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SUSCEPTIBILITY OF SEEDLING GORSE TO HERBICIDES

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Summary

Glasshouse experiments are described in which herbicides were tested on 2-3cm gorse (*Ulex europaeus*) seedlings and activity compared on the basis of GR50s. Most active were picloram and 2,4,5-T/picloram followed in order of decreasing activity by 2,4,5-T/glyphosate, 2,4,5-T/diquat, 2,4,5-T, 2,4,5-T/dicamba, 2,4-D/picloram, 2,4-D ester, 4-CPA ester, dicamba, fenoprop, MCPA ester, 2,4-D amine, mecoprop, 2,4-DB, 2,4-D/dicamba, MCPB ester, MCPA salt, dichlorprop and MCPB salt. Among non-hormones paraquat was more active than diquat or glyphosate. The results are discussed in relation to seedling gorse control in pasture and the use of seedlings for arboricide development work.

INTRODUCTION

Information on the susceptibility of gorse seedlings to herbicide sprays is scanty and conflicting. Yeates (1955) regarded seedlings up to 50cm high as relatively susceptible to 2,4,5-T in comparison with older bushes. Matthews (1975), however, states that seedlings are quite resistant in the cotyledon stage, that they become susceptible once they have passed the seedling stage and, thereafter, become increasingly resistant with age. The effects of other chemicals are not recorded.

Seedling susceptibility is of interest from two aspects. Firstly, the growth of gorse from seed is a major factor in reinfestation after clearing. Thus development of a herbicide treatment giving control without too much injury to pasture species would be of value. Secondly, if the comparative response of seedlings to different herbicide preparations is related to the response of older, established bushes, it should be possible to employ seedlings in the initial stages of studies aimed at developing improved treatments, thereby accelerating and simplifying the process of raising, treating and assessing test plants.

The present investigation was initially started to compare the effects of growth-regulator type herbicides on young gorse seedlings under glasshouse conditions. It is being continued and extended to a wider range of chemicals and mixtures and this paper summarises results to date.

METHOD

Gorse seed was extracted from top soil under old gorse bushes and scarified by treatment for 30 minutes with concentrated sulphuric

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acid before sowing. The seed was sown into a peat/pumice/soil mixture in 10 cm plastic 'Plantabags', 10 seeds per pot, and thinned to five seedlings per pot after emergence. Seedlings were sprayed when they had grown to the 6-10 leaf stage (before side shoots developed) and were 2-3 cm high.

Sprays were applied with an experimental plot sprayer at various dates between May 1976 and January 1977. Seeds sown in winter took about 12 weeks to reach the stage for spraying, a period reducing to 6 weeks in summer. After spraying, pots were left until partially affected plants were starting to make new growth (about 12 weeks during winter, reducing to 8 weeks in summer) when the final assessment was made by cutting plants at soil level and weighing. Degree of effect was calculated as percentage reduction in mean fresh weight of individual plants compared with the untreated controls. Each treatment was applied to four replicate pots (20 seedlings).

Each chemical was applied at a logarithmic range of application rates. In most tests the range was 0.1, 0.3 and 0.9 kg/ha but in one comparison of 2,4,5-T ester with a 2,4,5-T/picloram mixture the range was 0.0375, 0.075, 0.15 and 0.3 kg/ha and in another trial with 2,4,5-T rates of 0.02, 0.036, 0.064, 0.112 and 0.2 kg/ha were compared. The activity of different chemicals can conveniently be compared on the basis of the amount of material required to reduce the harvested fresh weight by 50% (GR50). These GR50s were calculated from linear regressions of percentage reduction against log application rate. Standard deviations of the log GR50s were calculated by a method suggested by Gordon (pers comm).

RESULTS

To date most trials have been done with single herbicides or mixtures based on chemicals of the growth-regulator type. The results are summarised in the first part of Table 1, where the chemicals are arranged in order of decreasing activity.

The most active compound under the experimental conditions was picloram K salt, where 100 g/ha, the lowest rate tested, gave more than 90% reduction in growth. If it is assumed that the slope of the regression line relating log application rate to percentage growth reduction is similar to that of most other chemicals tested, the GR50 of picloram is unlikely to have been above 40 g/ha.

The next most active group of materials consisted of those containing 2,4,5-T. The butyl ester alone was tested in four trials, the results of which agreed well and gave an average GR 50 estimate of 94g/ha. The three GR 50 estimates given by the 4:1 2,4,5-T ester/picloram K salt mixture also agreed closely, with an average of 40g/ha (total of both ingredients), suggesting that this formulation was approximately twice as active on gorse seedlings as 2,4,5-T ester alone. Mixtures of two parts, 2,4,5-T/one part glyphosate or diquat were intermediate in activity between 2,4,5-T alone and 2,4,5-T/picloram, while the 4:1 2,4,5-T/dicamba mixture appeared to be less active than 2,4,5-T alone.

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TABLE 1: Application rates of single herbicides and mixtures required to cause 50% growth reduction of gorse seedlings

Treatment/Chemical	Log g/ha $\pm$ s.d.	GR 50 g/ha
<i>Growth regulators</i>		
picloram K salt	<1.6	< 40
2,4,5-T ester/picloram K salt, 4:1	1.62 $\pm$ 0.27	42)
2,4,5-T ester/picloram K salt, 4:1	1.61 $\pm$ 0.35	41) 40
2,4,5-T ester/picloram K salt, 4:1	1.56 $\pm$ 0.18	36)
2,4,5-T ester/glyphosate 2:1	1.75 $\pm$ 0.17	56
2,4,5-T ester/diquat 2:1	1.85 $\pm$ 0.30	71
2,4,5-T butyl ester	2.03 $\pm$ 0.27	110)
2,4,5-T butyl ester	1.92 $\pm$ 0.20	84)
2,4,5-T butyl ester	1.97 $\pm$ 0.24	93) 94
2,4,5-T butyl ester	1.96 $\pm$ 0.24	91)
2,4,5-T/dicamba esters 4:1	2.28 $\pm$ 0.18	190
2,4-D ester/picloram K salt, 4:1	2.46 $\pm$ 0.26	290
2,4-D butyl ester	2.47 $\pm$ 0.25	290
4 - CPA butyl ester	2.50 $\pm$ 0.23	320
dicamba amine	2.54 $\pm$ 0.13	340
fenoprop amine	2.63 $\pm$ 0.67	420
dicamba methyl ester	2.70 $\pm$ 0.24	500
MCPA butyl ester	2.83 $\pm$ 0.29	670
2,4-D amine	2.87 $\pm$ 0.36	740
mecoprop K salt	2.97 $\pm$ 0.23	930
2,4-DB Na salt	2.98 $\pm$ 0.48	950
2,4-D/dicamba esters 4:1	2.99 $\pm$ 0.22	980
MCPB butyl ester	2.99 $\pm$ 0.25	980
MCPA K salt	3.05 $\pm$ 0.53	1120
dichlorprop K salt	(3.4)	(2500)
MCPB Na salt	(3.5)	(3000)
<i>Other chemicals</i>		
paraquat	2.21 $\pm$ 0.26	160
diquat	2.74 $\pm$ 0.48	545
glyphosate	2.90 $\pm$ 0.25	783
ioxynil	(>3.6)	(>4000)

After the 2,4,5-T group there was a further drop in activity to the group consisting of 2,4-D ester, alone or mixed with picloram, 4-CPA ester and dicamba amine, all with GR50s around 300 g/ha, and to fenoprop amine (420 g/ha). Among the other growth regulators tested MCPA was less active than 2,4-D, the phenoxypropionics and phenoxybutyrics less than the phenoxyacetics and, with the exception of dicamba, ester formulations were generally more active than amines, sodium or potassium salts. The two least active growth-regulators were dichlorprop K salt and MCPB Na salt, which had little effect at the highest rate tested (0.9 kg/ha) and for which GR 50s of the order of 2-3 kg/ha were estimated.

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DISCUSSION

With regard to the statistical validity of these results, the fact that they were obtained in nine different experiments over a period of 8 months using several different dosage ranges makes it impossible to compare all the chemicals tested in a single analysis of variance. Analysis of the results of individual experiments by this method showed large and significant differences between chemicals. The only way the whole range of chemicals can be compared, however, and the only way the results can be clearly and concisely shown is on some such basis as the GR 50 adopted here.

On this basis the standard deviations given suggest a much lower level of significance in the differences. Thus, if the difference in the log GR 50 for 2,4,5-T and 2,4,5-T/picloram (0.373) is tested by a *t* test based on the standard deviations, it is found not to be significant. This difference between the two statistical approaches can presumably be explained by the fact that, in the analysis of variance, the comparison is based on all rates applied (i.e. on all points on the regression line), whereas the comparison of GR 50s relates to single points on the lines.

The standard deviations given in Table 1 can thus be regarded as giving a measure of relative variability of the GR 50 estimates but not as a basis for calculating significant differences between chemicals. It is suggested that an increase in log GR 50 of 0.3 (i.e. a doubling of the actual application rate) could reasonably be regarded as indicating a genuine difference in activity between chemicals.

The relative effectiveness of the chemicals tested on young seedlings shows good general agreement with field experience on established bushes. 2,4,5-T was shown to be considerably more effective than other phenoxy herbicides, even when applied to soft, leafy seedlings only a few cm high rather than to the woody, leafless tissues of established gorse. Presumably the barriers to penetration in leafy seedlings are much lower than the leafless stems of older plants, suggesting that the superiority of 2,4,5-T over other phenoxyacetics is due to intrinsic differences in susceptibility rather than to differences in penetration. Phenoxypropionic compounds were generally lower in activity than phenoxyacetics, while phenoxybutyrics were lower still. MCPB in particular showed little effect on gorse seedlings and was found useful in field trials for control of weeds in establishing gorse plots.

Of the two commonly used additives in gorse herbicides, picloram K salt appeared to have very high activity and addition of picloram to 2,4,5-T also resulted in increased activity. In the field, Mason (1966) reported the mixture as more effective than picloram alone but on young seedlings it might be expected that a water-soluble formulation would have a relatively greater effect than on older plants in the field. Dicamba, either as ester or amine, was less active than 2,4,5-T and the mixture was intermediate in activity. This is not in agreement with Taylor and Patterson's (1969) finding that dicamba increased 2,4,5-T activity but, with more persistent chemicals such as dicamba, it is possible that the ultimate development of the effects on established bushes would be different from that on seedlings.

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A difference in the persistence of chemical activity was shown in an experiment where series of pots treated with 2,4,5-T and 2,4,5-T/picloram were harvested 3, 5½ and 8 weeks after spraying. With 2,4,5-T alone the maximum effect was noted at the first harvest (results not included in Table 1) but by the time of the second harvest a considerable degree of recovery occurred at the lower rates, so that a lower degree of activity was estimated (GR 50 of 93 compared with 51 g/ha). There was little further change by the third harvest when a very similar estimate of activity was obtained. The action of the mixture, on the other hand, appeared to be slower, so that the effects of the lower rates gradually increased and the second harvest gave a higher estimate of activity than the first (70 g/ha, not included in Table 1). With the final harvest the effects still appeared to be increasing, though the change in GR 50 estimate was relatively small.

In general the results of the present study suggest that chemicals active against gorse seedlings are also injurious to pasture grasses or legumes, so that selective herbicidal control is likely to be difficult. They also suggest, however, that the use of young seedlings to obtain a quick indication of the relative effectiveness of herbicide treatments could be of value. Any treatment showing promise on seedlings would obviously require further testing in the field, but this would apply equally to any system of testing based on glasshouse or pot-plant studies.

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