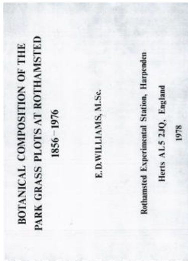
ROTHAMSTED RESEARCH

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



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Effect of Season on Botanical Composition

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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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temperatures early in the season tend to reduce the proportion of grasses. Seasonal variations in yield, however, cannot easily be related to differences in botanical composition at least as far as the three main groups of plants are concerned (Brenchley, 1935).

The weather conditions preceding the 1937 and 1938 and the 1975 and 1976 harvests were similar in many respects, the spring of 1937 and 1975 being very wet but 1938 and 1976 very dry. In 1938, % other species was high on both limed and unlimed halves of the unmanured plot but in 1976 only on the limed half; *Poterium, Plantago* and *Leontodon* were all increased. In 1976 only *Leontodon* had a greater % on the unlimed half than in 1975. The relatively small increase in % other species on the unlimed half in 1976 compared with 1975 (35% as against 29%) contrasts strongly with the increase in 1938 compared to 1937 (67% as against 35%) but the reason for this is unclear. *Arrhenatherum* on Plot 14 (N_2 *PKNaMg) limed increased in 1938 and 1976 compared to the levels in 1937 and 1975 but it decreased on Plot 9 with equivalent treatment where N is given as ammonium sulphate. Different depths of rooting of the same species on the two plots (Lawes & Gilbert, 1871) may possibly account for the different result. On both halves of the unmanured plot % legumes was about 2% less in 1976 than in 1975 but on the limed half of the PKNaMg plot there was very much more legume in 1976 than in 1975. Both these results are in accord with Cashen's conclusions (1947) from past data: these were that an extra 25 mm of rain increased % legumes by 0.5% on the unmanured plot and that a greater proportion of leguminous plants would be expected to occur on the plot receiving mineral manures *following* a dry year. (1975 was very dry from mid-May onwards).

Although seasonal effects are often in themselves not permanent they may precipitate developments and changes already occurring on the plots. It is possible for example that the large permanent decreases in *Holcus* on the unlimed halves of Plot 10 (N_2PNaMg) after 1938 and of Plot 9 (N_2PKNaMg) after 1962 and the increasing amount and eventual dominance of *Anthoxanthum* on these plots might, to a large degree, be associated with the extreme weather conditions in both years, the summer of 1938 being exceptionally dry and the 1962/63 winter exceptionally cold. It would be of great interest to know the mechanism of increase of *Anthoxanthum* on Plot 9– whether it was by rapid increase of the 'ecotypes' already present on it or whether there was incursion from nearby Plot 10.

GENERAL

There were large changes in yield and botanical composition of the plots during the early years; changes in yield were possible from the outset because of the presence of appreciable amounts of species like *Holcus* and *Lolium* which responded to the increased fertility and in botanical composition because of the large number of species present. Since the changes depended on both the range and type of species present initially, the potential for such rapid change might not exist in all vegetation types. For example, it is likely that if the experiment were now started on land whose botanical composition resembled the present day unmanured plot, changes in yield at least would be smaller since many of the species may have become adapted to the low nutrient status and so could not respond to increased supplies. Some evidence in support of this comes from results from the microplot experiment on Plot 5[1] (unmanured 1897-1963 following N_2 as ammonium sulphate) where increased supplies of nitrogen have resulted in only small increases in yield (Johnston, personal

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