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Rothamsted- the Classical Experiments

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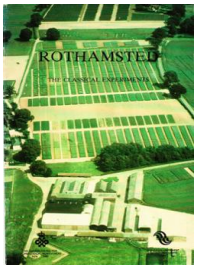

Broadbalk Wilderness

Rothamsted Research

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Some of the free-living nematodes of the Broadbalk soils are carried down in the water reaching the drains and can be caught on fine-mesh sieves at the outfalls. This has added to the knowledge gained more laboriously by taking soil samples and extracting the nematodes.

Other uses of Broadbalk

Broadbalk has for many years attracted the interest of scientists working in subjects that were not in the minds of Lawes and Gilbert when they planned the experiment. Because the soil of each plot is now in a virtually stable condition and cultivations and husbandry are changed as little as practicable the crops on Broadbalk offer especially good facilities for studying fluctuations of yield or of pests, diseases, etc., in relation to seasonal differences. It was on this field that, in 1935, eyespot (*Pseudocercosporella herpotrichoides*) was first identified in this country. Comparisons of yields and of differences in amounts of take-all (*Gaeumannomyces graminis* var. *tritici*) between continuous wheat on Broadbalk and other fields in shorter sequences of cereals over a period of years culminated in D. B. Slope and Judith Cox developing the hypothesis of 'take-all decline'. Severe symptoms of take-all are often seen in short sequences but seldom in the continuous wheat and the latter generally gives only about 1 t ha^{-1} less yield than wheat in rotation. This decline of take-all, although still inadequately understood, has since been shown to be common when cereals are grown continuously. H. F. Barnes studied the fluctuations in numbers of wheat blossom midges (*Contarinia tritici* and *Sitodiplosis mosellana*) for nearly 40 years. The statistical analysis of the relation between rainfall and yields of the Broadbalk plots was one of the first tasks of R. A. (later Sir Ronald) Fisher.

Recent projects that used Broadbalk material included:

(1) growth analysis in relation to yield of wheat from season to season in standard soil conditions.
(2) investigation of the uptake and losses of N fertilizer using ^{15}N as a tracer.

Material from the field is occasionally provided for workers outside Rothamsted.

BROADBALK WILDERNESS

In 1882 about 0·2 ha of the wheat crop on land unmanured for many years was enclosed by a fence at the end of the Broadbalk Field nearest the present farm buildings, left unharvested and the land not cultivated. The wheat was left to compete with the weeds, and after only four years the few plants surviving were stunted and barely recognizable as cultivated wheat. One half of the area has remained untouched; it is now woodland of mature trees about 20 m high, and leading species are ash, sycamore and oak. Hawthorn, now the understorey, is dying out. The ground is covered with ivy in the densest shade, and with dog's mercury, violet and blackberry in the lighter places.

The other half has been cleared of bushes annually to allow the open-ground vegetation to develop. This consists mainly of coarse grasses, hogweed, agrimony, willow-herb, nettles, knapweed and cow parsley, with many other species in smaller numbers. The bushes that appear are mostly hawthorn, dog-rose, wild plum, blackberry, with a few maple and oak.

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In 1957 this 'grubbed' section was divided into two parts, that farther from the woodland area has continued to be grubbed each year. The other part was mown several times during each of the next three growing seasons and the produce removed to encourage grasses as a preparation for grazing. Although the hogweed and cow parsley gave place to ground ivy, the grasses did not increase substantially until sheep were put in to graze. By 1962 perennial ryegrass and white clover had appeared, and they are now widely distributed. The ground ivy has almost gone, and the growth of the miscellaneous plants is much restricted.

The soil has gained much organic matter since the Wilderness was fenced off in 1882. Over the period 1883–1964, the net gain of nitrogen by the top 69 cm of soil from the grubbed part was 4·5 t ha^{-1}, and the corresponding gain of organic carbon 51 t ha^{-1}. The wooded and grubbed parts of the Wilderness accumulated carbon and nitrogen at almost exactly the same rates. By 1964, the Wilderness had gained more organic matter than the plot on Broadbalk receiving 35 t ha^{-1} of farmyard manure annually since 1843.

Legumes were absent from the grubbed section of the Wilderness until recently and the nitrogen gains (equivalent to 49 kg N ha^{-1} $year^{-1}$) appear to have come from rain, bird droppings, dry sorption of ammonia (13 kg N ha^{-1} $year^{-1}$) and from nitrogen fixation by bacteria in the rhizosphere of the perennial weeds. Acetylene reduction assays show that hogweed, hedge woundwort, ivy and ground ivy all support a nitrogen-fixing flora which can, under wet conditions, fix as much as 0·5 kg N ha^{-1} day^{-1}.

Nitrogen gains in the wooded section are as yet unexplained.

HOOSFIELD ALTERNATE WINTER WHEAT AND FALLOW

From 1856 to 1932 this area, which has been completely without manures since 1851, was divided into two strips which alternated wheat and fallow in successive years. From 1932 to 1982 a modification allowed a yearly comparison of a one-year and a three-year fallow but the effects were fairly small (Table 3) and since 1983 the experiment has reverted to the original design.

TABLE 3

Hoosfield Wheat after fallow (mean yields of grain, t ha^{-1})

	Hoosfield wheat Years of fallow		Broadbalk wheat Unmanured continuous
	1	3	
1856–65	1·8	–	1·2
1973–82	1·5	2·0	1·6

The variety of wheat has always been the same as on Broadbalk and the effects of fallowing may be roughly estimated by comparing yields of wheat on Hoosfield with continuous unmanured wheat on Broadbalk (Table 3). In the first 10 years of the experiment the one-year fallow gave an extra 0·6 t ha^{-1}. Unlike Broadbalk the yield on Hoosfield has declined during the experiment and from 1973 to 1982 the yield after one-year fallow equalled that of the continuous wheat.

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