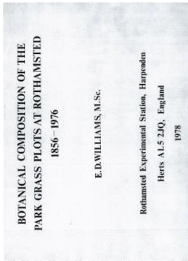
ROTHAMSTED RESEARCH

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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Relationship Between Fertiliser Treatment and Botanical Composition

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years were probably distorted by the abnormally high yields during the fifth decade. After the rapid increase and subsequent dominance of *Holcus* appreciable decreases in yield occurred. Although the larger yields on the limed halves were associated with *Alopecurus* and *Arrhenatherum*, changes in yield with time could not be correlated with changing botanical composition.

On plot 17, receiving sodium nitrate, yield has declined continuously although botanical composition has been relatively stable. However, on Plot 14, receiving the larger amount of sodium nitrate and PKNaMg, moderately stable yields have been associated with relatively stable botanical composition.

Although evidently it is possible to associate differences in yield on the Park Grass plots with differences in botanical composition and to outline changes in yield with time in relation to concurrent botanical changes it is clear that the relationship between yield and botanical composition is very complex and it is very difficult to establish causal relationships between the two. The complexity of the situation is due to the large number of species present, insufficient botanical data for some periods (e.g. 1877 to 1903), difficulties of estimating hay yield accurately on low-yielding plots and of satisfactorily eliminating the effects of variable and changing weather conditions. In addition, until 1960 estimates of yield were also affected by weather during hay-making. Another reason for the difficulty in correlating yield and botanical composition is that both are affected by a third factor, the fertiliser treatment and hence nutrient status of the soil. Yield is the indirect consequence of the effects of the fertiliser treatments on the responses and interactions or competition of the species present and depends on the fact that whereas some species may have very specific requirements and do not seemingly respond to increased fertility others may be less specific in their requirements and be able to respond to increased fertility.

Despite these difficulties it is nevertheless possible to characterise the extreme situations. In general, low-yielding plots, e.g. the unmanured and the PNaMg plots, have large numbers of low-growing dicotyledonous species together with unproductive grasses, or where conditions are acid and P and/or K are deficient, only acid-tolerant grasses are present, whereas the higher-yielding plots are now dominated by *Alopecurus* and *Arrhenatherum*. However, plots with roughly similar botanical composition may yield differently whilst others with similar total yields have very different botanical compositions.

RELATIONSHIP BETWEEN FERTILISER TREATMENT AND BOTANICAL COMPOSITION

The experiment is best known for the way in which the different fertiliser regimes have changed the presence and balance of species on the different plots. The subject has been comprehensively presented in many previous publications (Lawes, Gilbert & Masters, 1882; Brenchley, 1924; Brenchley & Warington, 1958) and need not be repeated here.

However, it must be emphasised that conclusions about the preferences of individual species and their response to various factors should take account of other factors involved and also of changes that have occurred with time. The distribution of species is not governed solely by the response to the presence or absence of one particular nutrient although data from Park Grass can be used to pinpoint some of the major determinants within a given situation. Additionally, the frequency of a given species may be determined as much by the response through competition of

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other species, as by the preferences of the species itself. In such situations further experiment is needed to determine the relative importance of the two factors. As pointed out previously, although *Holcus* is dominant on the acid conditions of the N_3PK plots this may be a reflection of differential survival and tolerance under these conditions and cannot be interpreted as a reflection of the preferences of the species. *Holcus* is now infrequent where potassium is not given (Plot 10) but was so dominant during the 1920s and 1930s that Brenchley and Warington (1958) concluded that the species was encouraged by omission of potassium. However, in the absence of nitrogen the species continues to be more plentiful without than with potassium. Similarly, without nitrogen and under fairly acid conditions (pH approx 5) *Arrhenatherum* is more abundant where K is withheld but when the plots are limed the opposite is now true, though not in the past. Also, on the limed sections of Plot 10, given N_2PNaMg, omitting K decreases % *Arrhenatherum* but the species appears to be increasing on this treatment. *Alopecurus,* often described in the past as requiring complete fertilisers, was dominant for 30-40 years at the beginning of the century on two plots (4^2 and 10 limed) which had not received K for about fifty years previously. Evidently, the species is able to survive under fairly low levels of K; its replacement by *Festuca rubra* might be because *Festuca* can tolerate even lower levels of K or it is better favoured by the increase in pH which occurred between 1923 and 1959 on these plots (Warren & Johnston, 1964)

A further example of a different response at different time is shown by the colonisation of *Chamaenerion angustifolium* on the plots. Following much damage to the vegetation of the unlimed half-plots receiving ammonium sulphate during the severe winter of 1928/29, more *Chamaenerion* established on plot 4^2 than on 11^1 and Brenchley & Heintze (1933) attributed this to the greater competitive ability of the vegetation on 11^1 than on 4^2. However, botanical analyses of the plots following the very cold winter of 1946/47 showed that much more *Chamaenerion* then established on 11^1 than on 4^2.

EFFECT OF SEASON ON BOTANICAL COMPOSITION

Since almost all the major differences between plots are apparent every year it is clear that seasonal differences are small compared to those due to treatments and in only abnormal seasons is the influence of treatment out-weighed by weather. Nevertheless, large effects occur in some seasons, but these are usually reversible e.g. following the drought of 1871 there was a large amount of *Bromus* on Plot 14 but it soon decreased afterwards. Also, following the droughts of 1921 and 1976, *Alopecurus* was much increased on the unlimed half of Plot 14 during 1922 and 1977. On the unmanured and other plots in 1938 and 1976, % other species was larger than usual and the relative increase in this group in dry seasons has long been recognised. This effect is noted in the White Books for the 1872 season: "With regard to the weedy herbage these also have necessarily been retarded in growth but the ill effects of a dry season are less felt by many of them than by the graminaceous or leguminous plants on account of the faculty which some of them possess for retaining and storing in periods of plenty through the agency of their fleshy roots a sufficiency of moisture and nutrient to supply the parent plant in time of scarcity like that which prevailed during the present year". Temperature may, as well as rainfall, affect the proportion of the three main groups of plants. In 1921 the proportion of grasses was high on most plots despite low rainfall presumably because of high temperatures; low

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