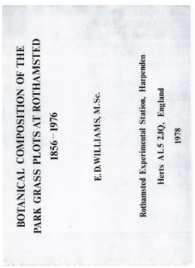
Botanical Composition of the Park Grass Plots at Rothamsted 1856-1976



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effect during the first 20 years.

Liming, especially the larger amount, decreased *Anthoxanthum* and *Holcus* but increased *Helictotrichon* and *Trisetum.* The amount of legume, although somewhat increased by lime, has been more dependent upon season than upon the liming treatment. The main other species have been *Plantago, Ranunculus* and *Achillea.* Neither % *Plantago* nor the time of its increase have been affected by lime, *Achillea* was little affected by low lime and decreased by high lime whereas *Ranunculus* was increased by low lime but decreased by high lime.

3. **FYM once every four years with NPK in other years** (Plot 20)

As on Plot 19 (FYM alone), *Alopecurus* has tended to be the main grass species on this plot but *Dactylis* and *Arrhenatherum* have also been prominent (Table 36). In contrast to Plot 19, where it declined during the 1940's *Alopecurus* remained at a high level on this plot. Although lime, especially the larger amount, increased % *Alopecurus* until 1925, it afterwards decreased it. In contrast, *Arrhenatherum* was decreased by both amounts of lime during the first three years; afterwards the smaller amount increased it but there was no increase with the larger amount until 1946-48. The effect of lime on *Dactylis* was small and somewhat erratic, and the larger amount tended to decrease it. *Poa pratensis* was decreased by the smaller but increased by the larger amount of lime though *Poa trivialis* was increased by both amounts. *Helictotrichon* has declined on all sub-plots of Plot 20; it was decreased by low lime at the start but then increased though high lime increased it throughout. In contrast *Trisetum*, decreased by both rates of lime at the start, was afterwards little affected. Both rates of lime decreased *Agrostis* but not *Holcus. Lathyrus* has varied greatly with season and has been increased by high lime throughout (Table 37).

Plantago, prominent in the late 40's was increased by both amounts of lime but *Achillea* little affected by low lime was increased by high lime. *Taraxacum* was also increased by lime.

2. CHANGES INDUCED BY THE NEW LIMING SCHEME

A. EFFECTS OF APPLICATIONS OF LIME BETWEEN 1965 AND 1968 ON THE BOTANICAL COMPOSITION OF PREVIOUSLY UNLIMED SUB-PLOTS *c* COMPARED WITH THAT OF SUB-PLOTS *d* (CONTINUOUSLY UNLIMED) OF PLOTS GIVEN AMMONIUM SULPHATE i.e. 1, 4^2, 9, 10, 11^1, 11^2 AND 18 AND OF 13 (FYM AND FISH MEAL)

To assess the effects of fresh applications of lime to previously unlimed sub-plots *c*, samples of herbage were taken for botanical analyses in 1973 from the relevant sub-plots and also from the corresponding permanently unlimed sub-plots *d* of the same plots. Although the plots were not sampled for botanical composition prior to the introduction of the new scheme in 1965, visual survey showed no changes in the flora of sub-plots *d* between 1965 and 1973. Since these sub-plots are dominated by single species, the botanical compositions of sub-plots *d* in 1973 may be taken as a measure of the composition of both *d* and *c* (i.e. the unlimed half-plot) at the start of the new liming scheme.

Since liming affected total dry matter yield at hay making as well as botanical composition, results are expressed not only qualitatively as % composition of hay but also quantitatively as amounts ha^{-1} as explained in the Introduction.

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1. Plots 1 (N_1) and 18 (N_2KNaMg)

The unlimed sub-plots of both plots 1 and 18 were dominated by *Agrostis* at the start of the new liming scheme and sub-plot *d* of both plots had more than 80% *Agrostis* in 1973. By 1973, 12.5 and 10 t ha^{-1} of calcium carbonate had decreased this species from 84 to 20% on 1c and from 83 to 52% on 18c (Table 38). *Anthoxanthum*, which contributed c.10% on 1 and 20% on 18, was less affected. The most obvious changes were extremely large increases in % *Festuca rubra* on both plots (from 3 to 50% on 1 and from 0.1 to 14% on 18) and the introduction or increase of a large number of other species including *Cerastium, Plantago, Rumex* and *Taraxacum* on both plots. *Lathyrus* and *Trifolium* also established on both plots but in greater amount on 1 than on 18, *Lathyrus* having spread inwards from adjacent Plot 14.

Since liming increased the yield of *c* relative to *d* approximately threefold on both plots in 1973, the effects on the amount of species per unit area of land (Table 39) differed from those on percentage composition (Table 38). For example, the large reduction in % *Agrostis* on 1*c* compared to 1*d* was largely offset by the increase in yield and on 18*c* the relatively smaller decrease in % *Agrostis* was more than counterbalanced by the increased yield so that there was almost twice as much *Agrostis* on 18*c* as on 18*d*. On the other hand, increases in % composition of particular species e.g. *Festuca* were greatly accentuated by the yield increases.

2. Plots 4^2 (N_2P), 10 (N_2PNaMg) and 9 (N_2PKNaMg)

The unlimed half-plots of these three plots were dominated by *Anthoxanthum* at the start of the new liming scheme in 1965 and the unlimed sub-plots *d* continue to be so (Table 38). About 20 t ha^{-1} of chalk, applied to these sub-plots between 1965 and 1968, decreased % *Anthoxanthum* from more than 70% to between 5 and 11%. The yield of hay was at the same time increased by at least 50% but the reduction in the amount of *Anthoxanthum* was nevertheless at least 80% (Table 39). In contrast to *Anthoxanthum* and to *Agrostis* in the previously discussed plots, % *Agrostis* on these plots was less affected by liming. However, on Plot 10*c* the combined effect of a small increase in % *Agrostis* and the 50% increase in total yield resulted in a large increase in the amount of this species. Liming allowed a range of grasses to increase or to establish. On Plots 4^2c and 10*c*, in the absence of potash, *Festuca rubra* increased greatly to form about half and a quarter of the total yield respectively; on 9*c* which receives potash, *Festuca* increased much less and formed only 3% of the total yield. *Holcus* increased greatly on 9*c* and 10*c* and *Poa pratensis* increased on all three sub-plots.

There was some evidence that *Holcus* increased further between 1973 and 1976 on 9*c* as also did *Arrhenatherum* (Tables 44 and 45). Only on 9*c* did legumes and appreciable amounts of other species establish.

3. Plots 11^1 (N_3PKNaMg) and 11^2 (N_3PKNaMgSi)

The unlimed half plots of 11^1 and 11^2 were dominated by *Holcus* in 1965 and sub-plots *d*, permanently unlimed, continue to be so. Twenty t ha^{-1} of chalk, applied between 1965 and 1968 have resulted in very similar changes in the botanical composition of both sub-plots. Percentage *Holcus* was decreased from 96 to 34% (Table 38) and the weight was, on average, halved (Table 39).

In 1973 *Arrhenatherum* contributed about 30%, *Poa pratensis* 12%, *Alopecurus* 8%

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and *Dactylis* 6% on sub-plots *c* but were absent on sub-plots *d*. No legumes were present in the samples from either plot in 1973 although visual survey had indicated that a few plants of *Trifolium pratense* were present on $11^2 c$ between 1966 and 1969. Liming allowed small amounts of *Anthriscus, Cerastium, Heracleum, Rumex* and *Taraxacum* to establish.

4. **Plot 13 (FYM and fish meal)**

The main effect of lime on this sub-plot has been to increase *Arrhenatherum* and the legumes, *Lathyrus* and *Trifolium pratense* and to decrease *Agrostis* and *Holcus*. Lime also appeared to have relatively large effects on some of the other species but since their individual contribution rarely exceeded 1% confirmation of the changes would be needed in other years. (Tables 38 and 39).

B. EFFECTS OF INCREASED APPLICATIONS OF LIME BETWEEN 1965 AND 1968 ON THE BOTANICAL COMPOSITION OF SUB-PLOTS *b* (WHOSE pH IS BEING RAISED TO 6) COMPARED WITH THAT OF SUB-PLOTS *a* (LIMED ONCE EVERY FOUR YEARS UNDER THE OLD SCHEME TO MAINTAIN pH AS IN 1965) OF PLOTS 4^2, 9, 10, 11^1 and 11^2.

As might be expected, increasing the rate of liming on previously limed sub-plots has effected fewer changes in botancial composition than liming sub-plots previously unlimed.

On plots $4^2 b$ and 10*b* whose pH was previously more than 5.5, only 3.7 t ha^{-1} of calcium carbonate were needed to raise the pH to 6 and this caused few changes in botanical composition. The only significant change was a large increase in both percentage and weight of *Helictotrichon* on $4^2 b$. Both *Plantago* and *Rumex* appeared to be increased by increased lime on $4^2 b$ but not on 10*b* (Tables 40 and 41).

Sub-plot 9*b* was slightly more acid than $4^2 b$ and 10*b* and was given twice as much lime (7.5 t ha^{-1}) to increase the pH to 6. The main effects of this in 1974 were to halve the % (Table 40) and weight (Table 41) of *Alopecurus* and to increase the legumes, particularly *Lathyrus*. Sub-plots 9*a* and 9*b* were again analysed in 1976. It is likely, however, that sub-plot *b* would still be in a state of change and sub-plot 9*a* received 14 t ha^{-1} of chalk in 1976 under the second phase of the new scheme. It is, therefore, not possible to determine how much of the difference in the results between 1974 and 1976 is due to season or treatment. In general, total yield was less, grasses particularly *Arrhenatherum* contributed less but legumes and other species relatively more in 1976 than in 1974. The 1976 analyses like 1974 showed more *Anthoxanthum, Festuca rubra* legumes and *Taraxacum* but less *Poa trivialis* on sub-plot *b* than on *c*. On the other hand, results for *Dactylis, Poa pratensis* and *Anthriscus* were in 1976 opposite to those in 1974.

The largest effects of increased rates of lime were on $11^1 b$, which received 25 t ha^{-1} of chalk and whose pH was only 4.2 at the outset, and on $11^2 b$, which received 15 t ha^{-1} of chalk and whose pH was 4.7. The increased amounts of lime on these sub-plots almost halved *Alopecurus* but increased *Arrhenatherum*, particularly on 11^1. *Holcus*, however, which had become plentiful in recent years, especially on 11^1, was markedly decreased. Small amounts of *Lathyrus* were found in samples from both *a* and *b* sub-plots of plots 11^1 and 11^2 in 1974. *Anthriscus* and *Heracleum* were increased by the increased rates of liming.

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