THE SELECTIVE SPRAYING OF HERBICIDES

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By and large the most productive pastures are those which contain about 40 per cent. clover in association with vigorous grasses, notably perennial and short-rotation ryegrass. The fertility of soils under these pastures can be built up to a high level by careful pasture management. However, the clover contribution is not constant, being greatest in summer. It is a fact that unseasonable or abnormal variation in clover contribution leads to a decline in pasture production; the speed of the decline can vary, but usually is sufficiently fast to cause immediate concern. This great importance of clover in pasture is determined primarily by the well-known phenomenon of nitrogen fixation by the symbiotic rhizobia species. It is unfortunate that clovers are not high producers in their own right.

To suit my purpose I intend to dwell a moment on some aspects of pasture lore. Under conditions suitable for plant growth the nodule bacteria on a clover plant will increase as the plant grows in size; as such, grazing must influence their number and vigour. Under a pure clover sward the greatest quantity of nitrogen should be fixed, but within this quantity much will be surplus to clover requirements and may be wasted by such agencies as leaching. By growing grasses in association with the clovers this surplus "fixed" nitrogen may be used economically. There is a rough balance then, where clover growth, surplus nitrogen, and grass demand are in equilibrium, but it is difficult to maintain. Of necessity grazing with animals repeatedly upsets this balance, much of the practice of good farming being aimed at reducing the influence. Clover appears to be the weakest link in the chain, but the importance of the nodule bacteria cannot be over-emphasised. To my knowledge there is little evidence about the effect of foliar applications of 2,4-D on the symbiotic rhizobia on the roots. By inference the effect can be expected to be great. Perhaps twisted clover petioles may be indicative of more serious damage to the pasture complex than is generally realised.

I believe that spraying pasture with hormone weedkillers at weedcidal rates can cause too much damage too often for ease of mind. Where a spraying has caused clover damage the usual sequence of events appears to be an initial increased grass growth with all the available nitrogen being used and clover ground space being reduced. The weakened clovers are subjected to adverse competition while the nodule bacteria must be retarded. A short-lived boost to grass growth follows, caused by the liberation of nitrogen from dead decaying bacteria. This in turn is followed by a nitrogen deficiency, which, pending the recovery of the clover and bacteria, and through weakening of the grass plants, permits the establishment of second rank grasses such as poa and the bents. Eventually the clovers and nodule bacteria resume, the grasses recommence normal growth, and with correct management a swing to clover dominance is followed by normal pasture growth. This order of events is not clear cut nor is the time taken for it to evolve. Cases will vary, but the outline is applicable generally.

To avoid upsets such as this it has been suggested that the relatively insensitive summer clover pastures may be sprayed safely or that severe grazing before spraying will reduce spray damage sufficiently. The first case does not appeal because clover herbage in summer constitutes the bulk of the greenfeed available to farmers and the second case lacks appeal because, despite the effort, some damage will ensue while the severe grazing itself constitutes a bad measure. Compensation by way

of increased production should follow the reduction in yield which follows normal pasture spraying. Indirect evidence points to this being so, but in the absence of direct evidence a doubt exists. Severe infestations and noxious weeds are special cases and should be sprayed forthwith. In general, spraying of pastures with weedkillers is either the best compromise available or a necessary evil, depending on point of view. Improvements are needed in either method or material.

At Wye College, Kent, Professor Wain and his colleagues have prepared and tested a range of phenoxybutyric acids which offer great promise. They are selectively activated by a range of enzyme enriched plants and could be a reasonably valid answer to the problem. Luckily, clovers appear to lack the necessary enzymes.

At Grasslands we have endeavoured to find alternative methods of application. Four years ago we commenced a series of experiments using 2,4-D in soil, with the aim of preventing the emergence of fast germinating ephemerals and of killing all buried weed seeds. We achieved the first aim reasonably well but the second aim only incompletely. Weeds could be expected to appear from time to time in the pasture sown subsequently. If the gain made was to be of value a selective application of weedkillers to the persistent weeds was needed. This approach has been successfully used in greenkeeping practice. The most stubborn local weeds are docks and Californian thistle. Both are unattractive to stock, although it is not usual to see docks in a sheep pasture. In dairy pastures selective rejection by the cows permits both species to be seasonally prominent, while their tall growth form places them higher than the pasture species—at least after grazing. Thus they are placed selectively within the range of a general weedkiller application made at a height of say 3in. to 6in. above the ground. If translocation really does function, there should be no real objection to applying weedkiller to the tallest growth of the weed plants.

To test the theoretically acceptable idea of selective application small plot trials were laid down in mid-February 1954. Using white clover dominant pasture 2in. to 4in. tall, topping, general spraying (that is boom spraying), and selective application were compared with no treatment. Selective application was carried out by using a hand brush. Treatment with 2,4-D at 2lb. acid equiv./acre as the polyethylene glycol ester and amine salts was applied to both dock and Californian thistle infested areas. Some results are shown in Tables 1 and 2.

Significance was proved between no treatment, mown, boom spraying, and selective application but not between materials. After 2 months, in April, the Californian thistles were tending to increase in number, but clover recovery was slow under boom spraying.

The same comments apply to Table 2 except that the benefit due to spraying was more rapidly lost due to regrowth and fresh seedling growth—notably in boom spraying. An autumn topping was tested independently elsewhere and after 2 months had reduced Californian thistles by about 80 per cent., but had permitted docks to increase by about 30 per cent.

The selective application as used here caused only slight clover damage. This was of a low order and when balanced against the efficiency of weed control led us to believe that the approach was worth while. It was decided to attempt the construction of a machine capable of selectively applying weedkillers.

Following a suggestion from E. O. C. Hyde, a machine was constructed. It consists of fan type nozzles spraying backwards into a catching tray. The nozzles are set to spray flat more or less parallel to the soil surface at a convenient height while the tray can be lowered at will. Spray material is delivered by pump as usual to the modified boom, and the surplus spray caught in the tray is returned to the supply system through a pump and filter. To exclude herbage and to prevent

TABLE 1—Californian Thistle Plot Trial Data collected after 4 weeks of trial							
		Treatment					
		O	Topped	PEG ester		Amine salt	
				Boom	Selec.	Boom	Selec.
Californian thistle	% decline in no.	— 17	— 53	— 96	— 85	— 94	— 85
	Mean nos. per s. yd. (corrected)	8.5	6.7	0.7	1.6	0.3	1.7
White clover	Relative cover	98	(60 ± 5.2) 100	42	77	38	82
Bare ground	As % total area	0	0	13	6	10	5
Mean count Californian thistles at outset was 11.6 ± 0.7 per sq. yd.							

back-lash of spray particles a metal grill has been fitted to the front of the tray and a 50-mesh sieve protects the floor of it. The machine is 3ft. wide. As it tracks forward tall weeds pass into the spray, are hit selective sprayings should be to give far better control of weeds than is possible by boom spraying with the added advantage of very little clover damage.

The first consideration then was would the machine work as intended? Mr. R. A. Nichols, a sand country farmer of Oroua Downs near Foxton, had a drought damaged pasture which had become dock infested. A good growth of both red and white clovers was interspersed with patches of ryegrass and browntop occurred throughout. Docks were uniformly thick (*Rumex* hybrid). The highest clover growth was about 4in. and the least difference between clover and dock was 2in. In places the pasture was a tough test of the machine which was set at the 4in. height. Using a mixture of 18 gallons of water and 2lb. acid equivalent of 2,4-D as amine salt boom spraying and selective application were applied in August 1954 at the equivalent rate by the tray, and bent over towards the nozzles, are sprayed all over, and then are left to resume their normal erect growth form.

At about 3 m.p.h. the time of exposure to spray for each plant appears to be similar to that applying under boom spraying. Accordingly the concentration of spray material used so far has been the same as for boom spraying. On a calm day with the machine stationary loss by drift appeared to be about 10 per cent. A pasture containing 3 docks per sq. yd. was sprayed in October, about 30 per cent. of the spray being lost. If spray is passing through the nozzles at the equivalent of 20 gallons per acre, 2 to 3 gallons may be lost as drift and 3 to 5 gallons placed on the weeds. It should be possible to cover any area in this manner about four times with the same total quantity of material as would be used in one boom spraying. In time the effect of these repeated of 18 gallons per acre. Boom spraying, selective application, and no

TABLE 2—Dock Plot Trial Data collected after 4 weeks of trial							
		Treatment					
		O	Topped	PEG ester		Amine salt	
				Boom	Selec.	Boom	Selec.
Docks	% decline in no.	— 14	0	— 65	— 43	— 71	— 62
	Mean nos. per s. yd. (corrected)	7.2	7.9	2.8	4.4	2.4	3.1
White clover	Relative cover	92	(66 ± 4.0) 100	11	77	21	74
Bare ground	As % total area	1	1	32	9	30	9
Mean count docks at outset was 8.2 ± 0.3 per sq. yd.							

treatment were compared. Within a week striking differences were evident, the control strips being unaffected and boom sprayed strips being severely damaged. Docks and clovers alike had suffered while the grasses, where they occurred, were undamaged. The selective application strips showed some dock control and little clover damage.

At that time about 95 per cent. of the docks under boom spraying were severely damaged, whereas selective application showed only 25 to 35 per cent. severely damaged, but no clover damage of consequence could be seen in selective spray strips. Regrowth of red clover in selective application strips following a grazing showed distortion of the new growth which pointed to disorganisation of bud meristems by translocated drift 2,4-D. This deformity virtually disappeared after the next grazing.

Two months later, in November, the selective application strips appeared to be similar to controls in clover content but had slightly fewer docks, whereas boom spraying strips were grass dominant or bare of vegetation.

Four months later still, or 7 months from commencement, the boom sprayed strips were still grass dominant, but many seedling docks were appearing in the bare ground.

Within a year there was little to distinguish any treatment, despite the initial severe damage in boom sprayed strips.

In my opinion the machine was successful so far as it was tested, but it needs critical study before this opinion can be consolidated and accepted.

The second consideration, namely the effectiveness of repeat sprayings, has not been tested. It is probable that with a greater difference in height between clover and dock, and with repeated selective sprayings, the result may have been clear-cut in favour of the machine. Future work will clarify the position.

No doubt in time the machine will be made more efficient and it will become possible to make wider use of less selective weedkillers such as maleic hydrazide. Economic considerations may possibly weigh against repeated selective sprayings, particularly at present when labour costs are so high. A part solution may be to arrange a set of machines in a similar way to gang mowers and to run the gang on a contract basis.

To conclude, the problem of clover damage in pastures sprayed with hormone weedkillers is a real one. Wain's new materials may be a very adequate answer. Meantime it appears to be possible to avoid boom spraying by controlling weeds in the seed-bed with 2,4-D and in the pasture by selective application of weedkillers. The machine for the selective application which is described here appears to be sound basically, but further work is needed to prove this point.

DISCUSSION

Q.—The equilibrium of the pasture must be maintained. Hormones retard clover growth without affecting grass growth and thus upset the equilibrium. To counter this the grass could be controlled by a grazing 3 weeks after spraying.

A.—If the clover is killed, grazing may easily pug the pasture.

Comment: Spraying will not necessarily lead to ryegrass dominance. In one example it resulted in clover dominance.

Q.—Did the speaker imply that summer spraying was less harmful than spring spraying?

A.—Not exactly. In summer the pasture is least sensitive to change.

Q.—If translocation really operates, small droplets should not be necessary. It would be better to use a large droplet size to minimise drift.

A.—Fine droplets should not be necessary.

Comment: Ryegrass is more sensitive to soil fertility than clover, and it is easier to get clover back into a pasture than it is to get back ryegrass.