EMERGENCE OF GORSE SEEDLINGS FROM A ROOT-RAKED AREA

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SUMMARY

Emergence of gorse seedlings was compared in pasture-covered plots, and in plots bared by herbicide or herbicide plus cultivation between February 1983 and November 1988. Most seedlings emerged from cultivated plots and least from pasture-covered ones. Emergence was greater during late summer and early autumn in each year. In November 1988 all plots were cultivated and observations on seedling emergence continued for a further 6 months. At this stage, fewest seedlings emerged from the previously cultivated plots, although differences were not significant. The recommended technique for minimising gorse seedling emergence is to leave the ground undisturbed and with a good pasture cover.

INTRODUCTION

Gorse (*Ulex europaeus*) produces large numbers of seeds which survive in the soil for at least 28 years (Moss 1959). Several authors have estimated gorse seed numbers in the soil as follows:

Moss (1959)	up to 3486/m ²	5 cm deep
Zabkiewicz and Gaskin (1978)	722 to 20742/m ²	6 cm deep
Rolston and Talbot (1980)	up to 2660/m ²	10 cm deep
Ivens (1982)	up to 2070/m ²	10 cm deep

Temperatures of up to 100°C stimulate gorse seed germination (Zabkiewicz and Gaskin 1978) and burning of gorse is reputed to encourage the germination of gorse seeds, and thus to deplete the seed bank in the soil. However, in practice, many viable gorse seeds survive even a good burn (Zabkiewicz and Gaskin 1978; Rolston and Talbot 1980). Rolston and Talbot (1980) suggested that the removal of the gorse canopy by fire was as important in initiating a germination flush as were the changes in soil temperatures during the burn. Ivens (1982) and Zabkiewicz (1979) both studied the emergence of gorse seedlings from naturally occurring seeds banks. Ivens (1982) recorded most germination in late spring and summer, and Zabkiewicz (1979) in summer and autumn. This discrepancy may have been due to site and season-specific temperature and rainfall differences. In the study described here, the seasonal emergence patterns of gorse seedlings and the decline in annual emergence were studied over a 6 year period after a dense stand of gorse had been root-raked.

METHODS

The experimental area, near Palmerston North, was a south facing hillside with tall, dense gorse until April 1979, when the gorse was burnt after being sprayed with herbicide in February 1978. Some areas of gorse were unaffected by the fire and gorse regenerated over most of the rest of the area. The whole area was root-raked in January 1983, leaving bare ground.

In February 1983, 18 plots (each 4 m by 3 m) were marked out on relatively smooth, almost flat land. The treatments, in six randomised blocks, were as follows:

1. **Pasture.** Ellett perennial ryegrass (*Lolium perenne*) (20 kg/ha) and Huia white clover (*Trifolium repens*) (3 kg/ha) oversown on 22 February 1983 and mown five to six times a year with a nylon string trimmer. Mown vegetation was usually left on the plots, being raked off only when long and lush.

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2. **Sprayed.** Ground kept bare by regular treatment with paraquat (Gramoxone) or glyphosate (Roundup), usually applied about four or five times a year.
3. **Cultivated.** As for treatment 2, but plots also cultivated to a depth of about 5 cm with a rotary hoe twice a year.

The trial area was fenced off from grazing, although cattle occasionally broke through the fence so that the trial site was trodden by sheep and cattle at these times.

Emerged gorse seedlings were counted at intervals of 1 to 2 months, initially in twenty .04 m² quadrats per plot, and later in whole plots. After the initial counts, both sprayed and cultivated plots were treated with paraquat (Gramoxone) to kill the gorse seedlings. In the pasture plots all seedlings were pulled out by hand, and this was also done in the other two treatments once seedling numbers had fallen.

Gorse seedlings were first counted in June 1983. After the seedling count on 30 November 1988, all the plots were cultivated by hand to a depth of 15 cm. Subsequent seedling emergence was observed at intervals until 31 May 1989.

No gorse plants flowered within 20 m of the plots during the trial.

RESULTS

Total seedling emergence was significantly greater in the cultivated treatment than in the other two treatments (Table 1), and more seedlings emerged in the sprayed than in the pasture treatment, although this difference was not significant. After the overall cultivation in November 1988, the above trend was reversed although there were no significant differences between any of the treatments at the 5% level of probability.

TABLE 1: Total numbers of gorse seedlings (/m²) which emerged under different treatments.

Treatment	Between 20 Feb 1983 & 30 Nov 1988 (before overall cultivation)	Between 30 Nov 1988 & 31 May 1989 (after overall cultivation)
1. Pasture	728	98
2. Sprayed	975	64
3. Cultivated	1471	44
LSD (5% level)	376.6	60.9

The seasonal (summer being December, January, February) pattern of seedling emergence throughout the trial in cultivated plots was as shown in Fig. 1. A logarithmic transformation was used to show comparisons between years more clearly. Although only results from the cultivated treatment are shown in Fig. 1, seasonal patterns were similar for all three treatments. In most years, most seedlings emerged in summer or autumn.

Annual total seedling emergence over the first 5 years is shown in Fig. 2, using a logarithmic transformation. Regression analysis showed that the slopes of the three lines did not differ significantly, although all were significantly greater than zero. Extrapolation of the lines suggests that seedling emergence in the pasture, undisturbed and cultivated treatments could be reduced to zero at about 7, 7.5 and 9 years after the commencement of the treatments.

DISCUSSION

The results reported here agree with those of Zabkiewicz (1979) and Ivens (1982) in that most gorse seedlings usually emerged in late spring, summer or autumn. The differences between years in the season of greatest germination can partly be explained by seasonal differences in rainfall. For example, summer 1984 was drier than usual, which may have shifted summer emergence into autumn (Fig. 1). As shown by Ivens (1983), the optimum germination temperature for gorse seeds is relatively high at 18 °C.

Fig. 1: Seasonal emergence of gorse seedlings throughout the experiment for the cultivated treatment (Treatment 3). Note log₁₀ scale on vertical axis.

Fig. 2: Numbers of emerging gorse seedlings in each year. Note log₁₀ scale on vertical axis.

Ivens (1978) observed that gorse seedlings emerged in large numbers when standing gorse was cleared, although laboratory studies have not shown any stimulation of germination by either light or alternating temperatures (Ivens 1983). In each year of this experiment, significantly more seedlings emerged from cultivated plots than from uncultivated ones. The likely explanation is that exposure of gorse seeds at the soil surface, as achieved by cultivation, stimulated germination, although changed soil moisture penetration or soil atmosphere composition could also have been responsible.

The slope of the regression line for annual seedling emergence from cultivated plots was less steep than, but not significantly different from, the slopes for the other two treatments (Fig. 2). Cultivation did not therefore hasten the rate of decline in gorse seedling emergence, even though it encouraged greater emergence. This is in contrast to the behaviour of nodding thistle (*Carduus nutans*) in a similar experiment (Popay *et al* 1987). Cultivation of all the plots in November 1988 increased seedling emergence, but numbers emerging were small by comparison with those at the start of the experiment. Differences between treatments were not significant, although there was a trend for less seedling emergence from the previously cultivated plots.

These results suggest that the rate of gorse seed loss from the soil by germination was similar whether the soil was cultivated or left undisturbed, although more seeds were lost due to effective emergence when the soil was cultivated. These facts do not fit the hypothesis that seeds exposed at or near the soil surface by cultivation are more likely to germinate. One alternative explanation is that gorse seeds are gradually losing innate dormancy, and that cultivation does little to accelerate this process. However, Ivens (1983) found that gorse seed collected from surface litter contained little hard seed. Another possibility is that gorse seeds in the soil are in a state of induced dormancy, which is gradually lost. A further explanation is that gorse seeds germinate at about the same rate whether they are on the soil surface or buried, but that deeply buried seeds are less likely to produce emergent seedlings. If this is so, the cultivation treatment here did not stimulate germination but it did mean that a higher proportion of the seeds which did germinate produced emerged and countable seedlings.

The results of this trial show that the best way to treat land which carries a heavy burden of gorse seed is to establish pasture as quickly as possible after the soil surface is bared, and subsequently to disturb the soil surface as little as possible. It may be better not to burn standing dead gorse, and to allow pasture to gradually establish under it. Pasture cover itself will not completely suppress new seedling emergence but will slow the growth of surviving seedlings. Gorse seedlings will still have to be controlled by grazing or by herbicides.

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