ROTHAMSTED RESEARCH

Rothamsted Report for 1963

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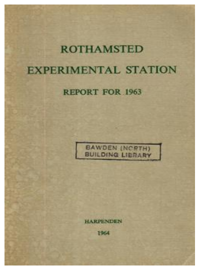

Field Experiments Section

G. V. Dyke

G. V. Dyke (1964) *Field Experiments Section ;* Rothamsted Report For 1963, pp 174 - 185 **- DOI: https://doi.org/10.23637/ERADOC-1-56**

FIELD EXPERIMENTS SECTION

G. V. DYKE

The field experiments at Rothamsted and Woburn are controlled by the Field Plots Committee: F. Yates (Chairman), G. V. Dyke (Secretary), F. C. Bawden, G. W. Cooke, P. H. Gregory, J. R. Moffatt, H. D. Patterson, C. A. Thorold, R. G. Warren and D. J. Watson.

In 1963 the staff of the two farms laid out and harvested 3,215 full-scale plots. Table 1 shows how they were divided according to crops and types of experiment.

TABLE 1

Number of full-scale plots harvested 1963

	Grain	Roots	Hay	Grazing	Total
Classical experiments:					
Rothamsted	189	—	122	—	311
Woburn	—	—	—	—	—
Long-period rotation experiments:					
Rothamsted	595	419	256	48	1,318
Woburn	164	510	64	12	750
Crop-sequence experiments:					
Rothamsted	166	36	72	—	274
Woburn	38	6	—	—	44
Annual experiments:					
Rothamsted	190	160	—	—	350
Woburn	88	80	—	—	168
Total	1,430	1,211	514	60	3,215

There were another 403 full-scale plots for which yields were not required and 48 that were laid out and harvested by other staff. There were 912 microplots, bringing the total to 4,578, fewer than in 1962, partly because one experiment on dates of sowing of spring wheat was abandoned because of the late season and partly because suitable sites could not be found at Woburn for two experiments on potatoes.

Broadbalk. As far as is known, the plots of Broadbalk have been sown with new seed each year, but seed of Squarehead's Master 13/4 was unobtainable from a merchant for the 1963 season, and for the first time Broadbalk was sown with grain grown on Broadbalk. The produce of several plots (excluding some with extremely unbalanced manuring) was mixed, cleaned and treated with a combined fungicide and insecticide dressing and sown on 30 November 1962. The field was still bare at the end of December when a spell of very severe weather began. There were 74 consecutive nights of ground frost, and the snow lay for 66 days. Once the soil warmed up, about mid-March, however, the wheat grew normally and yields, though smaller than in 1962, were about equal to the recent averages. Section Vb (next to the drain) carried its 5th crop after fallow and was sprayed (as was section Ia, 13th crop) with mecoprop/2,4-D. The two

https://doi.org/10.23637/ERADOC-1-56

sprayed areas were much cleaner than the rest, even than the 1st crop after fallow, which, on section II, suffered a particularly severe attack of wheat-bulb fly (*Leptohylemia coarctata* Fall.). On four plots (10, 11, 12 and 14) the crop was almost destroyed and the land left foul with weeds, of which the most conspicuous was mayweed (*Matricaria inodora*). These plots were mown and ploughed early to limit the seeding of the weeds. This is the first recorded instance of a complete failure on Broadbalk from wheat-bulb fly (see p. 153).

Some aspects of Broadbalk since the reintroduction of continuous wheat on section Ia are dealt with below (see p. 177).

Variety of wheat for Broadbalk and Alternate Wheat and Fallow. Unless special arrangements are made to maintain a stock of Squarehead's Master 13/4 it will be impossible to continue with this variety on the classical experiments which carry wheat. The introduction of a new variety, inevitably very different in many characters, may be expected to break the continuity of almost all aspects of these experiments. A modern variety with short straw will probably (at any rate on the well-manured plots) yield more grain but less straw than Squarehead's, but little is known of the behaviour of these varieties on land of such poor fertility as plot 3 of Broadbalk. A change of variety will break the continuity of the many observations of diseases, pests, weeds, etc., which are regularly made on the classical experiments.

When a change is made, a variety must be chosen that is likely to be satisfactory for many seasons, and so that the results shall have some relevance to present farming, it should be one widely grown in England. The achievement of maximum yields is not the main aim. It was decided in 1963 to test Cappelle under conditions comparable with some of the extremes found on the two classical experiments, in particular, on land unmanured for many years, and by contrast, on well-manured land. The cropped side of the Alternate Wheat and Fallow (Hoosfield—unmanured since 1851) was split to compare Squarehead's Master 13/4 with Cappelle, and the two varieties were also included in a variety trial on Long Hoos V (after potatoes). The mean yields were:

	N (cwt/acre)	SHM 13/4 Grain (cwt/acre)	Cappelle Grain (cwt/acre)
Hoosfield, after 1-year fallow	None	10·1	12·5
Hoosfield, after 3-year fallow	None	12·4	16·6
Long Hoos V, after potatoes	None	24·5	25·7
	0·50	27·1	34·7
	0·75	29·5	39·5
	1·00	28·8	39·9

With the larger dressings of N, Cappelle (as expected) yielded much more than Squarehead's Master, but, even at the small yields obtained on the Alternate Wheat and Fallow land, it also yielded more. These results suggest that if Cappelle were grown on Broadbalk, the well-manured plots might yield more than in the past and the others would not suffer any drop in yield.

https://doi.org/10.23637/ERADOC-1-56

Park Grass. When the snow melted in March there were large patches of white fungal mycelium on the unlimed half of plots 11–1 and 11–2 (minerals and 6 cwt sulphate of ammonia per acre), which carry almost pure stands of Yorkshire fog (*Holcus lanatus*). Later in the season much of the grass on these plots was dead, though (as usual) plenty of new seedlings grew and the sward re-formed. Plot 10 (unlimed) which also has much Yorkshire fog had less mycelium.

For notes on species newly recorded see p. 91.

Rothamsted ley–arable rotation. On some plots of grass, in particular the 3rd-year grazed leys on Highfield and the reseeded on Fosters, the snow melted to reveal large patches of white mycelium which rapidly disappeared. For some weeks the grass in the patches made no growth, but it later recovered completely.

The cocksfoot leys sown in 1962 suffered severely in the winter; those on Fosters were thinned but recovered to make a tolerable sward, whereas on Highfield large areas failed completely. Fungal mycelium was not seen on these plots. The Highfield plots were sprayed with paraquat, rotary cultivated and resown. Most of the plants that survived the winter were infected with one or other of the three viruses, cocksfoot streak, cocksfoot mottle and barley yellow dwarf. Several swards containing many species as well as cocksfoot were badly thinned during the winter; damage was greatest on swards heavily manured with N and hard grazed or cut late in 1962. It is not known whether virus diseases contributed appreciably to any of these failures. Those not resown recovered by mid-summer.

From the early years of the experiments the control of grassy weeds in the lucerne after the 1st season has been difficult on Highfield. The 3rd-year lucerne has usually been crowded out by annual grasses. Recently the 3rd-year lucerne on Fosters has also become very weedy. In future it is proposed to apply paraquat in early spring to the 2nd- and 3rd-year lucerne.

For the first time wheat was grown on plots newly ploughed from land reseeded with grass 12 years ago. On each field yield was less than after the alternating lucerne–arable system; on Highfield the difference was small but on Fosters about 8 cwt/acre. The plots after reseeded grass yielded about the same as those following 2 cycles of 3-year arable and 3-year grazed ley.

There are now 3 years' results with wheat after the 4 rotations since the introduction in 1961 of 4 levels of "Nitro-Chalk" (see Table 2).

On each field where "Nitro-Chalk" was not given the yield after lucerne was much larger than after the other treatment sequences, which differed little. The yield after lucerne increased with the 1st level of N but very little with more on both fields; the largest dressing caused lodging and depressed yields a little.

The yields after the cut and grazed leys differed very little, the grazed ley giving rather more wheat with the smallest dressings of N on Highfield but not Fosters. After both types of ley there were responses to N at all levels tested. After the arable sequence, however, yield increases for N were much greater, and the largest dressing gave about 3 cwt more grain

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TABLE 2

Wheat 1961–63, grain, cwt/acre

N (cwt/acre)	Lucerne	Grazed ley	Cut ley	Arable
		Highfield		
None	44·8	34·6	30·9	34·2
0·3	48·9	42·2	40·2	40·8
0·6	49·5	45·4	44·5	48·2
0·9	47·0	46·4	47·1	51·9
Mean	47·6	42·2	40·6	43·8
		Fosters		
None	45·3	29·6	30·3	28·4
0·4	53·1	37·7	37·8	39·4
0·8	54·2	41·5	41·2	47·7
1·2	52·6	43·5	42·4	50·1
Mean	51·3	38·0	37·9	41·4

than the 3rd on each field. On Highfield with 0·9 cwt N the wheat after arable gave 4·9 cwt more than after lucerne; the shape of the response-curve suggests that even more N could be profitably applied.

In early spring the wheat after reseeded grass was attacked by wireworms, and these plots were sprayed with aldrin; the effect on yield was thought to be negligible. Small patches of take-all occurred on some plots near isolated plants of couch-grass (see p. 107), and plants infected with *Cephalosporium* Stripe were also recorded (see p. 110).

Animal movements and soil fertility in the New Forest. Observations of ponies in part of the New Forest suggest that they may graze mainly on well-watered natural pasture near a stream but excrete mainly on higher areas, including one reseeded in about 1955. The yields of dry matter of the natural and reseeded areas were estimated by sample cuts from small plots protected from grazing. The natural pasture near the stream gave double the yield of the reseeded grass, but the percentage of K in the produce of the natural pasture was about half that of the reseeded. This confirms the suggestion that nutrients, especially K, are transferred by the ponies from the lower to the higher land. (Scowen, with Williams, Chemistry Department)

The Reintroduction of Continuous Wheat on Broadbalk

In the autumn of 1955 wheat was sown on the western part of section I of Broadbalk which under the scheme adopted in 1931 would have been fallow. Wheat has been sown each year since on this western part (now called section Ia), while the remainder (Ib) has continued in the 5-year cycle of fallow followed by four successive wheat crops. Section Ia has been treated exactly as the other cropped sections each year except that it has received weedkillers as follows:

1956: none
1957: MCPA

https://doi.org/10.23637/ERADOC-1-56

1958: mecoprop
1959: 2,3,6-TBA/MCPA
1960: mecoprop
1961: 2,3,6-TBA/MCPA
1962: 2,3,6-TBA/MCPA
1963: mecoprop/2,4-D.

All these were applied at the recommended rates and stages of growth.

The results of the modification of the Broadbalk experiment are discussed below. No great difficulty has been experienced in growing wheat continuously with the application of appropriate weedkillers, and because of the excessive growth of weeds on all unsprayed parts of the field, it has been decided that in future weedkillers will be used as required on all sections except Va, which will be kept as an unsprayed control. Section Vb (next to the drain) was cropped in 1963 (Va alone being fallow) and now carries continuous wheat.

Weeds. In May, soon after spraying, section Ia has fewer species and much less weed-cover than section Ib, but inspection of the stubble after harvest shows more species per plot and a greater total abundance of weeds on section Ia than on Ib. No species has been completely eliminated by the weedkillers used on section Ia, and by 1960 (the last year for which counts are complete) the number of viable seeds in the soil of Ia was only 15% less than in Ib. The numbers of seeds of some species, especially common vetch (*Vicia sativa*) and corn buttercup (*Ranunculus arvensis*), which are not well controlled by fallowing, were greatly diminished by spraying. Black medick (*Medicago lupulina*), although less abundant in growth where weedkillers have been used, has maintained a high reserve of seeds in the soil of section Ia because seed is shed by plants that germinate after spraying.

Weeds not controlled by the sprays used hitherto, including black grass (*Alopecurus myosuroides*), scentless mayweed (*Tripleurospermum maritimum*, formerly *Matricaria inodora*) and perennial grasses (*Poa trivialis* and *Agrostis stolonifera*) have increased slowly on section Ia. Weedkillers now exist for controlling all these weeds, but most of them must be applied at the right stage of development, earlier than those used hitherto. In many seasons the use of a tractor on the heavy soil early in the year is out of the question; aerial spraying may sometimes be the only suitable method, provided that adjacent areas are not subjected to accidental spraying.

Eyespot and take-all. Records kept since 1938 show no difference between section I and the other sections in the distribution of eyespot and take-all, but since 1957, when section Ia was first sprayed with weedkiller, eyespot at harvest has been consistently less on the 3 plots sampled (2B, 3 and 7) on this section than on the same plots of other sections after crop. The mean percentages of straws infected for the 7 seasons were 39·4 on section Ia (range from 16·4 in 1959 to 60·0 in 1958) and 52·8 on other sections after crop (range from 24·4 in 1959 to 74·5 in 1958). Similarly fewer straws on section Ia had severe lesions: 18·5% compared with 28·3% on other sec-

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tions after crop. On the 1st crop after fallow 24·6% straws were infected, 10·2% with severe lesions. There is no evidence to show whether eyespot is less common on section Ia because of the use of weedkiller or because of continuous wheat growing.

Take-all is not severe on section Ia, and the percentage straws infected is the same as in other sections after crop.

Yields of grain. The yields of grain on Broadbalk differ greatly from year to year; the 1st to 4th crops after fallow are present each year, but the later crops of the sequence (on section Ia) occur each in one season only. Before examining the yields of the sequence of 5th and later crops it is therefore necessary to make adjustments to allow for general differences in yield between seasons. Because of the movement of the fallow from section to section, this involves fitting constants by the method of least squares. This has been done separately for each plot, 2A to 19. The necessary assumption, that seasonal variations affect all the sections of a

TABLE 3

Broadbalk 1954–63

Grain (cwt/acre)

		Crop after fallow											
Plot		1st	2nd	3rd	4th	5th*	6th*	7th*	8th*	9th*	10th*	11th*	12th*
2A	D	28·4	23·6	20·6	20·0	17·9	22·3	25·2	15·4	23·3	17·9	21·7	21·8
2B	D	27·9	24·4	20·8	21·5	19·8	19·5	26·3	16·6	23·5	19·6	21·9	26·7
3	O	16·6	10·8	10·3	10·6	13·3	10·7	15·2	10·5	10·0	11·0	12·0	7·3
5	C	18·7	11·6	11·2	13·6	15·3	14·4	21·3	11·0	11·9	10·8	12·1	12·7
6	N_1C	21·4	15·9	13·8	16·4	15·0	16·6	21·2	14·9	14·1	15·2	17·7	16·3
7	N_2C	23·0	21·3	17·8	19·4	19·7	15·3	24·0	23·0	18·6	20·9	20·7	25·1
8	N_3C	24·7	23·6	20·4	21·3	22·5	16·4	25·0	24·4	20·4	20·9	26·5	37·6
9	N'_1C	20·8	18·2	16·5	15·8	13·7	12·4	21·1	21·4	18·0	14·7	21·9	20·4
10	N_2	16·0†	18·3	16·4	16·6	18·7	16·7	16·8	17·1	17·2	14·5	16·8	16·9
11	N_2P	15·8†	20·0	15·4	16·0	18·1	18·3	16·4	22·8	16·3	12·9	23·8	22·5
12	N_2PNa	16·6†	19·6	16·4	17·3	20·9	25·2	20·7	20·5	18·2	18·2	22·1	24·2
13	N_2PK	22·3	18·7	17·0	18·1	17·3	15·7	19·5	22·3	18·7	13·0	24·7	24·5
14	N_2PMg	18·2†	18·8	16·2	16·8	18·6	23·3	21·3	21·2	19·6	20·0	22·9	25·2
15	$N_2{}^+C$	23·1	16·4	15·4	16·1	15·8	16·9	18·4	20·0	17·5	18·1	17·8	23·0
16	N'_2C	23·1	22·8	21·4	21·8	19·7	16·6	20·9	22·7	23·8	17·2	24·5	31·2
17–18	N_2	22·8	18·4	18·5	19·9	20·6	14·1	23·3	17·5	16·6	14·0	22·3	20·5
17–18	C	17·1	9·6	8·3	8·9	8·1	8·8	8·5	9·8	8·2	8·8	12·4	8·7
19	R	20·6	16·0	14·6	16·0	17·4	17·1	17·6	16·0	15·9	18·5	20·2	20·7
	Mean	21·0	18·2	16·2	17·0	17·4	16·7	20·2	18·2	17·3	15·9	20·1	21·4

* Adjusted for differences between seasons.
† Crop failed 1963 because of wheat-bulb fly; yield taken as zero.

Rates per acre

D FYM at 14 tons (2A since 1885, 2B since 1843)
O Unmanured
C Superphosphate (P) at 65 lb P_2O_5, sulphate of potash (K) at 200 lb, sulphate of soda at 100 lb, sulphate of magnesia at 100 lb
N_1 Sulphate of ammonia at 43 lb N (21·5 lb in autumn, remainder in spring)
N_2 Sulphate of ammonia at 86 lb N (21·5 lb in autumn, remainder in spring)
N_3 Sulphate of ammonia at 129 lb N (21·5 lb in autumn, remainder in spring)
N'_1 Nitrate of soda at 43 lb N in spring
N'_2 Nitrate of soda at 86 lb N in spring
Na Sulphate of soda at 366 lb
Mg Sulphate of magnesia at 280 lb
$N_2{}^+$ Sulphate of ammonia at 86 lb N in autumn
R Castor bean meal to supply 86 lb N†

† Castor meal replaced rape cake in 1940. The rate of application remained at 1,889 lb until revised in 1955 to supply 86 lb N; average rate since 1955: 1,523 lb.

Note: Ground chalk is applied annually as follows:
100 lb calcium carbonate per 14 lb N as sulphate of ammonia
50 lb calcium carbonate per 14 lb N as castor meal
(Rates doubled in 1954.)

https://doi.org/10.23637/ERADOC-1-56

plot equally, is probably not justified and the adjustments are only partially successful.

Table 3 presents the adjusted yields of section Ia together with the mean yields of the 1st to 4th crops after fallow grown on the other sections in the 2 cycles 1954–63. The mean yields from all plots of the 1st to 4th crops after fallow are very close to those recorded in the first 4 cycles 1935–54 (*Rothamsted Report* for 1955, p. 162); the 2nd crop is about 2·8 cwt less than the 1st, the 3rd is 2·0 cwt less than the 2nd, but the 4th has yielded 0·8 cwt more than the 3rd. The mean yields of the later crops are with one exception greater than the 3rd crop and 3 of the 8 are within ±1 cwt of the 1st crop after fallow. There is no sign of a decline in yield, and no obvious effect of the use of weedkillers on the 6th and later crops. Plots given different treatments, however, show different trends of yield. On

TABLE 4

Mean yields of grain, cwt/acre

Treatment (per acre)	Plot numbers	Crops after fallow: 1st	2nd–4th	5th–8th*	9th–12th*
(i) *Effect of N in the presence of PKNaMg*					
No N	5, 17–18C	17·9	10·5	12·2	10·7
43 lb N	6, 9	21·1	16·1	17·0	17·3
86 lb N	7, 13, 16, 17–18N_2	22·8	19·6	19·5	21·0
129 lb N	8	24·7	21·8	22·1	26·4
(ii) *Effects of N and minerals*					
Nil	3	16·6	10·6	12·4	10·1
N_2	10	16·0	17·1	17·3	16·4
C	5	18·7	12·1	15·5	11·9
N_2C	7	23·0	19·5	20·5	21·3
Main effect of N_2		+1·8	+7·0	+5·0	+7·9
Main effect of C		+4·6	+2·0	+3·1	+3·4
Interaction of N_2 and C		+2·4	+0·4	0·0	+1·6
(iii) *Comparison of organic and inorganic manures*					
Nil	3	16·6	10·6	12·4	10·1
Farmyard manure (D)	2A, 2B	28·2	21·8	20·4	22·0
Effect of D	2A, 2B minus 3	+11·6	+11·2	+8·0	+11·9
Effect of N_3C	8 minus 3	+8·1	+11·2	+9·7	+16·3
Castor meal (R)	19	20·6	15·5	17·0	18·8
Effect of R	19 minus 3	+4·0	+5·0	+4·6	+8·7
N_2C	7 minus 3	+6·4	+8·9	+8·1	+10·2
P	11 minus 10	+1·7	0·0	+1·6	+2·5
K	13 minus 11	+6·5	+0·8	−0·2	+1·3
Na	12 minus 11	+0·8	+0·6	+2·7	+1·8
Mg	14 minus 11	−1·2	+0·1	+2·2	+3·0
(iv) *Forms of N*					
Sulphate of ammonia	6, 7	22·2	17·4	18·7	18·6
Nitrate of soda	9, 16	22·0	19·4	18·6	21·5
(v) *Time of application of sulphate of ammonia*					
21·5 lb N in autumn, 64·5 lb in spring	7	23·0	19·5	20·5	21·3
86 lb N in autumn	15	23·1	16·0	17·8	19·1
Difference	7 minus 15	−0·1	+3·5	+2·7	+2·2

* Adjusted for differences between seasons.
Treatment symbols as in Table 2.

https://doi.org/10.23637/ERADOC-1-56

plots 10, 11, 12 and 14 the 2nd crop after fallow is better than the 1st. This is largely explained by the failure of the 1st crop on these plots in 1963, when wheat-bulb fly (*Leptohylemyia coarctata* Fall.) attacked all plots after fallow. Damage was greatest on the 4 plots mentioned, and the cause of the difference is being investigated. In every season from 1954 to 1962 the yield of the 1st crop after fallow has been exceeded by that of one of the other sections on at least one plot; in 1959 on 11 out of 18. This effect cannot always be associated with attack by wheat-bulb fly or with more lodging in the 1st crop.

In the 12th crop after fallow (1963) plot 8 (minerals plus 6 cwt sulphate of ammonia) and plot 16 (minerals plus 5 cwt nitrate of soda) gave outstandingly large yields. The recorded yields, though about 5 cwt less than the adjusted ones given in Table 3, were larger than on any of the other sections in that season. In 1962 (also after a very hard winter) these plot-sections yielded exceptionally compared to the other sections. Plots that received no N in 1963 (3, 5, 17) showed the opposite effect, the 12th crop yielding less than the others (2nd–5th after fallow). This may be caused by the supply of N from leguminous weeds diminishing as the sprays have taken effect, or by the smaller weight of weed seeds (especially *Vicia*) contained in the harvested grain.

In general, the differences between large- and small-yielding treatments have tended to increase as the sequence of successive crops has lengthened (Table 4). Farmyard manure (*Rothamsted Report* for 1955, p. 163) behaves differently from complete fertiliser; the yield from FYM is larger in the 1st crop, but declines more rapidly in the later ones, and the increase in the last few seasons has been much less than on plot 8. The response to FYM has been similar in the groups of crops listed in Table 4, whereas the response to N_3C has increased greatly. The response to P has been small and has shown no clear trend. Na and Mg had small effects up to the 4th crop, but each increased the later crops by about 2·5 cwt. K, by contrast, increased the first crop by 6·5 cwt and had very little effect on the later ones. The large effect on the 1st crop is partly explained by the failure of plot 11 (N_2P) in 1963 because of wheat-bulb fly.

Nitrate of soda has given better yields than sulphate of ammonia; the difference, though not consistent, was as much as 2·9 cwt in the 9th–12th crops.

Except in the 1st crop after fallow, 4 cwt sulphate of ammonia applied in autumn has given smaller yields than the same amount divided, 1 cwt in autumn, 3 in spring.

Weed Control by Herbicides in Field Beans

By J. R. Moffatt

The preliminary and second report on the use of simazine to control weeds in field beans and potatoes was made in the Reports for 1959 and 1960. In 1961 and 1962 three further experiments were done on beans at Rothamsted, and these conclude the series.

In 1961 simazine was compared with 2,6-DBN (dichlobenil), which is

https://doi.org/10.23637/ERADOC-1-56

very toxic to seeds and buds. The 2,6-DBN was used in three different ways, worked into the seedbed, and as a post-planting and post-emergent spray, but where it was worked into the seedbed 2 weeks before sowing, very few bean or weed plants emerged, and no yields were taken. The beans were drilled 3–4 in. deep on 16 March and the post-planting sprays applied on 23 March; the post-emergence sprays were applied on 1 May.

A row spacing of 21 in., which allows inter-row cultivation to kill weeds, was compared with a theoretical spacing of 10½ in. by drilling a second time with the seed coulters mid-way between the rows of the first drilling. In practice, this technique was not very successful and the narrow row width varied considerably. The same seed and fertiliser rates per acre were used on both row spacings.

Full agricultural details of this experiment are given in *Numerical Results of the Field Experiments* 1961 (61/Dd/2.1).

The experiment as harvested consisted of 3 blocks of 19 plots each. The treatments were:

O = Beans drilled at normal (21 in.) spacing, no inter-row cultivations
A = Beans drilled at narrow (10½ in.) spacing, no inter-row cultivations
N = Beans drilled at normal (21 in.) spacing, inter-cultivated.

Treatments O, A, N taken factorially with:

No spray
S_1, S_2 = Simazine ½, 1 lb active material in 40 gal/acre as post-planting spray
D_1, D_2 = 2,6-DBN 1½, 3 lb active material in 40 gal/acre as post-planting spray

Treatments O and A taken factorially with:

2,6-DBN 1½, 3 lb active material per acre as post-emergence spray

TABLE 1

Tick beans—mean yield, cwt/acre

		No inter-row cultivation 21-in. row	No inter-row cultivation 10½-in. row (±1·35)	Inter-cultivated 21-in. row
No spray		22·5	21·0	26·8
Post-planting	S_1	23·1	21·8	27·0
	S_2	27·2	24·5	26·5
	D_1	25·9	23·0	25·6
	D_2	27·8	23·8	28·3
Post-emergence	D_1	21·5	20·6	
	D_2	20·0	21·2	
General Mean			24·1	

Weeds between the 21-in. rows were counted and identified on 3 random sample areas each of 162 sq in. in mid-June. Weeds in the rows were counted at the same time on three areas 9 in. wide on all plots cultivated between the rows.

Used as a post-planting spray, 2,6-DBN gave a yield as good as with

https://doi.org/10.23637/ERADOC-1-56

TABLE 2

Tick beans—mean weed numbers per sq. yd between rows

Weeds	Post-planting treatments					Post-planting treatments and cultivations				
	O	S_1	S_2	D_1	D_2	N	S_1N	S_2N	D_1N	D_2N
Black Bindweed (*Polygonum convolvulus*)	20·2	13·2	10·6	8·8	33·4	—	—	—	—	—
Chickweed (*Stellaria media*)	312·4	234·1	88·9	127·7	90·6	15·8	7·9	12·3	24·6	3·5
Cleavers (*Galium aparine*)	31·7	18·5	9·7	75·7	7·9	—	—	4·4	0·9	—
Couch Grass (*Agropyron repens*)	125·8	33·4	3·5	92·4	15·0	0·9	—	0·9	11·4	7·0
Fat Hen (*Chenopodium album*)	2·6	3·5	1·8	0·9	—	—	—	—	—	—
Knotgrass (*Polygonum aviculare*)	18·5	20·2	8·8	—	6·2	0·9	—	—	—	—
Pale Redshank (*Polygonum lapathifolium*)	10·6	3·5	33·4	8·8	0·9	—	—	—	—	—
Redshank (*Polygonum persicaria*)	606·3	398·7	80·1	124·9	146·1	3·5	7·9	0·9	7·0	6·2
Other weeds	5·4	4·5	—	0·9	2·7	—	—	—	—	—
Total	1133·5	729·6	236·8	440·1	302·8	21·1	15·8	18·5	43·9	16·7

TABLE 3

Tick beans—mean weed numbers per sq. yd in rows

Weeds	Post-planting treatments				
	S_1	S_2	D_1	D_2	N
Black Bindweed (*Polygonum convolvulus*)	1·8	0·9	3·5	0·9	5·3
Chickweed (*Stellaria media*)	29·0	3·5	75·7	24·6	73·9
Cleavers (*Galium aparine*)	37·8	20·2	15·8	4·4	16·7
Couch Grass (*Agropyron repens*)	6·2	—	5·3	2·6	10·6
Fat Hen (*Chenopodium album*)	—	—	0·9	—	—
Knotgrass (*Polygonum aviculare*)	2·6	2·6	0·9	—	2·6
Pale Redshank (*Polygonum lapathifolium*)	—	—	—	1·8	0·9
Redshank (*Polygonum persicaria*)	42·2	11·4	20·2	22·9	71·3
Other weeds	—	—	—	0·9	—
Total	119·6	38·6	122·3	58·1	181·3

simazine, but not when used as a post-emergence spray. Yields at 21 in. spacing were larger than at 10½ in. Table 1 shows yields and Tables 2 and 3 weed densities. Although the inter-row cultivations left fewer weeds between the rows than the spraying, this was not reflected in yields, and cultivating the sprayed plots did not increase their yield. Many of the weeds on the sprayed plot were stunted and died prematurely. The sprayed plots had fewer weeds in the rows than the cultivated ones, where the only post-planting treatment to control weeds was a stroke with a mechanical weeder and zig-zag harrow.

To measure the persistence of 2,6-DBN and see whether applying it well before sowing would make it an effective weed-killer but harmless to the crop, two experiments were done in 1961/62. In one with winter beans, drilling was delayed until 17 November to allow a month between applying 2,6-DBN and drilling and damage by birds was such that the land was drilled again with spring beans on 21 March. Table 4 shows counts of winter beans surviving in 5 rows 25 ft long and leaves little doubt that the post-planting spraying with 2,6-DBN killed at least half the beans. It also decreased the number of weeds (Table 5), whereas applying it a month before sowing had little effect on the number of bean or weed plants. Table 5 also shows good weed control by the double rate

https://doi.org/10.23637/ERADOC-1-56

of simazine (S) applied as a post-planting spray, and even better when applied half in winter and half in spring (S_2T).

TABLE 4

Winter beans—mean plant number per acre (in hundreds) on 4 June 1962

O	S_1	S_2	S_2T	D_1B	D_2B	D_1P	D_2P
418	548	450	422	619	599	197	106

O = No weed control
N = Normal inter-row cultivation
S_1, S_2 = Simazine 1, 1½ lb active material in 40/gal/acre
S_2T = Simazine 1½ lb active material in 40 gal/acre ½ autumn ½ spring
D_1, D_2 = 2,6-DBN 1, 2 lb active material in 40 gal/acre
B = pre-sowing spray (11 October)
P = post-planting spray (17 November)

TABLE 5

Winter beans—mean weed numbers per sq. yd

	O	S_1	S_2	S_2T	D_1B	D_2B	D_1P	D_2P	N
Annual Meadow Grass (*Poa annua*)	7·9	—	—	—	41·4	17·6	15·0	11·4	9·7
Bindweed (*Polygonum convolvulus*)	217·4	151·4	9·7	0·9	159·3	130·2	94·2	65·1	66·0
Chickweed (*Stellaria media*)	11·4	4·4	—	—	7·9	5·3	9·7	1·8	4·4
Cleavers (*Galium aparine*)	7·0	2·6	4·4	6·2	4·4	7·0	2·6	5·3	0·9
Couch Grass (*Agropyron repens*)	45·8	29·0	10·6	15·8	37·8	69·5	7·0	14·1	29·0
Fat Hen (*Chenopodium album*)	47·5	7·0	1·8	0·9	15·0	28·2	9·7	4·4	7·0
Knotgrass (*Polygonum aviculare*)	50·2	29·9	—	—	30·8	30·8	51·0	6·2	14·1
Mayweed (*Matricaria maritima*)	6·2	0·9	—	—	15·0	3·5	0·9	—	3·5
Common Orache (*Atriplex patula*)	22·9	25·5	22·9	—	22·9	25·5	7·0	0·9	19·4
Red Shank (*Polygonum persicaria*)	89·8	44·0	0·9	—	76·6	39·6	29·9	4·4	16·7
Other weeds	5·3	0·9	—	0·9	4·4	6·2	4·4	—	1·8
Total	511·4	295·6	50·3	24·7	415·5	363·4	231·4	113·6	172·5

The spring-bean experiment tested 2 levels of 2,6-DBN applied in the autumn or in spring, using a randomised block design with three-fold replication. The treatments were no weed control; normal inter-row cultivation; simazine at 2 levels (1 lb and 1½ lb/acre active material) as a post-planting spray; 2,6-DBN at 2 levels (2 lb and 4 lb/acre active material) applied either in autumn (A) or in spring (B). The autumn spraying was done on 17 November 1961, and the spring spraying on 19 February 1962; the seed was drilled on 21 March. Inter-row cultivations were done on the appropriate plots on 3 occasions.

Full agricultural details of this experiment are given in *Numerical Results of the Field Experiments* 1962 (62/Dc/2).

The crop on all plots sprayed in spring with 2,6-DBN was gappy and irregular in height and yields were not taken.

TABLE 6

Tick beans—mean yield, cwt/acre

O	S_1	S_2	D_1A	D_2A	N	Mean
27·8	31·2	32·0	28·4	23·2	30·4	28·8

O = No weed control
N = Normal inter-row cultivations
S_1, S_2 = Simazine 1, 1½ lb active material in 40 gal/acre
D_1, D_2 = 2,6-DBN 2, 4 lb active material in 40 gal/acre
A = Autumn application (17 November)
B = Spring application (19 February)

https://doi.org/10.23637/ERADOC-1-56

Weeds between the rows were counted and identified on 3 random sample areas each of 162 sq. in., on all plots on 14 June.

TABLE 7

Tick beans—mean weed numbers per sq. yd between rows

Weeds	O	S_1	S_2	D_1A	D_2A	N	D_1B	D_2B
Bindweed (*Polygonum convolvulus*)	24·6	—	3·5	12·3	6·2	7·0	—	—
Creeping Buttercup (*Ranunculus repens*)	50·2	—	0·9	73·9	61·6	19·4	3·5	6·2
Charlock (*Sinapis arvensis*)	11·4	—	—	4·4	8·8	1·8	—	—
Chickweed (*Stellaria media*)	47·5	0·9	—	9·7	6·2	9·7	0·9	0·9
Couch Grass (*Agropyron repens*)	22·0	—	—	7·9	6·2	1·8	—	—
Common Orache (*Atriplex patula*)	8·8	0·9	—	—	—	—	—	—
Pennycress (*Thlaspi arvense*)	1·8	—	—	3·5	—	—	—	—
Shepherds Purse (*Capsella bursa pastoris*)	8·8	—	—	0·9	0·9	2·6	—	—
Sow Thistle (Annual) (*Sonchus oleraceus*)	19·4	4·4	4·4	0·9	—	7·0	—	—
Speedwell, Field (*Veronica agrestis*)	32·6	—	—	7·0	—	0·9	—	—
Other weeds	10·6	3·5	—	—	0·9	0·9	—	—
Total	237·7	9·7	8·8	120·5	90·8	51·1	4·4	7· 1

Tables 6 and 7 show that neither the yield of beans nor the weed control was satisfactory from the single rate of 2,6-DBN applied in autumn; the yield was even smaller with the double rate, and weed control not much better. Simazine at both rates controlled weeds better than did the mechanical cultivations and also resulted in larger yields. To control weeds in spring beans, 2,6-DBN must be applied in spring, and then it carries greater risks than simazine of damaging the crop.

https://doi.org/10.23637/ERADOC-1-56