	7	60	53	42	55	35	61
13½-15 lb " "	-	-	-	-	-	-	-	-	-	-
20 lb " "	-	-	-	-	-	-	-	-	-	-
Infestation in control plots at time of treatments	-		85 per cent ground cover		-		26 per cent gr. cover	0.9lb rhiz/sq ft	26 per cent gr. cover	0.9lb rhiz/sq ft

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizomes

[x]A = in cereal stubble, B = as regrowth following some cultivation cultivation treatment, generally ploughing

TABLE I (continued)

Site	16. Lincs (11)		17. Montgomery	
Date(s) of spraying	2/10/58		10/10/58	10/11/58
Plot size (ac)	1/50		1/100	
"Couch" species	A. repens dominant some Agrostis sp.		Agrostis stolonifera	
Condition of "Couch"[x]	A		A	A
Foliage height	10-12 in.		5 in.	5 in.
Density	40- 70 per cent ground cover		100 per cent ground cover	100 per cent ground cover
Soil type	clay		-	
Cultivations and cropping	-/12/58 Plough -/3/59 worked & sown to barley -/10/59 Plough		13/12/58 Plough -/4/59 harrow four times 20/4/59 sown to oats	
Date of assessment	15.4.59	16.12.59	2.6.59	
Months after assessment	7½	14½	8	7
Type of assessment*	I	I	II	II
4-5 lb dalapon/ac	17	40	60	67
6 lb " "	-	-	-	-
9-10 " "	8	28	47	42
13½-15 lb " "	-	-	-	-
20 lb " "	5	45	65	30
Infestation in control plots at time of treatments	-	-	13 shoots/sq ft	

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage
IV = fresh weight of shoots and rhizomes

x A = in cereal stubble, B = as regrowth following some cultivation treatment, generally ploughing

The value of a split application of dalapon was investigated in three trials but little advantage was shown by such an application compared to the same dose applied at a single time (see Table II).

TABLE II. A COMPARISON OF SINGLE V. SPLIT APPLICATION OF DALAPON

(Results of all assessments transformed to scale 0-100)

Site	Bucks		Lincs (II)		Montgomery	
Dose (lb/ac).	9 or 4½ + 4½		10 or 7 + 3		10 or 7 + 3	
Interval between split appl. (days)	9		14		7	7
Date of assessment	22.5.58	16.9.58	15.4.59	16.12.59	2.6.59	2.6.59
Months after treatment	7	11	7½	14½	8	7
Type of assessment*	III	III	I	I	II	II
Single application	40	29	8	28	47	42
Split application	20	25	5	42	49	40
Control.	100	100	100	100	100	100

* I = score for abundance of foliage
II = shoot counts
III = ground cover of foliage

The application of nitrogen to "couch" to encourage more vigorous growth in the hope that this may lead to better effect from a subsequent application of dalapon was investigated by Mr. R. G. Hughes S.E. region N.A.A.S. After a hay cut, a top dressing of nitrogen was applied and spraying carried out three weeks later. The unmanured plots had "couch" 4-6 in. high at the time of spraying whereas the nitrogen treated "couch" was 6-12 in. high. Results suggest that the nitrogen top-dressing may have improved the control slightly (see Table III).

TABLE III. The EFFECT OF NITROGEN ON THE CONTROL OF "COUCH" WITH DALAPON (BERKS III)

(Results of all assessments transformed to scale 0-100)

Date of assessment	21.1.59	24.3.59	22.10.59	
Months after spraying	7	9	15	
Type of assessment*	I	III	III	IV
5 lb dalapon/acre	29	9	65	52
" " " " + N	32	5	46	39
10 lb " "	26	10	42	55
" " " + N	22	6	35	39
Control	100	100	100	100

* I = score for abundance of foliage
III = ground cover of foliage
IV = Fresh weight of rhizomes and shoots

The effect of rolling was also investigated by Mr. Hughes. Plots on a cereal stubble were sprayed with 4½ and 9 lb dalapon/ac and rolled 9 days later on 24th October 1958. On the same day further plots were sprayed with 4 lb dalapon and rolled immediately before or after spraying. The rolling did not bruise the "couch" leaves to any extent but bent them over, exposing them more. Results, which are summarised in Table IV, provide no clear evidence but suggest that rolling may have improved the control of "couch" particularly with the lower doses of dalapon.

TABLE IV. THE EFFECT OF ROLLING ON THE EFFICIENCY OF DALAPON (BUCKS)

(Results of all assessments transformed to scale 0-100)

Date of assessment		22.5.58	16.9.58	
Months after treatment		7	11	
Type of assessment*		III	III	I
4½ lb dalapon	sprayed 15.10.58	40	41	52
4½ lb " + roll 9 days later		26	34	46
9 lb "		19	12	18
9 lb " + roll 9 days later		10	17	31
4½ lb "	sprayed 24.10.58	26	31	46
4½ lb " + roll before spraying		16	29	36
4½ lb " + roll after spraying		16	26	41
Control - rolled		92	81	108
Control - unrolled		100	100	100

* I = Score for abundance of foliage
III = Ground cover of foliage

DISCUSSION

Satisfactory assessment of results proved difficult for several reasons. An effect of dalapon is to induce dormancy which may delay recovery of surviving rhizomes and too early an assessment may unduly favour dalapon; after recovery, differences in infestation between plots will begin to even out and too late an assessment may prejudice results against the chemical treatment. Infestations are always in a state of flux under the influence of seasons, weather, cultivations, competition from crops etc. and a difference in a few weeks in assessment may have a marked effect on results obtained. Different methods of assessment have given different results: this may be seen in Table I for the Devon (II) and Berks (III) experiments where different methods of assessment were carried out simultaneously.

Some of the variability in results can be attributed to these factors. A further factor may be that reinfestation is more probable, through the dragging of rhizomes by implements etc., on the smaller plots than on the larger plots used in the trials; this may have affected in particular some of the long-term results. Some possible factors contributing to the particularly bad results with three spray treatments (at Cornwall, Derby and Montgomery) are noted under "Results".

Ripper (1958) has stressed the value of ploughing in assisting the effect of dalapon. Control does not in general appear to have been substantially the poorer after treatment where ploughing was not carried out within two months of spraying, although often in such cases the spraying was in the spring with seed-bed cultivations following within a few months.

The trials do not indicate that any particular type of cultivation, crop, weather condition, etc. following spraying had any marked influence on results.

There is nothing in the few trials where stubble spraying was compared to spraying regrowth after ploughing, to suggest that there is particular advantage in either system and the results do not show whether there is any advantage in spraying in the spring or in the autumn. The natural fluctuation in the relative density of Agropyron repens and Agrostis spp. where they occur together (see for example Berks (I) and West Sussex sites, Table I) makes comparison of results, to obtain information on the relative susceptibility of species to dalapon, unreliable.

Thus the trials carried out under practical field conditions have shown dalapon, at doses in the range of 4-20 lb/ac, to be unreliable as a means of giving a persistant control, in the order of 80 - 100 per cent of couch or bent, but they have not been capable of satisfactorily indicating reasons for the inconsistent results. Split applications of dalapon, the use of a nitrogen top-dressing some weeks before spraying, and rolling of the "couch" about the time of spraying have not materially assisted in the control of "couch" with dalapon.

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THE RESPONSE OF AGROPYRON REPENS TO AMINO TRIAZOLE

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Summary. In a series of pot experiments on Agropyron repens the 'activation' of amino triazole by NH_4SCN (ammonium thiocyanate) was verified. Some evidence indicated that the effect of NH_4SCN was not on penetration of amino triazole. A high degree of control was obtained with very low doses of amino triazole + NH_4SCN, but A. repens established from rhizomes from a second site was less susceptible. In field experiments this herbicide was not so effective as in the pot experiments.

INTRODUCTION

The herbicidal properties of 3-amino-1,2,4-triazole were first indicated about 8 years ago (Behrens, 1953). There were many early reports of effectiveness for the control of Agropyron repens, but results were variable. In 1958 combinations of amino triazole and ammonium thiocynate (NH_4SCN) were found to give an enhanced effect on Agropyron in the U.S.A. (Anonymous, 1959). We have therefore investigated the effect of amino triazole both with and without NH_4SCN on Agropyron repens in pots (K.H.) and in the field (R.J.C.) during the past two years.

METHODS AND MATERIALS

For the pot experiments rhizomes were dug up from the field, cut into four-node sections and planted in moist sand. When shoots started to emerge, the rhizomes were washed out of the sand, selected and graded for evenness of sprouting, and five sections transplanted into a soil-sand mixture in a ten-inch earthenware pot. After growing-on in the open or the greenhouse to the appropriate stage of shoot-growth, they were sprayed by a specially constructed laboratory machine embodying a fan nozzle moving over the plants at a constant speed. Volume rates between 46 and 67 gal/ac were used. and the spray solutions contained 1.0 per cent v/v of a polyoxyethylene sorbitan monolaurate surface-active agent (Tween 20). Residues of herbicide on the foliage were washed off by simulated rainfall approximately 24 hr after spraying. All experiments included some treatments with dalapon as a standard grass killer. Technical grades of amino triazole and dalapon were used.

In the field experiments 0.005 acre plots were sprayed by Oxford Precision Sprayer at 20 gal/ac, using technical amino triazole and two commercial materials.+ No further surface-active agent was added. Assessment was by counting of shoots in random quadrats.

RESULTS

In the first pot experiment the plants were sprayed when the shoots were mostly at the three-leaf stage and about 6 in. high in late December 1958. The plants were kept for the rest of the winter in the greenhouse with no

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+ "Dowpon" and "Weedazol-T.L."

supplementary lighting, and moved into the open in April. In this instance amino triazole alone was compared with an already formulated mixture containing equal amount of amino triazole and NH_4SCN.* Some activation of amino triazole with pentachlorophenol had likewise been claimed (Constable, 1957) and a formulation containing an equal amount of sodium pentachlorophenate (PCP-sodium)** was also used. To investigate whether other contact herbicides gave the same effect, mixtures of amino triazole with equal amounts of pentachlorophenol as an emulsion, with one-quarter the amount of dinoseb-triethanolamine, and with one-eigth the amount of diquat, were also included. Doses are indicated in Table I.

TABLE I. PERCENTAGE OF ORIGINAL RHIZOME SECTIONS PREVENTED FROM PRODUCING VIABLE NEW SHOOT OR RHIZOME GROWTH DURING 247 DAYS FOLLOWING SPRAYING.

Dose of amino triazole lb/ac	Amino triazole	Amino triazole + NH_4SCN	Amino triazole + PCP-sodium	Amino triazole + PCP	Amino triazole + dinoseb-triethanolamine	Amino triazole + diquat	Dalapon-sodium
1	87	93	10	40	67	73	-
2	100	100	54	80	100	66	-
4	100	100	67	87	100	60	0
8	93	100	93	100	100	100	0

Initial effect on the foliage was relatively slight, both from amino triazole and dalapon, except where diquat or high doses of the other contact herbicides were included. Ultimately there was some growth of new green shoots in dalapon pots, and of albino shoots in most amino triazole pots. There was a slight superiority of amino triazole with NH_4SCN over amino triazole alone in killing the original shoots and reducing albino regrowth. At 136 days after spraying the rhizomes were removed for examination. Very few of the original rhizome sections were visibly dead but whereas there was vigorous growth of new rhizomes in the controls (20 g dry weight per pot) there was no new rhizome growth in any pot that had received an amino triazole treatment (except for a trace with the 1 lb/ac rate with PCP-dodium). Prevention of new rhizome growth was not quite so complete with dalapon, reduction in dry weight of new rhizome being 97 and 99 per cent at 4 and 8 lb/ac respectively. Original rhizome sections not producing new rhizome were replanted and re-examined 247 days after spraying. The proportion of the original rhizome sections which were then still inhibited from producing any new shoot or rhizome growth are given in Table I. Such rhizomes looked incapable of ultimate survival. The outstanding features shown by the data are the ultimate effectiveness of amino triazole with or without NH_4SCN, the dose range not going low enough to differentiate between these two series, and the reduced efficiency of amino triazole when a contact herbicide was present in the spray solution.

In the second pot experiment the shoots had three to four leaves when sprayed in mid-November 1959. The plants were kept in the greenhouse, with

* Amchem M 616
** Amchem M 617

supplementary fluorescent lighting to lengthen the photoperiod during midwinter, and moved into the open in April. Lower doses of amino triazole were used to show up any effect from the addition of NH_4SCN. An attempt was also made to determine whether the action of NH_4SCN was due to its effect on the penetration of amino triazole. Three sets of plants were sprayed with amino triazole and NH_4SCN. One set received both in the same spray solution. The second set was first sprayed with NH_4SCN, this was washed off the foliage on the following day, and then, one day later, sprayed with amino triazole. In the third set the amino triazole was applied first, washed off after one day, and sprayed with NH_4SCN on the second day. All the amino triazole applications were made on the same day. The plants sprayed with NH_4SCN first, showed no visible effect when they came to be sprayed with amino triazole. Indeed, the only effect shown at any time by the NH_4SCN controls was the development of a few small necrotic spots several days later.

The kill of shoots present at the time of spraying was greater than in the previous experiment with both dalapon and amino triazole. This effect was still greater if the plants received NH_4SCN at any time, than if they were treated only with the amino triazole. This enhanced toxicity caused by the NH_4SCN was still apparent 12 weeks after spraying. In all instances albino shoots were produced at low but not at high doses. After 223 days the rhizomes were washed free from soil, examined and the dry weight of new rhizome growth determined. At this time there was an average of 99 g of new rhizome per control pot. The percentage reductions in weight are given in Fig. 1. All amino triazole treatments were superior to dalapon, even doses as low as 0.25 lb/ac having a marked suppressive effect. The data verify the activation of amino triazole by NH_4SCN and this activation occurs, though to a somewhat lesser extent, if the NH_4SCN and amino triazole are applied separately and are never present together on the surface of the foliage.

Original rhizome sections which had not produced any new growth at this time were replanted and examined again 275 days after spraying. The proportion of sections which had not produced any new viable shoot or rhizome growth during this time are shown in Fig. 2. No sections treated with dalapon had died and all had shown regrowth by this time. The results with amino triazole were still good and if the results shown in Fig. 2 and Table I are compared it will be seen that the same doses in the two experiments produced remarkably similar results. Fig. 2. indicates that the addition of NH_4SCN to the amino triazole solution increased the effectiveness by about four times, if the two components were applied separately the increase was about twice. The fact that one obtains any increase at all from separate applications, particularly when the NH_4SCN is applied after the amino triazole, indicates that the effect of the former is not on penetration.

As a result of an observation by J. G. Elliott (unpublished) that amino triazole activated with NH_4SCN gave superior effects on other grasses at low pH, solutions of amino triazole with and without NH_4SCN and buffered at about pH 4 were also included. It was thought that the pH effect would be on the dissociable NH_4SCN rather than on amino triazole itself. However, in this instance on A. repens, lowering the pH reduced the phytotoxic effect at all stages of the experiment and irrespective of whether NH_4SCN was present.

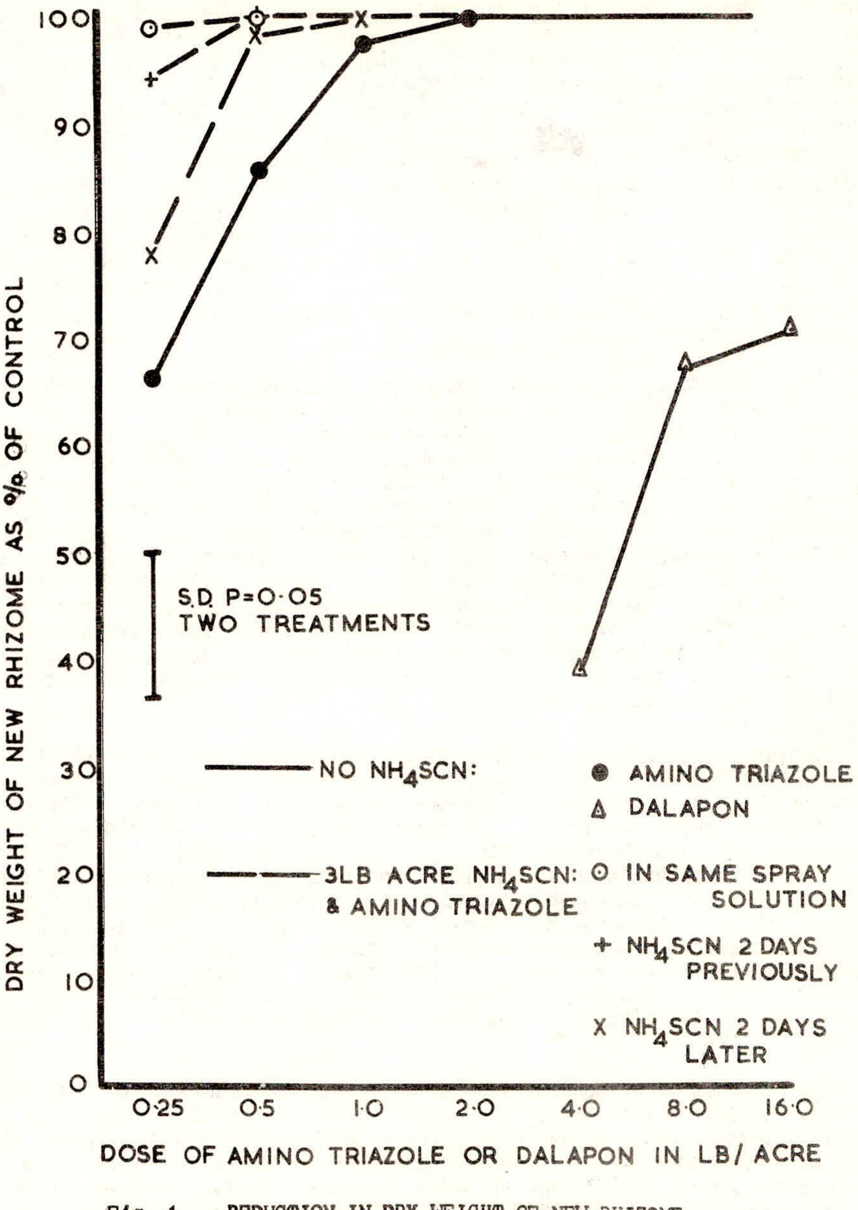

Fig. 1. REDUCTION IN DRY WEIGHT OF NEW RHIZOME PRODUCED DURING 223 DAYS FOLLOWING SPRAYING.

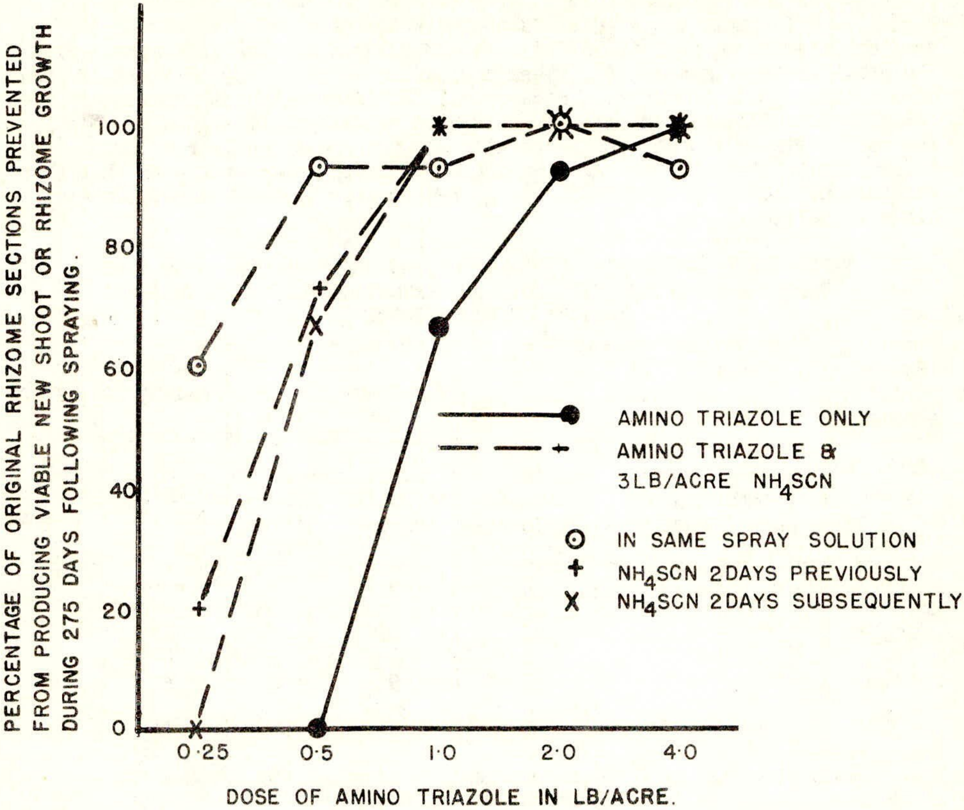

Fig. 2. EFFECT OF AMINO TRIAZOLE IN PREVENTING NEW GROWTH BY RHIZOMES.

A third experiment was designed to ascertain whether activation and a high level of effectiveness was obtainable under summer conditions. Shoots had mainly three leaves at the time of spraying in mid-June, 1960, and the plants were kept in the open. In addition to NH_4SCN, thiourea was also tested as an activator in view of its chemical similarity (NH_4SCN is converted to thiourea by heating) and physiological activity. Rhizomes for this experiment were obtained from Headington, about five miles from the previous source of supply at Wytham. However, to provide continuity, amino triazole with NH_4SCN, and dalapon were also applied to a set of plants raised from Wytham rhizomes.

NH_4SCN and thiourea alone were without effect. Detailed observations made on vegetative growth 28 and 78 days after spraying indicated a relatively small effect from dalapon and amino triazole treatments and an absence of activation by NH_4SCN or thiourea on the Headington material. There was a greater response to amino triazole + NH_4SCN but not to dalapon, with the Wytham material.

Dry weights of new rhizomes were determined 79 days after spraying, when the controls gave an average 35 g per pot. These data are presented in Table II. The main set of results on the Headington material show: (1) a smaller effect from both amino triazole and dalapon treatments compared with the previous experiments; (2) less activation with NH_4SCN; (3) an absence of activation with thiourea. Some additional treatments not reported in the table indicated that there was no activation of dalapon by NH_4SCN or thiourea. The most striking feature of the results was the greater effect of amino triazole with NH_4SCN on the A. repens from Wytham, as compared with that from Headington. On the other hand, the A. repens from Wytham was not more susceptible to dalapon.

TABLE II. INHIBITION OF GROWTH OF RHIZOME PRODUCED IN 79 DAYS FOLLOWING SPRAYING, EXPRESSED AS PERCENTAGE REDUCTION IN DRY WEIGHT OF NEW RHIZOME

Source of Agropyron	Headington			Wytham		Headington	Wytham
Dose of amino triazole (lb/ac)	Amino triazole only	Amino triazole + NH_4SCN*	Amino triazole + thiourea*	Amino triazole + NH_4SCN*	Dose of dalapon (lb/ac)	Dalapon-sodium	Dalapon-sodium
0	-	0	6	-		- -	-
0.33	35	52	46	62	2	47	19
1.0	53	73	53	91	6	59	40
3.0	99	98	97	100	18	54	51

S.D. (P = 0.05). Two treatments: Headington 16; Wytham 28.
* 3 lb/ac in all cases.

Two field experiemnts, one in Berkshire, the other in Oxfordshire, were sprayed in 1959. The results one year after treatment are set out in Table III. Experiment A was in a fallow and there was a dense cover of Agropyron shoots, mainly with three to four leaves, when sprayed in early May. There was an appreciable kill of foliage, increasing with dose in each case, and little regrowth probably because of the dry season. The foliage remaining was resprayed with the same treatments at the end of July. There were no cultivations until early 1960 when the field was ploughed and sown to a spring cereal. In this instance both amino triazole with NH_4SCN and dalapon at the highest dose performed well. Technical grade amino triazole alone was less effective.

TABLE III. REDUCTION IN NUMBER OF SHOOTS IN THE YEAR FOLLOWING SPRAYING, IN TWO FIELD EXPERIMENTS

	Experiment A			Experiment B		
	Dose: lb/ac*	per cent reduction	shoots/ sq yd	Dose: lb/ac	per cent reduction	shoots/ sq yd
Amino triazole	4	73	9.2	2.5	43	6.4
	8	87	6.5	5	35	6.8
				10	58	5.4
Amino triazole + NH_4SCN**	4	95	3.7	2.5	40	6.5
	8	99	2.2	5	54	5.7
				10	57	5.5
Dalapon-sodium	2	35	14.3	5	5	8.2
	4	71	9.3	10	29	7.1
	8	94	4.3	20	53	5.7
S.D. P = 0.05.			4.1			1.1

* This dose on each of two occasions.

** NH_4SCN in amounts 95 per cent of those of amino triazole.

Experiment B was in a cereal stubble and there was a strong dense growth of Agropyron shoots six to eight inches high when sprayed in mid-September. The experiment was ploughed in mid-November, cultivated in the spring and mangolds were drilled in late April. The level of control obtained was not as high as in Experiment A. Amino triazole at 5 lb/ac + NH_4SCN and dalapon at 20 lb/ac gave comparable results, and the difference between amino triazole alone and the 'activated' formulation was slight.

DISCUSSION

The pot experiments verify the activation of amino triazole with NH_4SCN with respect to its effect on Agropyron repens, but suggest that the magnitude of this effect may vary with conditions. The results indicate that this activation is not due to some effect of NH_4SCN on the penetration of amine triazole into the plant, but is concerned with some later phase in the exertion of its phytotoxic action.

The most striking feature of the pot experiments was the high degree of effectiveness of amino triazole + NH_4SCN even at doses as low as 0.25 lb/ac. Ultimate results were superior to those from dalapon at far higher doses. However, it must be borne in mind that these experiments were carried out under a specific set of conditions with only short rhizome sections, and therefore it is not possible to extrapolate them to all field conditions. The dalapon effect might have been improved by a treatment simulating ploughing at a suitable time after spraying, although this is not always necessary in the field. Such a treatment might, of course, equally well benefit an amino triazole application.

In the pot experiments there was some variation in degree of control obtained from amino triazole according to conditions, and the results in field experiments were markedly inferior, when allowance is made for much higher doses in the latter. The salient point is therefore that amino triazole + NH_4SCN possesses a very considerable potential for the control of Agropyron repens but the conditions enabling it to produce its maximum effect and the reasons for variable results must be elucidated, so that it can be used reliably in the field. The present experiments provide certain 'leads'. Firstly, in all the pot experiments dormant pieces of rhizome had produced shoots but had not yet produced new rhizomes at the time of spraying. It may be that the treatment is less effective once an extensive new rhizome system is present. Therefore some suitably timed cultivations to reproduce these pot conditions may be necessary prior to spraying to produce good results in the field. Some of the factors which must be evaluated in order to define such a treatment are being investigated in current pot experiments. These include the length of rhizome fragment from which shoots are produced, the depth in the soil from which the rhizomes sprout, and the stage of plant development with respect to both shoot and new rhizome growth.

The difference in response of rhizomes derived from two separate sources suggests a reason for variable results in the field. The untreated controls from the two sites showed certain morphological differences in the shoot when growing under the same conditions. There is an obvious need for an investigation of possible correlations between morphological features and high susceptibility and of the relative frequency of occurrence of extremely susceptible or resistant clones. Their existence implies the possibility of a build-up of more resistant populations, in this connection it is slightly reassuring that clonal differences in response to amino triazole and dalapon were not identical.

Finally, the fact that results from the summer pot experiment were slightly inferior to those of the earlier experiments, even on the Wytham material, suggests that some environmental factors may be important. In this connection, it could be postulated that the relatively poor results from the field experiments are attributable to their being sprayed in an unusually dry season. It may be relevant that in the summer pot experiment over 1.5 inches of rain fell on the third day after spraying, which may have led to considerable leaching through the pots. This may be important if appreciable amounts of amino triazole are taken up from soil. Occurrence of soil uptake would widen the number of environmental variations which may be of importance, compared with the situation where only foliar entry is involved. Work has already been started to investigate some of these possibilities.

Acknowledgements

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THE CONTROL OF PERENNIAL GRASSES WITH DIPYRIDYL HERBICIDES ALONE AND IN MIXTURES

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Summary: Greenhouse and box tests indicated that mixtures of the dipyridyl herbicides with dalapon or amitrol gave initially quicker top kill of the existing foliage than dalapon alone and better translocation of the chemicals. Subsequent field trials confirmed the quicker initial effects from the mixtures but these mixtures did not appear to have any greater effect on the regrowth than did dalapon alone. The addition of wetters improved the action of the dipyridyl herbicides but did not have any marked effect on the other treatments.

INTRODUCTION

In the study of the herbicidal activity of the dipyridyl herbicides, greenhouse and field trials were conducted to evaluate their effects on couch grasses (Agropyron repens and Agrostis spp.). These herbicides were tested alone and in combination with established grass killing chemicals such as 2, 2 dichloropropionic acid (dalapon) and 3-amino-1,2,4-triazole.

METHODS, MATERIALS AND RESULTS

Greenhouse Trials

These trials had two main objects:-

(a) to compare translocation of the mixtures with that of the pure chemicals

(b) to give some indication of the field performance of these mixtures as sprays.

Rhizomes of couch, Agropyron repens, each 10 in. long were collected in the field and planted in John Innes Compost in seed boxes. Each rhizome produced from 3 to 12 green shoots and these were ready for treatment in the translocation tests when they had reached the 2-3 leaf stage and when they had reached the 4-6 leaf stage for the spraying tests. The two dipyridyl herbicides, diquat (1,1'-ethylene-2,2'-dipyridylium dibromide) and PP.910 (1,1'-dimethyl-4,4'-dipyridylium dimethosulphate) were tested alone and in mixtures with dalapon (sodium) and amino triazole. Dalapon and amino triazole were also included on their own.

In tests to compare the translocation of these mixtures, all the leaves on one shoot at one end of the active rhizome were painted with the appropriate chemicals alone or in combination. The treatments and results are set out in Tables I and II.

TABLE I. AERIAL SHOOTS PRESENT 3 MONTHS AFTER TREATMENT AS PERCENTAGE OF THOSE ORIGINALLY PRESENT

(UNREPLICATED TEST)

Diquat gm/100 ml \ Dalapon gm/100 ml	0.0	2.5	5.0	7.5
0.0	100	50	67	63
0.25	100	40	40	22
0.5	67	13	0	0
1.0	83	67	0	0

TABLE II. AERIAL SHOOTS PRESENT 39 DAYS AFTER TREATMENT AS PERCENTAGE OF THOSE ORIGINALLY PRESENT

(MEAN OF THREE REPLICATES)

Dipyridyl gm/100 ml \ Amino triazole gm/100 ml	0	1.25	2.5
0	100	69	73
0.5 Diquat	64	72	0
0.5 PP.910	14	31	36

The spray trials were carried out on rather older plants and the following treatments were applied at the equivalent of 40 gal/ac: diquat 1 lb/ac, PP.910 1 lb/ac. dalapon 5 and 10 lb/ac and amino triazole 2.5 and 5 lb/ac. The boxes were sprayed with the chemicals alone and with combinations of diquat or PP.910 with dalapon or amino triazole. An area measuring 2 x 2 yd was marked out in the open in which the boxes of couch grass were placed, the whole area then being sprayed. Observations were then made to determine speed of kill and of subsequent regrowth.

Two days after spraying the dalapon/diquat treatments had caused severe scorch of all aerial growth while diquat alone produced only very slight tip scorch on 50 per cent of the plants. The dalapon treatment caused some scorch effects six days after spraying. Ten weeks after spraying all the shoots sprayed with the dalapon/diquat mixtures had been killed and there had been no regrowth; with dalapon alone all the sprayed shoots had been killed but there was regrowth which was slightly inhibited. The shoots treated with diquat alone had by this time recovered completely from the initial scorch and were growing normally.

The behaviour of shoots sprayed with dalapon/PP.910 in mixture followed much the same pattern as those sprayed with dalapon/diquat mixtures:- complete kill of aerial growth, with no regrowth up to 7 months after spraying. At this time slight regrowth had occurred on shoots treated with dalapon alone. PP.910 alone initially gave a good kill of aerial shoots but subsequently regrowth took place.

Spray applications of diquat, PP.910/amino triazole gave similar results to diquat, PP.910/dalapon mixtures, in so far as initial scorch, followed by kill of shoots was much more rapid than when the chemicals were applied alone. A good kill of plants was obtained 22 days after spraying with PP.910/amino triazole mixtures, whereas few shoots were killed by PP.910 alone, or by diquat/amino triazole mixtures. No kill of plants with diquat or amino triazole applied alone was obtained at this time.

Five months after spraying excellent kill of top growth was obtained with PP.910 alone and in mixture with amino triazole. After one year plants sprayed with PP.910 alone produced some regrowth, as did those sprayed with PP.910 plus the low rate of amino triazole. The high rate of the PP.910/amino triazole mixture gave 100 per cent kill and no regrowth occurred. Plants treated with diquat alone and in mixture with the low rate of amino triazole were making good recovery from the initial scorch and had produced much new growth a year after treatment. A good initial kill was also obtained with amino triazole alone, the plants not killed being severely affected. A year after treatment there was 100 per cent kill with no regrowth.

Field Trials

A randomized block design with four replicates was used in all trials. The plot size was either 6 yd x 4 yd, or 6 yd x 6 yd. Eight trials were laid down in the autumn of 1959 and four in the spring of 1960. No cultivations prior to spraying were carried out on the trials.

A standard rate of 1 lb/ac of both diquat and PP.910 was used alone and in mixture with dalapon or amino triazole. Dalapon was used at 5 and 10 lb/ac of the sodium salt and amino triazole was used at 5 lb/ac in these mixtures. A split application with a 10 day interval between applications of 7 + 5 lb/sodium salt of dalapon/ac was also included. A wetter (Lissapol NX) at 0.1 per cent vol/vol was used in some trials.

The chemicals were applied in water with an Oxford Sprayer calibrated to deliver 20 gal/ac.

The damage was graded by eye. Initial top kill was graded 0 - no kill 10 - complete kill and regrowth was graded 0 - complete regrowth, 10 - no regrowth.

TABLE III. DIQUAT, PP.910, DALAPON AND AMINO TRIAZOLE

Number		1			2			3		
Site Details	Grasses	Agropyron repens			Agropyron repens agrostis stolonifera			Agrostis stolonifera		
	Date sprayed	17.9.59			16.11.59			23.9.59		
	Date ploughed	23.10.59			December 59			30.10.59		
Assessment	Top kill days after spraying	11	35		11	36		9	29	
	Regrowth weeks after spraying			26			22			31
Treatment										
Diquat 1 lb/acre		8.0	6.0	0.5	4.0	0.5	1.0	8.0	3.0	1.0
Diquat 1 lb/ac + wetter								8.5	2.0	2.0
PP.910 1 lb/ac		9.0	7.5	2.5	5.0	2.5	2.0	8.0	5.5	2.0
PP.910 1 lb/ac + wetter								9.5	8.5	3.5
Dalapon 5 lb/ac		7.0	7.5	6.0	1.0	3.0	6.5	4.5	6.0	9.0
" 10 lb/ac		7.5	8.0	7.5	1.5	4.0	9.0			
" 5 lb/ac + wetter								5.0	5.5	8.0
" 10 lb/ac + wetter										
" 7 + 5 lb/ac		8.0	8.5	8.5	1.5	4.0	8.5	4.5	7.5	9.0
" 7 + 5 lb/ac + wetter										
Amino triazole 5 lb/ac		8.5	8.5	2.5	1.0	0.5	4.5			

Top Kill 0 = No kill 10 = complete kill
Regrowth 0 = complete regrowth 10 = no regrowth

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TOP KILL AND CONTROL OF REGROWTH ASSESSMENTS, AUTUMN SPRAYED TRIALS

4			5			6			7			8	
Agrostis gigantea			Agropyron repens Agrostis stolonifera			Agrostis stolonifera			Agropyron repens Agrostis Stolonifera			Agropyron repens Agrostis stolonifera	
2.10.59			13.10.59			24.11.59			29.10.59			10.11.59	
30.10.59			13.11.59			Spring 1960			December 59			April 1960	
7	20		3	20		13	27		4	35		7	42
		30			23			21			21		
8.0	3.0	1.0	8.5	5.0	1.5	4.0	0.5	1.0	4.0	2.5	3.0	5.0	4.0
9.0	3.5	1.5							6.0	4.0	3.5	5.0	4.5
9.0	7.0	5.0	9.0	7.0	0.5	5.0	2.5	2.0	5.0	6.0	5.5	5.0	6.0
9.5	8.5	6.5							6.5	7.5	6.0	5.0	6.5
6.5	4.0	8.0	6.0	6.0	7.0	1.0	0.5	2.5	3.0	4.0	9.0	3.0	5.0
			6.5	6.0	8.5	2.0	1.0	7.0	2.5	3.5	9.0	3.0	5.0
7.0	4.5	8.0							3.5	4.0	9.0	3.0	6.5
									2.5	4.0	9.5	3.0	5.5
7.0	5.0	8.0	5.5	7.0	9.0	1.0	1.0	8.5	3.0	4.5	9.0	3.0	6.5
									3.0	5.0	9.5	2.5	6.5

TABLE IV. MIXTURES OF DIQUAT OR PP.910 WITH DALAPON OR AMINO TRIAZOLE

Number		1			2			3		
Site Details	Grasses	Agropyron repens			Agropyron repens Agrostis stolonifera			Agrostis stolonifera		
	Date sprayed	17.9.59			16.11.59			23.9.59		
	Date ploughed	23.10.59			December 59			30.10.59		
Assessment	Top kill days after spraying	11	35		11	36		9	29	
	Regrowth weeks after spraying			26			22			31
Treatment										
Diquat 1 lb/ac + Dalapon 5 lb/ac		6.0	6.5	6.0	3.5	3.0	6.0	5.0	4.5	7.5
" " " 10 "		8.0	8.0	7.5	4.5	5.0	8.0			
" " " 5 + wetter								6.5	6.0	8.0
" " " 10 + wetter										
" " Amino triazole 5 lb/ac		9.0	8.5	1.5	2.5	2.0	4.0			
PP.910 1 lb/ac + Dalapon 5 lb/ac		8.5	7.5	6.0	5.0	5.0	6.5	7.5	6.5	5.5
" " " 10 "		8.5	8.0	7.5	4.5	3.5	7.5			
" " " 5 + wetter								9.0	8.5	6.0
" " " 10 + wetter										
" " Amino triazole 5 lb/ac		9.0	8.0	2.5	5.0	4.5	4.0			
Control		2.5	3.5	1.0	1.0	0.0	0.0	2.5	1.5	1.0

Top kill 0 = No kill 10 = complete kill
Regrowth 0 = complete regrowth 10 = no regrowth

TOP KILL AND CONTROL OF REGROWTH ASSESSMENT, AUTUMN SPRAYED TRIALS

4			5			6			7			8	
Agrostis gigantea			Agropyron repens Agrostis stolonifera			Agrostis stolonifera			Agropyron repens Agrostis stolonifera			Agropyron repens Agrostis stolonifera	
2.10.59			13.10.59			24.11.59			29.10.59			10.11.59	
30.10.59			13.11.59			Spring 1960			December 59			April 1960	
7	20		3	20		13	27		4	35		7	42
		30			23			21			21		
6.5	4.0	8.0	6.5	7.0	5.5	1.5	1.0	4.0	3.5	5.0	8.0	3.5	6.0
			6.5	7.0	8.0	1.5	2.0	7.0	3.0	5.5	9.0	4.0	6.0
7.5	6.5	7.5							3.5	4.5	8.0	4.0	6.5
									4.0	6.0	9.0	3.5	6.0
8.5	7.0	8.0	8.0	7.5	6.0	2.5	2.0	6.0	4.0	7.0	8.0	3.5	6.0
			8.0	8.0	8.5	2.0	2.5	7.5	4.0	7.0	9.0	3.5	7.0
9.0	9.0	8.0							4.5	8.5	8.5	4.5	6.5
									5.0	9.0	8.0	3.5	8.0
5.0	1.0	1.0	5.5	3.0	0.5	1.0	0.5	0.5	2.5	1.0	1.5	2.5	2.0

TABLE V. DIQUAT, PP.910, AND DALAPON ALONE AND IN MIXTURE.
TOP KILL ASSESSMENTS, SPRING SPRAYED TRIALS

Number		9		10		11		12	
Site Details	Grasses	Agropyron repens		Agrostis stolonifera		Agropyron repens agrostis stolonifera		Agropyron repens agrostis stolonifera	
	Date of spraying	24.3.60		13.4.60		21.4.60		7.4.60	
Assessment	Top kill days after spraying	7	42	7	22	8	35	12	26
Treatment									
Diquat 1 lb/ac + wetter		4.5	1.0	6.5	1.5	7.5	1.5	5.5	1.0
PP.910 1 lb/ac + wetter		5.0	5.0	8.5	7.5	8.0	7.5	9.0	9.5
Dalapon 5 lb/ac		0.5	2.5	0.0	2.0	0.5	2.5	0.5	1.0
" 5 lb/ac + wetter		0.5	2.5	0.0	2.0	1.0	3.5		
" 10 lb/ac		0.5	3.0	2.5	1.0	1.0	4.5	1.0	2.0
" " + wetter		0.5	3.0	2.5	1.0	1.0	5.0		
Diquat 1 lb/ac + dalapon 5 lb/ac		1.0	2.5	4.5	3.5	2.0	3.0	3.0	3.0
" " 10 lb/ac		1.0	5.0	4.5	4.0	2.0	4.5	3.0	3.5
PP.910 1 lb/ac " 5 lb/ac		4.0	8.0	7.5	8.0	6.5	7.5	8.0	9.0
" " 10 lb/ac		5.0	9.0	8.0	8.0	7.0	9.0	6.5	8.5
Control		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Top kill 0 = No kill
10 = Complete kill

In general the dipyridyl herbicides either alone or in mixture with dalapon or amino triazole gave the best top kill in the two weeks after spraying. PP.910 was rather more effective than diquat in the majority of trials. This initial top kill was not so marked in those trials sprayed late in the year (November) and early in the spring (March) when the air temperatures were low.

The top kill from dalapon on its own a month after spraying was in general not quite as good as that from the mixture including PP.910 but there was little difference in those mixtures containing diquat. Plots treated with diquat alone were showing signs of recovery at this stage but on those treated with PP.910 there was little recovery especially in the spring-sprayed trials. The addition of a wetting agent appeared to improve the long term effect of PP.910 but had only a slight effect on the other treatments.

Data on regrowth from the spring-sprayed trials are not available but data regrowth from the autumn-sprayed trials indicate that there is little difference between the results from the mixture treatments relative to dalapon and amino triazole on their own. Diquat and PP.910 alone did not give an adequate control of Agropyron repens but there was an indication in trials No. 4 and 7 that PP.910 at 1 lb/ac plus a wetting agent did give a useful partial control when Agrostis stolonifera and Agrostis gigantea were present.

DISCUSSION

There is a clear indication from the greenhouse tests that the kill of Agropyron repens due to translocated herbicide is greater with the dipyridyl mixtures with dalapon than it is with either component alone. Field trials confirmed that there was a more rapid initial top kill with these mixtures, but subsequent regrowth on the mixture treated areas was no less than on those treated with dalapon alone. This decrepancy is of sufficient interest to justify speculation.

The development of Agropyron repens in the field has been reviewed by Sagar (1960). The growth is mainly from the apical bud of the rhizome; in detached rhizomes equivalent to those used in the greenhouse tests an indefinite number of auxiliary buds also develop. Developing buds provide metabolic sinks in the sense used by Crafts (1959). However, many buds remain dormant unless the rhizomes are cut into 1 node segments. The translocated herbicide would normally travel to the metabolic sinks provided by the developing buds and this would show as a kill in the greenhouse trials. In the field the killing of the developing buds may only encourage the development of buds normally dormant and these would only be killed by further movement of active herbicidal chemicals from the developing buds which had been killed or other tissue. Dalapon may be capable of this further movement while the dipyridyls may not, hence long term assessments in the field would only detect the effect of the mobile dalapon. The advantage of the initial kill of active buds would not be appreciable in the field where adequate reserves of dormant buds are present to maintain a full stand of grass and as long as an excess of formant buds exists dipryridyl/dalapon mixtures are unlikely to show any appreciable practical advantage.

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RESIDUAL PHYTOTOXICITY OF AMINO TRIAZOLE AND DALAPON TO BARLEY AND KALE

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Summary: In a series of field experiments a study was made of the relative phytotoxicity and persistence in the soil of amino triazole and dalapon under different soil and climatic conditions. This showed that, at recommended rates of application, the residual toxicity of dalapon was considerably greater to barley and kale than amino triazole. For example, barley and kale planted 5 weeks after spraying dalapon were slightly damaged, whereas no injury occurred following amino triazole treatment. Despite dry weather, the experiments also showed that rotary cultivation was more effective than ploughing in accelerating the breakdown of residues of amino triazole though the reverse may be true of dalapon. However, it must be borne in mind that couch control with amino triazole is more effective if coupled with ploughing.

INTRODUCTION

Chemical treatments have certain advantages over cultural methods for the eradication of couch, (Agropyron repens) and other perennial grasses from arable land. Firstly, successful fallowing is dependent upon dry weather to kill the exposed rhizomes, whereas the action of herbicides is influenced to a much less extent by climatic conditions. Secondly, land under fallow is unproductive, whereas little or no alteration to the cropping programme is necessary where chemical methods of control are used. Amino triazole or dalapon applied to the land in the autumn can be planted with complete safety in the following spring. On heavy land, however, farmers frequently desire to sow a winter cereal shortly after the previous crop has been harvested, or alternatively, they may wish to spray in the spring prior to sowing. Thus the period of time available for the control of perennial grassy weeds is much restricted and a knowledge of the residual life of the herbicides under field conditions on different soil types from spring, summer and autumn applications is of considerable importance. Furthermore, ploughing should be compared with rotavation as a method of affecting rate of breakdown of chemical residue.

It was with the object of finding the information on these problems that this series of experiments was carried out.

METHODS AND MATERIALS

Three split-plot experiments with randomized block layouts were carried out on light, medium and heavy soils. Each site was in fallow at the time of treatment and contained a mixed flora of perennial and annual weeds in cereal stubble.

Main treatments were amino triazole at 3, 4 and 6 lb/ac, dalapon at 7.4 and 11.1 lb/ac and an untreated control. The amino triazole contained ammonium thiocyanate as an activator. For convenience, results have been quoted in this paper in terms of the mean of the doses applied, (i.e. 4.3 lb/ of amino triazole and 9.25 lb of dalapon/per ac) and these approximate to the rates recommended in