BURN-TIMING AND BRACKEN VIGOUR

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Summary

Plots of bracken (*Pteridium aquilinum* var. *esculentum*) were burnt off at eight different dates to determine the effect that time of burning has on rhizome starch reserves and frond regrowth vigour. The midsummer burn caused large reductions in frond fresh weight per unit area for 2 years. This correlated well with large reductions in rhizome starch reserves. Burning in either spring or winter appeared to result in increased starch reserves, possibly magnifying the problem. For maximum effectiveness it is recommended that site-preparation burning be done as soon as the fronds mature.

INTRODUCTION

Bracken is a serious weed on steep agricultural and forest land in many parts of the world. The traditional method of dealing with it in New Zealand forests has been to burn prior to planting followed by one or more hand-tool release cuttings around the trees depending on the relative vigour of the bracken regrowth and of the crop. Recently, effective chemical methods of control have been devised.

Field observations had suggested that for one or more years after burning the vigour of bracken regrowth might be affected by the timing of the burn. It was surmised that the massive production of new fronds over a short period each spring-early summer should heavily deplete rhizome-stored starch. Consequently, destroying these newly-developed fronds before they had accomplished any substantial replenishment of this reserve could significantly reduce regrowth vigour, especially if the timing was such that there was little immediate post-burn frond regeneration. If this could be confirmed it seemed possible that manipulation of burning time might significantly reduce the bracken problem. The work of Muller-Stoll and Michael (1949) supported this. They showed that the rhizome starch content of European bracken (*P. aquilinum* var. *typicum*) dropped to 4% at the beginning of July (in Europe) and suggested that this was the best time to cut the fronds.

Our study involved burning plots of bracken at different times of the year and determining the effect of this on frond regrowth and rhizome starch reserves for the ensuing 2 years.

METHOD

The trial was situated in hilly country immediately east of Rotorua City at an elevation of approximately 550 m. The area, which was covered with dense bracken 1.4 - 2.5 m tall, appeared not to have been burned for 8-10 years. Seven-metre x 19m plots were burnt at eight different times during the period September 1974 to June 1975 (See Figs. 1-6). Four replicates were burnt each time. The replicates were blocked according to microsite and burning dates were assigned at random within blocks.

Data collection involved cutting, counting, and fresh weighing all the fronds within a randomly selected, 3.5 x 5.7 m sub-plot within each burnt plot. This was done during August, a different sub-plot being used each year. Within each harvested sub-plot, five systematically located, 13.5

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cm diameter x 45 cm deep soil cores were extracted using a cylindrical, maul-driven core sampler. All the bracken rhizome segments were extracted from each core. It is estimated that 90-95% of rhizomes were in the top 45 cm of soil. Sections 1 cm long were removed from the centre of each rhizome segment for freeze drying, grinding, and starch determination using a modification of the procedure of Dekker and Richards (1971) described in Cranswick (1978). The remainder of the rhizomes were oven dried and the quantity of rhizome starch in kilograms per unit ground surface area was calculated.

The results in terms of oven-dry weight of rhizomes, rhizome starch concentration, rhizome starch quantity, frond numbers, frond fresh weight and average frond weight were subjected to 2-way and 3-way analyses of variance with *microsite* and *year* as the second and third factors. Although *microsite* and *year* proved statistically significant in some instances they generally did not assist in the interpretation of the results. Graphs of the *microsite*-adjusted means were often more inconsistent and less easily interpreted than those of the unadjusted means. Consequently, only the latter have been presented (Figs. 1-7). Although there were highly significant differences between years in some of the 3-way analyses of variance, it was impossible to interpret these because of the apparently large natural variability (possibly of climatic origin) from year to year as shown by the untreated controls (see especially Figs. 5 and 6).

RESULTS AND DISCUSSION

The results indicate that there are significant burning-date-dependent differences in bracken regrowth response for at least two years after burning. Average frond numbers produced on the midsummer-burnt plots (Jan. 28) in 1976 (Fig. 1) increased 2 to 2½ times compared with the plots burnt in winter and spring and the unburnt controls. Conversely, average frond weight (Fig. 2) in 1976 was diminished on the January-burnt plots to one-quarter or one-fifth of that for the spring-burnt and unburnt plots. The graphs showing frond numbers and average fresh weights produced in 1977 are still of the same general form as those for 1976. However, as might be expected further away in time from the influence of burning, the magnitude of the differences between average frond numbers diminished and the average frond weights increased.

Of more immediate importance for tree establishment was the influence of burning date on frond fresh weight per square metre in 1976 and 1977 (Fig. 3). The January-burnt plots, on which the new fronds had just matured at the time of burning, had approximately 42% less fresh frond weight in 1976 and 51% less in 1977 than the plots burnt in spring or winter. There is some evidence that burning in the spring or winter may even magnify the problem. Frond fresh weights of plots burnt at these times occasionally exceeded those of the unburnt controls.

Between-plot variation was such that both the 1976 and 1977 fresh frond weights/m² gave mean squares of a low order of statistical significance ($p = 0.113$ and 0.265 respectively) in the 2-way analyses of variance. However, when the data for both years were combined in a 3-way analysis of variance (effectively doubling the quantity of data), *burn-date* was highly significant ($p = 0.003$). Also, whereas one might have expected smooth or continuous response curves, the results are in fact somewhat erratic, especially those relating to the autumn and winter burns. As this cannot be accounted for on the basis of any known cause it must be assumed to be due to the variability among plots and inadequate replication.

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The effects in 1975 and 1976 of burning-date on rhizome dry weight (Fig. 4), starch concentration (Fig. 5), and starch quantity (Fig. 6), and on frond fresh weight/m² produced the succeeding summers (Fig. 3), show very similar patterns. There are pronounced minima in each instance corresponding with the late January burn, and sometimes secondary maxima and minima corresponding with the later burns. It seems probable, as already suggested, that these later erratic results are spurious.

Since frond production is partially dependent on the starch reserves present at the time of the new season's growth (Whittle 1964), it may be inferred that the effect of burn-timing on frond production is via its effect on rhizome starch levels (Fig. 7). The power function ($y = ax^b$) correlations between the 1975 rhizome starch quantity means and the 1976 and 1977 frond weight/m² means ($r = 0.94$, $r = 0.85$) and between the 1976 starch quantity means and 1977 frond weight/m² means ($r = 0.75$ after removal of one anomalous pair of values) provide good evidence of this.¹

Once again, an apparent stimulatory effect from the early burns is evident in some of the 1976 starch levels. It is noticeable that burning at most times of the year tends to have a rejuvenating effect on frond production. As Watt (1976) observed, old bracken stands, unburnt for many years, often appear degenerate and decadent. The fronds are few, often large and massive, and appear subject to mechanical damage from wind, and prone to disease. Spring frond-production is slow and maturation late compared with recently burnt sites. These latter produce numerous shorter and healthier fronds which emerge, expand, and harden off early. This effect appears to carry over for several years. The tendency for starch levels to be increased more by spring than by autumn or winter burns may be due to the early maturing, dense, rejuvenated regrowth which develops immediately after the spring burns (Fig. 3). This would contribute very substantially to starch replenishment during much of that summer and autumn. Later-burnt plots had little or no subsequent regrowth that season so that assimilation was cut short by varying amounts depending on the timing of the burn.

CONCLUSIONS

These results indicate that there are growth responses in bracken dependent on burning-date which could be of importance to forest establishment and that these responses are mediated through the effect of frond removal on photosynthesis and starch accumulation. Also, the effects on starch and frond growth last for *at least* two years. Although the starch reduction did not approach the 90%-plus found by Williams and Foley (1976) to be necessary for rhizome degeneration, it is evident that reductions of the order of 50% brought about by a single burn when full frond expansion has just been completed can significantly reduce the weight of frond regrowth for at least 2 years after burning.

It is suggested that, in the absence of chemical treatment, a worthwhile contribution towards abating the bracken nuisance on sites of low bracken vigour can be made simply by manipulating the time of burning. Even where foliar herbicide treatments are planned an appropriately timed burn a year in advance, when frond expansion has just ceased, could be advantageous. The large number of dormant frond buds stimulated into growth implies that fewer may be left to be killed off chemically, and the 2-2½ times increase in the number of fronds produced the following summer should ensure many more points for a foliar-applied herbicide to enter the already debilitated rhizome system.

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- FIG. 1: Average number of bracken fronds/m² in August 1976 and 1977 in relation to burning date in 1974/75 (UC = unburnt control).
- FIG. 2: Average fresh weight of bracken fronds in August 1976 and 1977 in relation to burning date in 1974/75 (UC = unburnt control).
- FIG. 3: Fresh weight of bracken fronds/m² harvested in August 1975, 1976, and 1977 in relation to burning date in 1974/75 (UC = unburnt control).
- FIG. 4: Oven-dry weight of bracken rhizomes/m² in August 1975 and 1976 in relation to burning date in 1974/75 (UC = unburnt control).
- FIG. 5: Bracken rhizome starch concentration in August 1975 and 1976 in relation to burning date in 1974/75 (UC = unburnt control).
- FIG. 6: Bracken rhizome starch quantity/m² in August 1975 and 1976 in relation to burning date in 1974/75 (UC = unburnt control).

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FIG. 7: Fresh weight of bracken fronds/m² (y) in 1976 in relation to rhizome starch quantity/m² (x) in 1975.

$$\hat{y} = 1.058x + 0.409$$

Correlation coefficient, $r = 0.94$.

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¹ Of interest for future work was the very high linear correlation between rhizome starch quantity and oven-dry weight of rhizomes : 0.992 in 1975 and 0.929 in 1976. It would seem that oven-dry weight of rhizomes per square metre alone is a good indicator of rhizome starch reserves in bracken.