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USE OF DYE TO ASSESS SPRAY COVERAGE ON GORSE

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Summary

Several water soluble dyes were evaluated for use in simulated spraying trials on gorse (*Ulex europaeus*). Trials conducted throughout the gorse growing season showed a seasonal variation in distribution of dye on the different plant parts. The dosage received by plants increased in a regular fashion throughout the growing season and showed clearly that least spray was received by plants in the winter period.

INTRODUCTION

Determining the quantity and distribution of a specific herbicide on a plant or on the ground is an exacting and laborious procedure. Despite this, the known variation in spraying constancy demands some form of quantitative assessment.

A possible approach involves the use of dyes or fluorescent chemicals either in simulated trials or as additives to herbicide formulations. In New Zealand this approach was suggested as early as 1955 in connection with the first helicopter spraying trials (Little 1955), but apparently little use has been made of it since then.

There are several ways of using a coloured additive in a spraying trial: the method chosen was to determine total and localised distribution of the spray on the plants by extraction and quantification of the dye. Excellent descriptions of the methods possible with either coloured or fluorescent dyes on crops and fruit trees have been published recently (Lake and Taylor 1974; Sharp 1974; Uk 1977), though only one report states the efficiency of dye recovery from actual plants (Sharp 1976).

The objective of this dye trial was to use the dye recovery technique for a rapid assessment of spray distribution on gorse plants as they developed throughout a growing season. Though in retrospect some replication would have been desirable, it seems that the harvesting of 10% of the sprayed plot gave sufficient accuracy to show several distinct trends.

MATERIALS AND METHODS

Choice of dye

Since all dye recovery work was intended for field operation use, both the spray and extraction solvent had to be water. Hence the dye had to be water soluble, non-toxic, reasonably available and pure, aesthetically acceptable and have a high light stability and absorption at a specific wavelength. The principal criterion was the completeness of dye removal from foliage by the minimum number of water washes. Tartrazine gave the best result, but as this test only gave relative recoveries there was a further check on this dye.

Sections of gorse branches (10 cm long; the cut end sealed with wax) were sprayed with dye solution (at 10 g/litre concentration) within a glass vessel taking care to prevent spray droplets escaping from the

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enclosed space. Three sections were sprayed consecutively, then the spray on the walls of the glass vessel and on the foliage sections was carefully washed off, and together with the unused spray solution, quantified in a spectrophotometer. Total recoveries from vessel and gorse (after two water washes of the foliage) added up to 100.3, 100.4, 100.4, and 100.5% of the starting dye mass in each of four trials. This was considered satisfactory.

Field methods

Tartrazine solution (10 g/litre concentration) was sprayed from 1 m above the plant tops in a single pass with the FRI precision sprayer (Sanderson 1974: fitted with 730077T-jet nozzles and operated at 205 k Pa delivering the equivalent of 330 litres /ha) over a 5 x 2 m plot of mature gorse (4 years old, up to 1 m high) at a site at Mt Thomas, Canterbury, each month from September 1977 to April 1978. An hour after spraying, a 1 m square area of gorse was harvested at ground level: each stem was sectioned into 20 cm lengths, then flowers and pods were removed, followed by new foliage. Tissue from equivalent positions in each height class was combined and then extracted twice in a known volume of water (typically 5 or 10 litres). Samples from each water wash were collected and stored at 4 °C until analysed the following day. The oven dry weight (80 °C for 1 week) of the washed plant material was also determined. The mass of dye recovered by each wash was calculated from its absorption at 435 nanometers and that of a response curve from standard dye solutions.

RESULTS AND DISCUSSION

The results of the dye recovery trial are presented in Fig. 1 and show a seasonal pattern of spray interception by flowers and seed-pods (up to 24% of the total) and new foliage (maximum of 31%). Hence throughout this trial most of the dye landed on the stems and older foliage by using this particular combination of sprayer, nozzles, pressure and application rate. Other trials have established that different combinations of nozzles and carrier volumes can be expected to alter the distribution ratio (Balneaves and Gaskin, unpublished).

Fig. 1 Seasonal percentage distribution of dye on gorse plants. F, P, and NF signify flowers, seed-pods and new foliage present.

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Fig. 2 Seasonal variation in mass of dye intercepted by gorse foliage plus stems and flowers plus seed-pods /m² plot. (Sept. 1977 data not available).

When the total mass of dye intercepted by the plants was determined there seemed to be at first sight a marked seasonal variation (Fig. 2) for foliage (old plus new) and for flowers plus pods. The latter showed a more regular and expected trend, i.e. decreasing interception with decreasing presence, but the foliage interception was more irregular. However, the trend from the foliage interception was related closely to the total percentage interception (Table 1).

Table 1. Seasonal variation in percentage interception, gorse tissue weight, dye mass and dosage received by m² gorse plots.

	Month/Year						
	Oct 1977	Nov 1977	Dec 1977	Jan 1978	Feb 1978	Mar 1978	April 1978
Percentage interception	44	53	27	26	53	49	32
Tissue dry weight (g/m ²)	2970	2970	1310	1120	1840	1680	2090
Total mass dye (mg/m ²)	178	212	108	106	211	203	129
Dosage received (mg dye/kg tissue)	62.7	71.4	82.5	94.0	115.0	120.0	61.5

The possible causes for this variation in interception are threefold: poor dye recovery technique; spraying inaccuracies; and varying plant interception. The first was ruled out by the excellent dye recovery from foliage in the initial laboratory tests and after chemical analysis of gorse foliage wax and wettability measurements showed wax composition and

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interaction to be constant. If spraying inaccuracies i.e. variable deliveries were responsible, then on occasion only half of the required volume would have had to be applied (see percentage interception values in Table 1). A discrepancy of this magnitude can be discounted since the volume remaining after spraying was checked each time and did not vary by anywhere near this factor. A similar seasonal variation in interception by the flowers and pods would also have been expected from such a cause.

Variable gorse stand interception could be due to differences in gorse plant density; if so, then the tissue dry weight values should reflect this (Lake and Taylor 1974). This is indeed the case (Table 1) as the recorded dry weights of plants harvested (per m²) during December and January are the lowest of the entire series and so for that reason the mass of dye intercepted during these months is also the lowest. However, when the relative doses applied, i.e. mg of dye /kg dry weight gorse tissue are calculated, the seasonal trend is quite different and reflects more closely the seasonal change in development of the gorse plants (Table 1). There is a steadily increasing 'dosage' received by the plants, culminating in a maximum in March when the greatest quantity of old and new foliage is still on the plants. The dosage value then drops in April consistent with the dropping of older foliage and giving a result remarkably like the late winter value recorded in the previous October spraying. This also suggests that any dosage received by plants throughout the remaining winter months would stay fairly constant at this low value.

Although a repeat of this trial during the following season (1978/79) was marred by several events, the results remaining showed an identical trend in seasonal interception and dosage, but with a maximum approximately a month earlier (February instead of March), consistent with the difference in climate during these years.

CONCLUSIONS

It is obvious that spray distribution will vary with the equipment used, but the present work also indicates that plant growth and development can affect it to a considerable extent. This is especially evident when considering the total interception of spray by plants. For example the more open or less dense stands of gorse sprayed in Dec/Jan intercepted much less of the spray, leaving up to 74% of the spray to either settle on the ground or blow away. Furthermore, it would seem that regardless of the equipment or conditions, seasonal plant development also determines the dosage received. This raises the possibility of delivering twice as much herbicide onto plants at no extra cost, and possibly when labour and equipment are more readily available, simply by changing spraying dates. However, even more of the spray intercepted at such a time can be expected to land on mature foliage or stems and changes in formulations or types of herbicides may be necessary to take advantage of this. The fact that most effective gorse control with 2,4,5-T sprays is obtained by spraying during spring and early summer (October to December; Balneaves 1978) confirms the fact that factors other than dosage or plant interception efficiency control herbicide effectiveness.

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