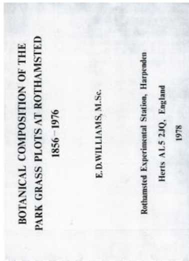
# Botanical Composition of the Park Grass Plots at Rothamsted 1856-1976






## Changes With Lime

### Rothamsted Research

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## CHANGES WITH LIME

Comparison of treatments and discussion of the effects of lime under the main schemes have, as mentioned earlier, been made several times in the past. The present analyses were not undertaken primarily to provide further evidence of these differences, and since only a limited number of plots were analysed in any one year, the results do not lend themselves readily to valid detailed comparisons of all treatments. It is, however, apparent in view of the many long-term changes already noted on some plots and relative stability on others, that differences between treatments will also be affected. However, such detailed comparisons would probably be applicable only to the particular site in question whereas a study of succession within particular types of communities would be expected to be more widely applicable. Except on the plots given sodium nitrate, the effects of lime are very pronounced but the differences between unlimed and limed half-plots are often not much greater than those which have occurred with time on the unlimed half-plots as they have become gradually more acid. For example, the botanical composition of the unlimed half of Plot $11^1$ in 1903 was qualitiatively similar to that of the limed sub-plots *a* in 1974.

In so far as comparison is possible the effects of lime under the new scheme, particularly where it has been applied to previously unlimed sub-plots, have appeared in general larger than the effects in 1914 of lime applied under the old scheme in 1903 and 1907. The reason for this is that between that time and 1965, when the new scheme was started, the unlimed halves of the plots in question became progressively more acid; this was reflected in their botanical composition : whereas a wide range of species were present in 1903, in 1965 the unlimed sub-plots were dominated by single acid-tolerant grasses. The initial effect of lime applied in 1903 was to encourage or discourage differentially species already present but lime applied under the new scheme also allowed species which were absent at the time or present in extremely small amounts to be introduced or to increase on the newly-limed sub-plots. The increase in pH also at the same time caused a marked reduction in the dominant species. One of the effects of fresh lime during 1965-68 was to allow re-introduction of species previously present on the plots before they became so acid. For example, *Festuca*, much increased on 1*c*, was very abundant on Plot 1 unlimed during 1939 and 1940, the composition of 18*c* in 1973 resembled that of the unlimed sub-plot in 1923, $4^2c$ in 1973 probably resembled that of the unlimed half during the 1920s (it was not analysed between 1914 and 1949), 10*c* that of 10 unlimed in 1948, 9*c* that of 9 unlimed during 1926 and 1927, $11^1c$ that of $11^1$ unlimed in 1903 and $11^2c$ that of $11^2$ unlimed during the first ten years of the century. This provides further evidence that the effects of lime have not been much greater than changes which have occurred naturally with time. This was also so on sub-plots given increased rates of lime. The effect of lime on these plots was to accentuate the trends already occurring with time: the decline of *Alopecurus* already occurring since 1948 was increased by increased rates of lime. It is likely, however, that sub-plots which have received lime under the new scheme are still in a state of change, albeit a slower one than during the first seven years. Brenchley (1937), describing the effects of lime, states "that the initial effect may be accentuated with time until a certain position" (presumably of relative stability) "is reached as far as effect of liming is concerned, although seasonal conditions will still cause fluctuations in the normal way".

In general, lime in the new scheme has shown that under acid conditions relatively small changes in soil pH (Thurston, Williams & Johnston, 1976) in the uppermost soil

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layers may bring about fairly large changes in the botanical composition. For example, the changes in botanical composition on Plot 18*c* were associated with only 0.2 pH unit increase in the uppermost 7.5 cm of soil in 1971, although the pH of the 'mat' of partially decomposed organic matter was raised from 3.9 to 6.3 (Johnston, 1972). The effects of recent lime on the botanical composition of the swards has, in general, been more consistent than on yield since it has been less subject to seasonal variations. Also, although in 1973 recent lime on $11^1$ increased yield of sub-plot *c* compared to *d* by only about 20%, but by as much as 70% on $11^2$, changes in botanical composition were similar. The reduction in the acid-tolerant grasses and replacement by other species was accompanied by large increases in yield, especially at the first cut on sub-plot *c*. However, changes in the proportion of grasses already present e.g. on sub-plot $11^2b$ had little effect on yield, although pH was raised from 4.7 to c.6.0 in the uppermost 22.5 cm.

Although the unlimed sub-plots of plots $4^2$, 9 and 10 were very similar, consisting of c.70% *Anthoxanthum*, and although this was decreased to 5-10% by lime, the species was replaced by different amounts of different species on the different sub-plots. On $4^2c$ *Anthoxanthum* was replaced mainly by *Festuca rubra* on 9*c* by *Holcus* and on 10*c* by both. It is clear therefore that a prediction of the effects of lime entails not only knowledge of the existing flora and extent of pH change but also previous fertiliser application or nutrient status of the soil as well as the proximity of other species. The presence of *Festuca rubra* on K-deficient soil in the pH range 4.7-5.5 on the Park Grass plots confirms this association on other soils and under other management conditions (*e.g.* Castle & Holmes, 1960; Murphy, 1960; Heddle, 1967; Smith, Elston & Bunting, 1975; Arnold, Hunter & Gonzalez-Fernandez, 1976). The relatively small effect of lime under the new scheme on % *Agrostis* on plots receiving $N_2$ is similar to the effects at the start of light lime on Plot 19, where there was also no reduction during the first 8 years although there were large reductions later. It is, however, not clear why lime should increase the amount of *Holcus* on sub-plots 9*c* and 10*c* whilst decreasing it on $11^1c$ and $11^2c$.

It is now abundantly clear that, although some species are plentiful in very acid conditions whilst others are absent, great caution needs to be exercised in categorising species simply into those that are discouraged or encouraged by liming. The distribution of species is influenced by the relative preferences and tolerances of other species and also the influence of lime depends on the pH range and extent of change and on what other nutrients are applied. For example, although *Holcus* dominates the unlimed acid sub-plots of $11^1$ and $11^2$ this may not be because it prefers acid conditions *per se* but because it is better able to survive and is not subjected to competition from other species in such conditions. There have been some instances, as already noted, where the amount of *Holcus* has been increased by lime on Park Grass. Similarly, *Rumex*, which may appear to prefer acid conditions, also grows well on limed soils but is subject to increased competition there (Brenchley, 1935).

## ASSOCIATION BETWEEN BOTANICAL COMPOSITION AND YIELD

Although the experiment was set up as an agricultural investigation and the treatments induced large changes in yield these were soon associated with conspicuous changes in botanical composition. However, the fact that complete fertilisers ($N_3$PK) increased yield three-fold even in the first year suggests that this was achieved by the response of species already present at the outset,



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