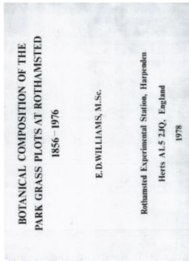
ROTHAMSTED RESEARCH

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


BOTANICAL COMPOSITION OF THE
PARK GRASS PLOTS AT ROTHAMSTED
1856 - 1976

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1978

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Changes With Time

Rothamsted Research

Rothamsted Research (1978) *Changes With Time ;* Botanical Composition Of The Park Grass Plots At Rothamsted 1856-1976, pp 9R - 10R **- DOI: https://doi.org/10.23637/ERADOC-1-156**

3. COMPARISON OF THE BOTANICAL COMPOSITION OF PLOTS 3, 7 AND 14 IN 1975 AND 1976

(Tables 42, 43, 44 and 45)

The present botanical composition of these plots has already been discussed when successional changes were presented and the very different weather conditions preceding the 1975 and 1976 harvests have also been emphasised.

There was nevertheless good agreement between the results for the two seasons especially for the major components on the plots. For example, on the unlimed half of Plot 3 (Unmanured), *Festuca rubra* contributed 32-33% in both seasons and *Agrostis* on the unlimed half of Plot 7 (PKNaMg) was 29 and 31% in 1975 and 1976 respectively. Also on the unlimed half of 14 (N_2*PKNaMg) *Arrhenatherum* and *Alopecurus* were co-dominant but on the limed half *Arrhenatherum* was dominant in both 1975 and 1976. The unlimed half of Plot 7 consisted of 30% *Arrhenatherum* in 1975 and although only partial analysis was done in 1976 (Table 44) about three-quarters of the grass fraction (40%) appeared to consist of *Arrhenatherum* in that year.

There were also some differences between seasons. The most significant of these was the increase in % other species on the limed half (L) of Plot 3 and the large increase in % legumes on the limed half of Plot 7 in 1976 compared with 1975. The increase in other species on 3L in 1976 was mainly at the expense of the grasses but the increase in legumes on 7L was accompanied by a decrease in other species so evidently the drought induced different reactions in different communities. Particular species e.g. *Hypochaeris* and *Leontodon* were much encouraged in 1976; *Dactylis* and *Lolium* also appeared more abundant than usual and *Arrhenatherum* was more plentiful on 14L in 1976 than in 1975.

DISCUSSION AND CONCLUSIONS

CHANGES WITH TIME

As pointed out in the Introduction the present analyses were initiated to quantify the changes in botanical composition on those sub-plots which had received new or increased rates of lime under the new liming scheme. The analyses were then extended to include plots with unchanged treatment to assess whether and how much they had changed since the previous hay analyses during 1948 and 1949. At the same time it became clear that a better appraisal of the present-day flora would be achieved by considering it not only in relation to changes in the immediate past but also in relation to the main changes on the plots throughout the duration of the experiment. The scope of the work was, therefore, widened from a presentation of the results of the 1973-1976 analyses to include also a review of past results. However, because of the large amount of accumulated data the results section dealt only with those changes which were deemed large enough or to have continued for long enough to be obviously 'significant'. It is likely that other changes have occurred especially in minor components which the method of analysis was not sensitive enough to detect. Plot yields have changed (usually decreased) slowly with time but except in the early (1862-77) and late (1973-76) analyses the amounts of species per unit area of land were not calculated; in view of the yield changes it is possible that over a period of time the changes in the amount of species might be somewhat greater or smaller than the percentage figures suggest. Although percentage composition can be compared throughout, because of the change

https://doi.org/10.23637/ERADOC-1-156

in the method of estimating yield (hay before 1960 but dry weight since then) the absolute amount of species after 1960 cannot be compared with that before that date.

With the introduction of the four-year liming scheme in 1903 and the new liming scheme on some plots in 1965 the parts of the plots with unchanged treatment have become progressively smaller; thus for the ammonium sulphate plots the continuously unlimed section is now only a quarter of that during the first 47 years and on other plots half that at the outset. Nevertheless, despite the smaller area, because of the large differences between treatments and the length of time they have continued, it is possible to ascertain what successional changes are occurring.

Although many of the major differences between plots were established in the early years and have persisted throughout the duration of the experiment the dynamic nature of the vegetation on the plots has also long been recognised. Commenting on the 1858 results, particularly on the proportion of *Lolium* in the samples, Lawes and Gilbert (1859) stressed that "it must not be supposed that figures which represent the proportion of flowering and seeding stem of a certain plant at a given period of the season are at the same time accurate indications of the relative development of the total plant under all the conditions in question. It must be borne in mind that the numerous plants which constitute the complex herbage of our meadows have each their natural period of flowering and seeding. It must be remembered that by cutting time some plants are grown up and disappeared whilst others may escape the scythe. Plants may be present in diminished numbers or in such limited growth that they are not obvious at all times when observations are made and still less are they found in the samples. When circumstances become favourable again they re-appear". Brenchley (1937) also pointed out "that the botanical composition of the herbage of any particular area of grassland is by no means static, but is in a constant flux, varying not only from year to year, but also from one season of year to another. This is true even when the treatment of these plants is the same for many years". Apart from these short-term variations between and within seasons, the available evidence, including that from recent analyses, shows that long-term changes are also occurring on most plots. That is, botanical composition continues to change systematically despite unchanging treatment. The extent, rate and direction of the changes, however, vary between treatments. On some plots definite increases or decreases in certain components have occurred during the last 30 years, on others a complete change in dominant species has occurred, on others the changes have been cyclical such that the present-day botanical composition more closely resembles that sixty than thirty years ago and on yet others few changes have occurred in the dominant species although changes may have occurred in more minor components. The fact that groups of plots are behaving similarly confirms that the changes are genuine, and not haphazard.

The unlimed halves of the unmanured plot (3) and of those receiving PKNaMg (7) or PNaMg (8) had much more *Festuca rubra* during 1975 and 1976 than they had during 1948 and 1949. On the unmanured plot the 32% recorded was larger than any in the past although the species exceeded 20% during 1872-1903; on the other two plots similar or larger values were recorded in the past but not since 1935 on 7 (PKNaMg) and 1941 on 8 (PNaMg). On the limed halves of the unmanured and PNaMg plots there was also much more *Festuca* during 1975 and 1976 than during 1947 and 1948 but on the PKNaMg plot only small amounts were present, as previously. It is unlikely that these increases were merely seasonal since there was good agreement between the two contrasting seasons. On Plots 3 and 7, % grasses also appears to have increased

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recently. Some of these changes could be explained by the plots becoming more acid but this possibility is ruled out by the fact that recent analyses (Table 3) have shown the pH on these plots to be largely unchanged since 1959. *Dactylis* has also decreased generally in this group of plots except possibly on the PNaMg plot, where it has always been very infrequent and *Helictotrichon* and *Rumex* have also decreased. However, not all changes have been similar : whereas *Holcus* has decreased on the unmanured plot, especially on the unlimed half, it has increased greatly on the other two plots.

The unlimed halves (or quarter-plots since 1965) of all plots given the intermediate amount of ammonium sulphate, except the one not given phosphate, have become dominated by *Anthoxanthum* since the last analyses in 1948 and 1949. Visual survey suggests that they became so during the late 50's and early 60's. Even on the plots not given phosphate (Plot 1 (N_1) and Plot 18 (N_2KNaMg) the amount of *Anthoxanthum* has increased substantially. On these plots however, a similar precentage of *Anthoxanthum* has occurred in the past: on Plot 1 *Anthoxanthum* increased to about 15% and remained at that level until after 1919 and then declined, but on Plot 18 only in one other year (1920) was as much *Anthoxanthum* recorded as in 1973. However, since past records and present analyses show much seasonal variation in this species further analyses would be required to ascertain whether the increases on these two plots are transient or permanent. Also, although *Anthoxanthum* has evidently dominated the unlimed halves and later sub-plots *d* of Plots 4^2, 9 and 10 for the last 10-15 years, it is not clear whether the proportion (70%) now on the plots represents an equilibrium position with *Agrostis* or whether the species is still increasing to a completely dominant position as *Holcus* has done on Plots 11^1 and 11^2. Further analyses in 5-10 years time would be needed to assess this.

Most of the plots now dominated by *Arrhenatherum* and *Alopecurus* have shown systematic variations in these components in the past. On the limed halves of Plot 9 (N_2PKNaMg) and 11^1 (N_3PKNaMg) where *Arrhenatherum* is now dominant or co-dominant with *Alopecurus* respectively, the relative proportions of the two species in 1974 and 1976 more closely approximated to those in 1914 (ten years after the start of the main liming scheme) than they did in most of the intervening years, when *Alopecurus* was dominant. As on Plot 9, *Arrhenatherum* is also now dominant on 11^2. A decline in *Alopecurus* also occurred during the 1930s and 1940s on plots given FYM, especially on the unlimed and lightly limed sub-plots of Plot 19 which did not receive inorganic fertilisers. In contrast on Plot 20, which received NPK as well as FYM, there was less decline in *Alopecurus* and this did not occur on the unlimed sub-plot. On Plot 18 (N_2PNaMg), which lacks K, a very pronounced decline in *Alopecurus* occurred on both lightly and heavily limed sub-plots.

Amongst the half-plots that have shown little change during the last fifty years or so are those unlimed and given the largest amount of ammonium sulphate and PKNaMg (Plots 11^1 and 11^2) which are dominated by *Holcus*. The unlimed and limed half-plots of Plot 14 (N_2 as sodium nitrate) and 7 (PKNaMg), which are dominated by *Alopecurus* and *Arrhenatherum* respectively, have also been relatively stable although some decline in *Dactylis* has occurred recently compared to the level during the 1940s. It will be of great interest to see whether these plots remain stable in the future; in particular, whether *Anthoxanthum* which has appeared to increase on 11^1d since the 1973 analysis will continue to do so.

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