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The Long Term Experiments

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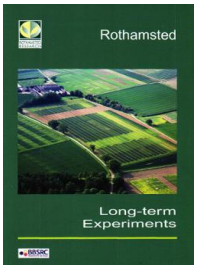

Exhaustion Land

Rothamsted Research

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EXHAUSTION LAND

Unlike some of the other Classical experiments, which have been modified without losing the continuity of many of their treatments, this experiment has had several distinct phases since it started in 1856.

From 1856 to 1901, annual dressings of N, P, K or FYM (from 1876 only) were applied. Wheat was grown initially (1856-1875) then potatoes (1876-1901). There were 10 plots from 1876 to 1901.

From 1902 to 1939 no fertilisers or manures were applied and, with a few exceptions, cereals were grown. Yields were recorded in some years; residual effects of the previous treatments were very small in the absence of fresh N fertiliser.

From 1940, fertiliser N was applied to all plots. Nitrogen not only increased yields, but also demonstrated the value of P and K residues remaining in the soil from the first period of the experiment. From 1940 to 1985, spring barley was grown and N fertiliser applied to all plots every year, initially at a single rate, but in 1976 the 10 main plots were divided to test four rates of N. The residual effects of the P and K were initially large but declined as amounts of available P in the soil declined (Table 6).

Table 6. Exhaustion Land; mean yields of barley grain.

Period	N, kg ha^{-1}	Cultivar	Plots 1, 2, 5, 6 no P, no K	Plots 7, 8 residues of PK fertilisers 1856-1901	Plots 3, 4 residues of FYM 1876-1901
			Mean yields of grain, t ha^{-1} at 85% dry matter		
1949-63	63	Plumage Archer	1.8	2.9	3.2
1970-75	88	Julia	1.8	4.2	4.8
1980-83	0	Georgie	0.7	1.5	2.3
	48		1.1	2.2	3.2
	96		1.1	2.7	3.8
	144		1.2	2.8	3.8

In 1986, after a long period when the P residues in particular were being "exhausted", it was decided to see how quickly this decline in soil fertility could be reversed. Annual, cumulative dressings of 0 v 44 v 87 v 131 kg P ha^{-1}, as triple superphosphate, were tested on five of the original plots (each divided into four sub-plots). Basal N and K were applied such that these nutrients did not limit yield. Responses to fresh P were rapid. After just three years, where P applications had

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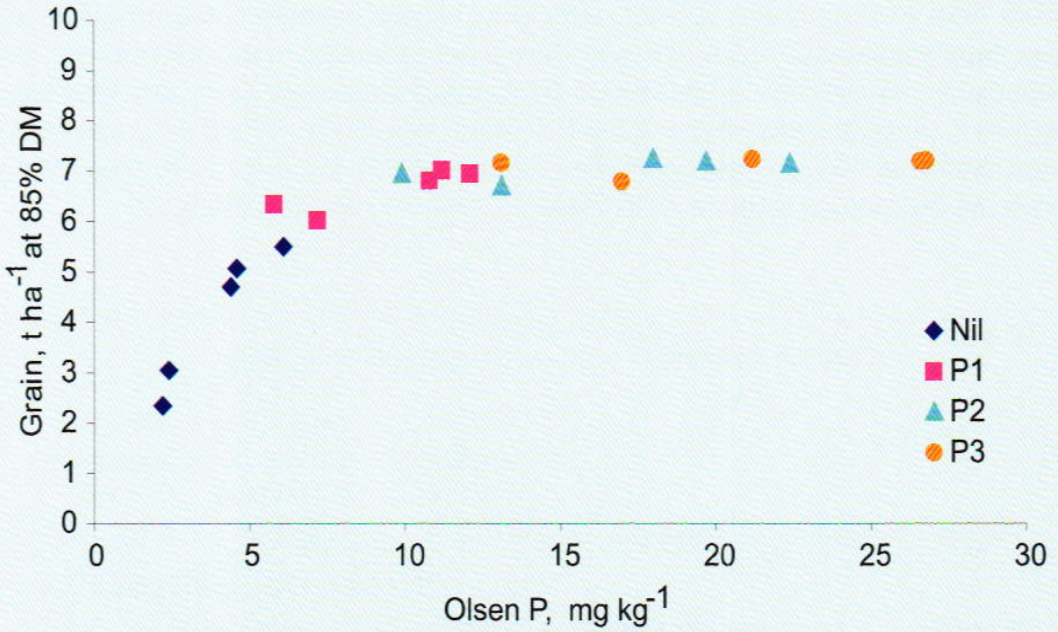
increased available-P (Olsen P) above a critical level, a yield "plateau" was reached (Fig 7). Although further applications of fresh P increased soil P, they did not increase yield. Applying three fixed rates of P stopped after seven years and, since 2000, maintenance dressings, equivalent to offtakes by the crop, have been applied (not to the no-fresh-P sub-plots). Wheat has been grown since 1992. Typically, it showed the same response to available-P as spring barley *i.e.* above a critical level, *on this soil*, of about 10-12 mg kg^{-1} there is no further increase in yield. In the first year that wheat was grown take-all was severe (especially in plots deficient in P) despite many decades of continuous spring barley. This raises interesting questions, as yet unanswered, about the nature and causes of take-all decline.

Fig.7 Exhaustion Land. Response of spring barley after 3 years fresh P



On the other half of the experiment, the effects of K residues (in the presence of basal P and N) on yield are investigated.

HOOSFIELD WHEAT AND FALLOW

From 1856 to 1932, this 0.4 ha area, which has received no applications of fertiliser or manure since 1851, was divided into two strips that alternated between wheat and fallow in successive years. From 1934 to 1982, a modification allowed a yearly comparison of a one-year and a three-year fallow but the effects were small and, since 1983, the experiment has reverted to the original design. It does receive chalk, when needed, and pesticides.

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