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FLAME CULTIVATION EXPERIMENTS 1965

by

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One of the few methods available for the destruction of weeds, apart from cultivation or the use of chemicals, is the application of heat by means of a flame 'cultivator'. From the nature of the treatment, flaming might be expected to have similar effects to contact herbicides, i.e. relatively little selectivity, the main effect on the above-ground parts of plants, more effect on small than large weeds and only a temporary effect on perennials. In order to verify these assumptions and to obtain information on the relative merits of flaming and herbicides, a series of trials was conducted in the summer of 1965, with the co-operation of Shell-Mex and B.P. Gasses Ltd. and Maywick Appliances Ltd.

Materials and methods

The flame treatments were applied with the 'Maygas' flame cultivator. This is a propane-fired machine which is fitted to the three-point linkage of a tractor. It is equipped with eight downwardly-directed gas burners which can be arranged to cover varying widths of swathe. The most usual swathe width is 9 ft. In the present series of trials a width of 6 ft was normally used. The normal operating pressure was 30 psi, at which pressure each burner produced 304,00 Btu/hour and the whole set of burners consumed 112 lb of fuel/hour. Speeds varied from  $\frac{1}{2}$  to 4 mph and the area treated by the machine at these speeds was equivalent to 0.36 to 2.9 acre/hour. Herbicide treatments were applied with Oxford Precision sprayers.

Three experiments were conducted of which details are given in Table 1. In addition a small observation trial was done on strawberries.

Results

Experiment 1 (H/12/65) At the time the flame and herbicide treatments were applied conditions were warm ( $20^{\circ}\text{C}$ ) and dry, and the stand of weeds covered approximately 50 per cent of the surface area. Subsequently the degree of effect was scored at intervals for eight weeks, the basis for scoring being 0 = no effect to 10 = complete kill. The scores recorded are shown in Table 2.



Table 1 Experimental details

Experiment	1	2	3
Date treated	(H/12/65) 30 June	(E/7/65) 21 June	(AA/26/25) (a) 10 May (b) 8 June
Crop	None	None	Potatoes
Main weed	<u>Raphanus raphanistrum</u> <u>Chrysanthemum segetum</u> <u>Agropyron repens</u>	<u>Chrysanthemum segetum</u> <u>Raphanus raphanistrum</u> <u>Matricaria recutita</u>	<u>Poa annua</u> <u>Stellaria media</u> <u>Raphanus raphanistrum</u>
Height of weeds	6 - 10 in	(a) 14, 20, 10 in* (b) 8, 15, 9 in* (c) 1, 1½, ½ in*	(a) 1 in (b) 6 in
Flaming speeds	1, 2 and 3 mph	1, 2 and 4 mph	(a) 3 mph (b) 1.5 mph
Herbicide treatments	paraquat 0.5 and 1 lb/acre and various other contact herbicides	paraquat 0.5, 1 and 2 lb/acre	paraquat diquat mixture 0.75 lb/acre + prometryne 1 lb/acre
Replications	herbicides - 3 flaming - unreplicated	3	4

\*mean heights of three species in order listed above, cultivated (a) 3 months, (b) 2 months, and (c) 1 months previously.

Table 2

Score for weed control (0 - 10) at various intervals after applying treatment

Treatment	3 days	1 week	2 weeks	4 weeks	8 weeks
Flaming 3 mph	8	7	5	3	0
" 2 mph	9	9	7	4	1
" 1 mph	9	9	8	7	2
Paraquat 0.5 lb/acre	8.0	7.7	7.0	5.0	1.0
" 1 lb/acre	9.0	8.3	8.3	7.7	3.0

The figures show that the slowest rate of flaming, 1 mph had very similar effects to paraquat 1 lb/acre, both treatments giving good control of weeds for about four weeks. The intermediate speed was more or less equivalent to paraquat 0.5 lb/acre and the control lasted for about two weeks. The effects of the highest speed only lasted for one week, many plants appearing to be badly scorched for a few days but then recovering. The larger plants of Raphanus raphanistrum (wild radish) and Chrysanthemum segetum (corn marigold), especially the latter, recovered quickly. Smaller plants of these species together with Spergula arvensis (spurrey), Aethusa cynapium (fools parsley) and Viola arvensis (field pansy) were more permanently affected. It was noteworthy that Agropyron repens (couchgrass) started to grow again more quickly after flaming, even at the slowest speed, than after treatment with paraquat.



Experiment 2 (E/7/65) Weather conditions at the time of treatment were similar to those in Experiment 1, and the weed stand even more dense. On the plots cultivated three months previously (stage a) there were an average of 57 C. segetum, 16 R. raphanistrum and 9 M. recutita (wild chamomile) plants/sq ft; plots cultivated two months previously (stage b) had 15, 2.5 and 7 plants/sq ft respectively of the three species and those cultivated one month previously (stage c) 12, 1.5 and 3 plants/sq ft. With stages a and b there was virtually a complete cover of weeds (heights are given in Table 1.)

The effects of the treatments applied to the oldest and intermediate plants (stages a and b) were assessed by means of scoring for vigour, density and flowering after three weeks. The three scores all show similar relative effects and those for density are given in Table 3.

Table 3  
(Stages a and b) Score for reduction in density (0 - 10)  
of plants three weeks after treatment

Treatment	<u>Stage a (oldest)</u>			<u>Stage b (intermediate)</u>		
	C.s.	R.r.	M.r.	C.s.	R.r.	M.r.
Flaming 4 mph	2.9	0	5.9	1.4	0.7	0
4 mph twice*	1.1	0.9	9.0	3.6	3.4	2.0
Flaming 2 mph	1.9	0.2	8.8	4.0	2.1	0.7
Flaming 1 mph	6.8	6.6	10.0	4.9	7.0	2.4
Paraquat 0.5 lb/ac	7.3	8.4	10	5.6	7.2	6.1
" 1 "	8.9	9.3	10	8.2	8.8	7.3
" 2 "	9.0	9.3	10	9.1	9.7	9.7

\* treatment repeated on 28 June

C.s. = Chrysanthemum segetum

R.r. = Raphanus raphanistrum

M.r. = Matricaria recutita

The treatments applied to the youngest weeds (stage c) were assessed by counting before and after the application, at intervals of one and three weeks. In the period before the pre- and first post-treatment count, weed emergence continued and the newly emerged seedlings were counted separately at the one week assessment. The results are shown in Table 4.



Table 4

(Stage c) Number of plants remaining after one and three weeks as percentage of original counts

The one week counts are divided into percentage of original plants remaining and (in brackets) additional plants which emerged after treatment

Treatment	1 week			3 weeks		
	C.s.	R.r.	M.r.	C.s.	R.r.	M.r.
Flaming 4 mph	79 (10)	90 (8)	99 (17)	62	82	120
4 mph twice*	-	-	-	55	63	94
Flaming 2 mph	21 (7)	21 (5)	44 (12)	30	52	78
Flaming 1 mph	1 (4)	1 (4)	6 (6)	8	10	22
Paraquat 0.5 lb/ac	0.3 (5)	48 (7)	0.3 (1)	10	65	10
" 1 "	0.2 (6)	14 (10)	0 (2)	9	18	20
" 2 "	0 (3)	7 (10)	0 (1)	8	13	21
Control	94 (14)	98 (14)	100 (18)	97	77	115

\* treatment repeated on 28 June

C.s. = Chrysanthemum segetum

R.r. = Raphanus raphanistrum

M.r. = Matricaria recutita

In this experiment flaming was generally somewhat less effective than in experiment 1. On the youngest weeds (stage c) flaming at 1 mph gave good control of weeds for at least three weeks and was roughly comparable to paraquat at <sup>0.5</sup> 1 lb/ac. R. raphanistrum was more resistant to paraquat than C. segetum or M. recutita, whereas all three were similarly affected by flaming, but as Raphanus only made up 10 per cent of the weed stand, this difference between the treatments had little effect on overall percentage kill. Neither the 2 or 4 mph flaming treatment (whether applied once or twice) gave adequate weed control, and not only did larger numbers of the treated weeds recover but larger numbers of fresh seedlings also emerged, especially with M. recutita.

On the older weeds (stages a and b) even the best flaming treatment was less effective than the lowest dose of paraquat and the two faster speeds had little effect after three weeks. Among the weeds treated at the most mature stage (stage a) Matricaria was markedly more susceptible to flaming than the other two species. This difference between the species, however, did not occur at the intermediate stage when Matricaria appeared much more resistant, not only to flaming but also to paraquat. The stage b plants were noted to have less lush growth than at stage a, which may be associated with this variation in susceptibility.

Experiment 3 (AA/26/25) The main object of this experiment was to compare husbandry techniques in the potato crop, normal ridging and



cultivation being compared with weed control by herbicides (the crop being grown in beds at different plant spacings) and by flaming (again with the crop in beds). In addition, variations in size of the planted tuber were investigated. Two flaming treatments were applied. The first, under warm (16.5°C), dry conditions, shortly before emergence, at the same time as the herbicide, and the second as an inter-row treatment under wet conditions a month later, when the crop was 1 ft high. The herbicide treatment consisted of a mixture of diquat and paraquat 0.75 lb/acre combined with prometryne 1 lb/acre to provide a residual effect.

The first flaming was applied to a moderately dense stand of small seedling weeds (an average of 23.6 per sq ft), of which the most important species were Poa annua (annual meadow grass), Stellaria media (chickweed) and R. raphanistrum (wild radish). C. segetum (corn marigold), Spergula arvensis (spurrey), Polygonum aviculare (knotgrass) and shoots of Agropyron repens (couchgrass) were present in smaller numbers. With the exception of Agropyron all weeds were well controlled for several weeks and after a month, when the second flaming was applied, only a few weeds up to 6 in. high were present. In comparison, the herbicide treatment gave virtually complete weed control, which persisted until the potato canopy closed in. As in Experiment 1 it was observed that Agropyron regenerated more rapidly after flaming than after treatment with herbicide.

The inter-row flaming was done with a single burner moving at 1.5 mph between pairs of rows 17.3 in. apart. At the time of treatment the space between the foliage of adjacent rows was only of the order of 6 in. and a considerable amount of scorch resulted. The damage was sufficient to reduce yield from 18.1 (herbicide) to 16.6 (flaming) tons/acre with one size of seed and from 17.5 to 15.4 tons/acre with the other. It was considered, however, that the initial flaming alone controlled weeds well enough to prevent appreciable competition with the crop, and that without the inter-row flaming the yield would not have been affected.

Observation on strawberries. Flaming was tested on 12 August as a method of burning off strawberry foliage after harvest and as an inter-row treatment for killing unwanted runners. The speeds were approximately 0.5, 1 and 1.5 mph.

The effects of the overall leaf burning treatment were somewhat obscured by the fact that flaming set fire to the straw beneath the plants. In areas where the straw did not ignite, the treatments killed the foliage, but did not burn it away. The combined action of flaming and straw burning had the desired effect. To achieve actual burning of leaves by flaming alone two treatments would be required at about a week's interval.

The inter-row treatments killed the foliage of the runners, but even at the slowest speed the crowns of the runner plants were not killed and



subsequently resprouted.

### Discussion

The experiments confirm that the effects of flaming are similar in many ways to those of contact herbicides. Small seedlings are more readily killed than larger plants, perennials regenerate after being burnt back and the effect is non-persistent. Applied when a flush of weed seed germination is in progress weeds become re-established very quickly. Under conditions less favourable for germination the treated area can remain weed-free for longer periods.

In comparison with paraquat, flaming at speeds of the order of 1 mph is approximately equivalent in weed killing effectiveness to a dose of 0.5 - 1 lb/acre as judged by these trials. On certain species, such as A. repens, paraquat has a more lasting effect, presumably because of a certain amount of translocation. In the present series of experiments, however, the overall levels of kill are generally similar. Flaming is as effective on grasses as on dicotyledonous weeds, a feature it shares with paraquat. It is worth noting, however, that few alternative contact herbicides have this property. Limited observations on strawberries suggest that paraquat is more effective in killing unwanted strawberry runners than flaming.

Compared with paraquat from another aspect, the potato experiment suggests that flaming is less easy to apply as a directed treatment, at least with existing equipment. At the moment, therefore, flaming appears more likely to be of value as a pre-emergence treatment than as an inter-row treatment in a growing crop. Because of the general similarity of their effects, however, the key factor influencing the choice between flaming and a contact herbicide is cost.

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