

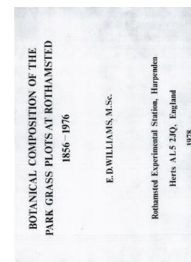
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## Botanical Composition of the Park Grass Plots at Rothamsted 1856-1976

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### C. Plots Receiving Nitrogen As Sodium Nitrate

#### Rothamsted Research

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Small amounts of *Lathyrus* were present on this plot in most years in the past and the amount increased during the late 1930's and 1940's; it is now abundant (Table 25). As on the limed half of Plot 7 (PKNaMg) the species was unusually abundant during 1976. Before 1940 other species rarely contributed more than 4% to the yield but since then they have ranged from 4 to 14%, the increase being mainly in *Heracleum* and *Taraxacum*.

#### 6. N<sub>3</sub>PKNaMg (Plot 11<sup>1</sup>) and N<sub>3</sub>PKNaMgSi (Plot 11<sup>2</sup>)

On Plot 11<sup>1</sup> (with the largest amount of ammonium sulphate) *Alopecurus* and *Arrhenatherum* increased slowly to reach about 30% in 1903 and 1919 respectively. Both species then declined to very small amounts. Percentage *Dactylis* doubled during the first ten years, then decreased to its original level between 15 and 20 years and then virtually disappeared. Neither *Poa* species, both about 10% at the start, persisted. Neither *Lolium* nor *Holcus* were as much encouraged in the early years as on Plot 9, with a smaller amount of N. In fact, *Holcus* declined during the early years, but then increased greatly as *Alopecurus* and *Arrhenatherum* declined. It has been dominant on this plot since c. 1910 (Table 26). *Agrostis*, encouraged during the early years, has not persisted on this plot to the same extent as on the plots receiving N<sub>2</sub>. *Anthoxanthum* has been present in only small amounts; in 1973 it made up 5% of the herbage and appears to be increasing. Except during the early years, or in exceptional seasons, only small amounts of other species have occurred on this plot. The botanical composition of Plot 11<sup>2</sup>, which receives Si as well, has been similar to 11<sup>1</sup> except that *Holcus* probably became completely dominant later. *Alopecurus* contributed 30% to the yield of this plot in 1919 whereas it had declined to 1% on 11<sup>1</sup> by 1914. *Arrhenatherum* also persisted for longer on 11<sup>2</sup> than on 11<sup>1</sup> (Table 27).

As on the plot receiving N<sub>2</sub> (96 kg N ha<sup>-1</sup>) and PKNaMg, *Alopecurus* and *Arrhenatherum* are the most abundant grasses on the limed end of these plots. Without silica (Plot 11<sup>1</sup>) *Alopecurus* and *Arrhenatherum* were equally abundant in 1914, 11 years after the start of liming. *Alopecurus* then increased and *Arrhenatherum* decreased markedly. Afterwards *Alopecurus* decreased and *Arrhenatherum* increased so that they were again present in roughly equal proportions in 1974. On 11<sup>2</sup> *Alopecurus* was twice as abundant as *Arrhenatherum* in 1914 and a similar sequence of events occurred but on a different scale so that in 1964 there was almost twice as much *Arrhenatherum* as *Alopecurus*. There has, for most of the time, been more *Dactylis* on 11<sup>2</sup> than on 11<sup>1</sup>. Although *Poa pratensis* has declined *Poa trivialis* has increased. A large increase in *Holcus* has occurred on both plots since the 1947 and 1949 analyses. *Taraxacum* established on these plots during the 1940's and since then *Anthriscus*, *Heracleum* and *Rumex* have increased slightly.

### C. PLOTS RECEIVING NITROGEN AS SODIUM NITRATE

These plots were started in 1858. Plot 15 (already discussed) which has received PKNaMg since 1876, received 96 kg N ha<sup>-1</sup> as sodium nitrate annually between 1858 and 1875.

#### 1. N<sub>1</sub> (Plot 17)

The botanical composition of this plot contrasts strongly with that of Plot 1, which receives the same amount of nitrogen, but as ammonium sulphate. Grasses have usually contributed about 70% and other species 30% to the yield of plot 17 but legumes only

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a trace [Table 7(c)]. About 30 species of plants occur on this plot. There has, with the possible exception of *Anthoxanthum*, been no large or permanent increase in the acid-tolerant species: the plot now has less *Holcus* than in the past and there is less *Agrostis* than at the outset (Table 28). *Alopecurus* contributed almost a quarter of the yield at the start and also in 1976 but about 10% less than this in most of the intervening years. *Dactylis* increased during the first decade of the century and was abundant from 1925 to 1949 but declined sometime between that time and 1975, when it was 5%. *Festuca rubra* has been the other main grass. A small amount of *Lolium* has persisted on this plot. There have been few legumes. *Plantago* has been the main other species throughout. *Leontodon* increased at the beginning of the century and was 4% in 1975 as also was *Ranunculus*.

The vegetation on the limed half of this plot (Table 29) has been relatively stable although *Festuca* has decreased recently. A larger percentage of *Lolium* was recorded on this plot than on any other plot in recent years and more *Trifolium pratense* was also present than in the past. As on the unlimed half plot *Plantago* and *Leontodon* are the main other species.

### 2. N<sub>1</sub>PKNaMg (Plot 16)

About 80-90% of this plot consists of grass. Legumes have been variable ranging from about 2 to more than 10% and other species about 10% [Table 7(c)]. The plot now has about 20 species. *Festuca*, *Helictotrichon*, *Holcus* and *Trisetum*, all prominent during the early years, afterwards declined. *Alopecurus* increased greatly during the first 60 years and was 51% in 1919; it then declined and was 29% in 1975. At the same time *Arrhenatherum* increased so that the two species are now co-dominant (Table 30).

On the limed half of this plot *Arrhenatherum* increased much as on the unlimed half. *Alopecurus* which was equally abundant on both half-plots in 1914 afterwards declined earlier and to a greater extent on the limed half so that it was only 4% in 1975 (Table 30). *Festuca* and *Helictotrichon* were much reduced in 1975 compared to 1949. The main recent change in other species on the limed half has been a very large increase in *Heracleum*. *Ranunculus* and *Taraxacum* have also increased.

### 3. N<sub>2</sub>PKNaMg (Plot 14)

This plot has had a large percentage of grass and usually has less legume and other species than Plot 16 [Table 7(c)]. It has also had slightly fewer species.

As with the smaller amount of sodium nitrate *Alopecurus* quickly increased and as on that plot was 50% of the herbage in 1919. It remained at a high level (35-62%) during the next 20 years, declined to c. 30% during the late 1940's but had increased slightly again by 1975 and 1976. *Arrhenatherum* established sooner and had in fact reached 41% on this plot before starting to increase on Plot 16 (N<sub>1</sub>PKNaMg); it has been co-dominant with *Alopecurus* especially since the late 1940's. The amounts of *Anthriscus* and *Taraxacum* have fluctuated throughout the course of the experiment (Table 31).

Liming this plot more than halved % *Alopecurus* from about the fourth year onwards but increased % *Arrhenatherum* from the fifth year onwards (Table 32). The amount of *Alopecurus* was further reduced in the 1940's. *Dactylis* has decreased as also has *Festuca rubra*, and *Anthriscus* and *Taraxacum* have fluctuated as on the unlimed half. Details of the differences between the botanical composition of parts of the plot in the sun and in the shade are outlined by Brenchley & Warington (1958) –



in general *Dactylis* and *Arrhenatherum* were less but *Festuca rubra* much more abundant in the shade than in the sun.

#### D. PLOTS RECEIVING ORGANIC MANURES

None of the plots now receiving farmyard manure (FYM) have the treatment dating back beyond 1905. Plot 13 which has received FYM and fish meal alternately once every four years since 1905 received  $N_2$  (as ammonium sulphate) and PKNaMg between 1856 and 1904 and straw until 1897. Plot 19 which has FYM once every four years received  $N_1$  (as sodium nitrate) and PK between 1872 and 1904. Plot 20 which also received  $N_1$  (N as potassium nitrate and PK) during the same period also now receives FYM every fourth year but also N (30 kg ha<sup>-1</sup> as nitrate of soda), P (15 kg ha<sup>-1</sup> as superphosphate) and K (45 kg ha<sup>-1</sup> as sulphate of potash) in intervening years.

Plot 13 was included in the liming scheme of 1903 and is now in the new one. Plots 19 and 20 (like 18) were divided in 1920 into lightly, heavily and unlimed thirds to test two laboratory methods for measuring the lime requirement of soils. (Warren & Johnston, 1964). They are not included in the new liming scheme and were not analysed during 1973-76. They were, however, unlike the plots in the main liming scheme, analysed in the years immediately after liming and so provide evidence of the rate of change in different constituents after liming, not available from any other plots. For this reason past results for these two plots are also included (see also Brenchley, 1925 and 1930).

##### 1. FYM and fish meal (Plot 13)

The main species on the unlimed end of this plot has for most of the time been *Alopecurus*. It increased until the mid-40's to c. 50%, then declined to 16% in 1974. *Agrostis* increased in the mid-40's and was twice as abundant as *Alopecurus* in 1973 and *Holcus* has increased markedly since 1949 (Table 33).

*Alopecurus* was increased by lime in 1919 but then declined to less than on the unlimed half. *Arrhenatherum* was also increased by lime in 1914 but then declined before increasing to become the most plentiful grass in 1948. Although lime had only small effects on *Dactylis* in the early years it greatly increased it during 1946-48 so that it contributed more than 20% in those years. With lime *Agrostis*, *Anthoxanthum* and *Festuca* are infrequent and *Holcus* now much reduced. Legumes, although variable between seasons were plentiful on the limed half. *Plantago* has been the main other species, although it was much reduced on the unlimed half in 1974 (Table 33).

##### 2. FYM every fourth year (Plot 19)

Although *Alopecurus* was slightly more prominent than most other species it declined during the 30's and for most of the time there has been no single dominant. Legumes have been plentiful but variable, and although *Plantago* was the main other species during 1946-48 there was also much *Ranunculus* and *Achillea* (Table 34).

Lime had little effect on *Alopecurus* until the ninth year when low lime increased but high lime decreased it (Table 35). Afterwards during 1946-48 both amounts of lime increased *Alopecurus*. The effects of lime on *Dactylis* depended upon the season: in many years there was little effect but in others there were large (and similar) increases with both amounts of lime. *Festuca rubra*, little affected at the start, was usually decreased by lime although high lime increased it during the eighth and ninth years. High lime decreased *Agrostis* from the fifth year onwards but low lime had little