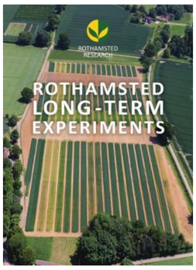
# Guide to the Classical and Other Long-term Experiments, Datasets and Sample Archive






## Hoosfield Spring Barley 31

### Rothamsted Research

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## Hoosfield Spring Barley

Spring barley has been grown continuously on this experiment since 1852. It offers interesting contrasts to Broadbalk; being spring-sown it has only needed to be fallowed four times to control weeds and it tests not only nitrogen, minerals and FYM but also sodium silicate (Table 6).

The design of the experiment is of a factorial nature (Warren & Johnston, 1967) with strips 1-4 (Plan 3), originally testing four combinations of nutrients: 0 v P v KMgNa v PKMgNa, crossed by four Series, originally testing no N or three forms of N, applied (usually) at 48 kg N ha$^{-1}$ (Series 0, no N; Series A, ammonium sulphate; Series AA, sodium nitrate; Series C, rape cake, later castor meal).

The sodium nitrate Series was divided in 1862 for a test of 0 *v* sodium silicate; this was modified in 1980 to test: 0 v silicate 1862-1979 v silicate since 1980 v silicate since 1862. Additional plots, on the south side, test: unmanured (plot 61); ashes, 1852-1932 (plot 62); residues of FYM applied 1852–71 (plot 71); FYM since 1852 (plot 72). Ashes were tested because in the early years of the experiment they were used to bulk up the different fertilisers to the same volume for ease of spreading. Thus, ashes alone were tested to ensure that no additional nutrients were being added. Two new plots, started in 2001, test: P2KMg (plot 63) and FYM (plot 73). Strip 5 tested various other combinations of N, P, K and Mg.

Short-strawed cultivars have been grown on the whole experiment since 1968 when most of the existing plots were divided and a four-level N test started, replacing the test of different forms of N. Growing barley in rotation with potatoes and beans was tested on parts of Series AA and C. The effects of the two-year break on the yield of barley were small, and barley has been grown each year on the whole experiment since 1979.

In 2003, several major changes were made to the experiment. On the “Main” plots (see Plan), the four-level N test continued but P and Mg are being withheld on some plots (and on parts of Series AA) until levels of plant-available P and Mg decline to more appropriate agronomic levels. Series C and Strip 5 are now used to test responses to plant-available P; basal N is applied and some plots receive K fertiliser to ensure that K is not limiting yield. The silicate test on Series AA has been simplified by stopping the four-level N test and applying basal N.

Until the 1980s, PK with appropriate amounts of N, gave yields as large as those from FYM (Figure 7). More recently, yields have increased on the long-term FYM soil such that, on average, they are not now matched by fertilisers alone. The difference in yield on these soils, with very different levels of SOM in the top 23cm (1.0% and 3.8% organic C in NPK and FYM plots respectively), is probably due to the improved soil structure and improved water-holding capacity, and to additional N being mineralized and made available to the crop at times in the growing season, and in parts of the soil profile, not mimicked by fertiliser N applied in spring. The purpose of the new FYM treatment, which started in 2001, is to see how quickly yields can be increased and how long it takes for yields comparable with those on the long-continued FYM treatment to be achieved. Yields on the new FYM treatment are now about 2 t ha$^{-1}$ larger than on the NPK plots but are still about 1.0 t ha$^{-1}$ less than those on the long-continued FYM plots (Figure 8). This implies that much of the difference in yield is due to the mineralization of extra N, but there may be further benefits as soil structure gradually improves. However, much of the N mineralised from the extra SOM on the FYM-



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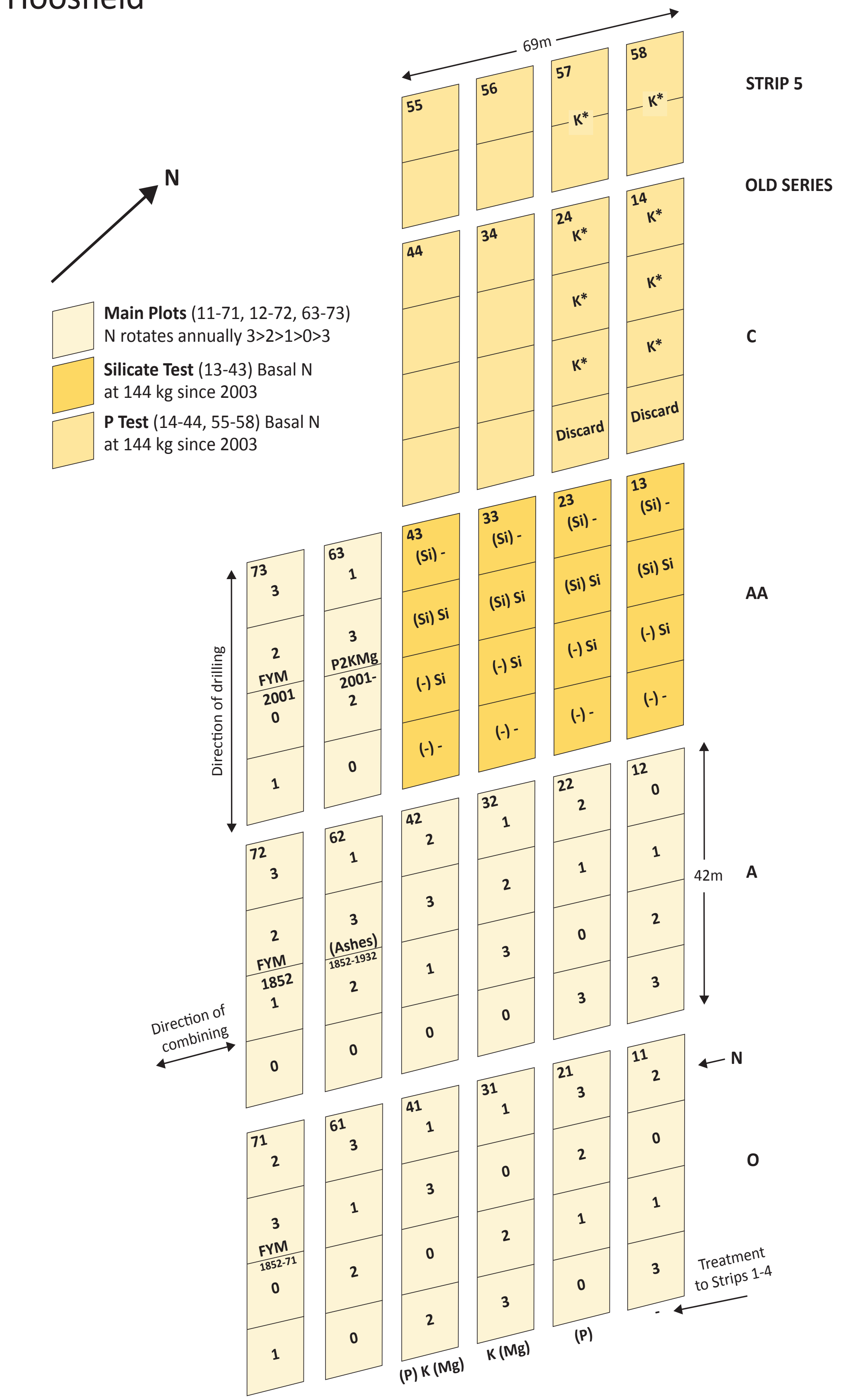
# Hoosfield



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## Table 6. Hoosfield fertiliser and organic manure treatments.

**Annual treatment per hectare**

**Nitrogen (applied in spring)**

| | |
|---|---|
| N 0, 1, 2, 3 | 0, 48, 96, 144 kg N as calcium ammonium nitrate (Nitro-chalk)<br>N rates rotate in the order: N3 > N2 > N1 > N0 |

**Organics (applied before ploughing in autumn)**

| | |
|---|---|
| FYM 1852 | Farmyard manure at 35 t since 1852 |
| FYM 2001 | Farmyard manure at 35 t since 2001 |
| FYM 1852-71 | Farmyard manure at 35 t, 1852-1871 only |

**Minerals (applied before ploughing in autumn)**

| | |
|---|---|
| P2 | 44 kg P as triple superphosphate since 2001 |
| (P) | 35 kg P until 2002 (to be reviewed for 2020) |
| K | 90 kg K as potassium sulphate |
| K* | 180 kg K, 2004-8 (450 kg K in 2003) |
| (Mg) | 35 kg Mg as Kieserite every 3 years until 2002 (to be reviewed for 2020) |
| Mg | 35 kg Mg as Kieserite since 2001 |
| Si | 450 kg sodium silicate since 1980 |
| (Si) | 450 kg sodium silicate 1862-1979 |

Note: Na as sodium sulphate discontinued in 1974 (applied with K and Mg),
P, K and Mg last applied to Series C for 1979

**Series treatments (last applied 1966; 1967 for parts of Series C)**

| | |
|---|---|
| 0 | None |
| A | 48 kg N as ammonium sulphate |
| AA | 48 kg N as sodium nitrate |
| C | 48 kg N as castor bean meal |

Note: Old Series C and Strip 5 used as a "P" Test since 2003. These plots and those on the Silicate Test (on old Series AA) receive 144 kg basal N

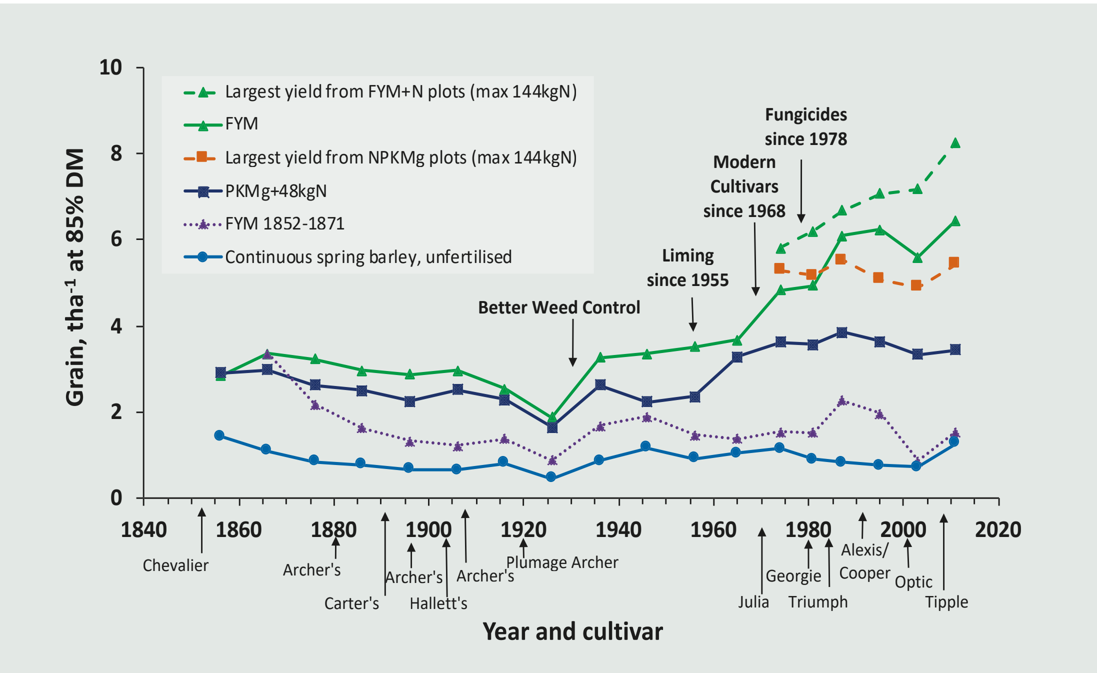


Fig. 7 Hoosfield; mean yields of spring barley grain and changes in husbandry, 1852-2015.



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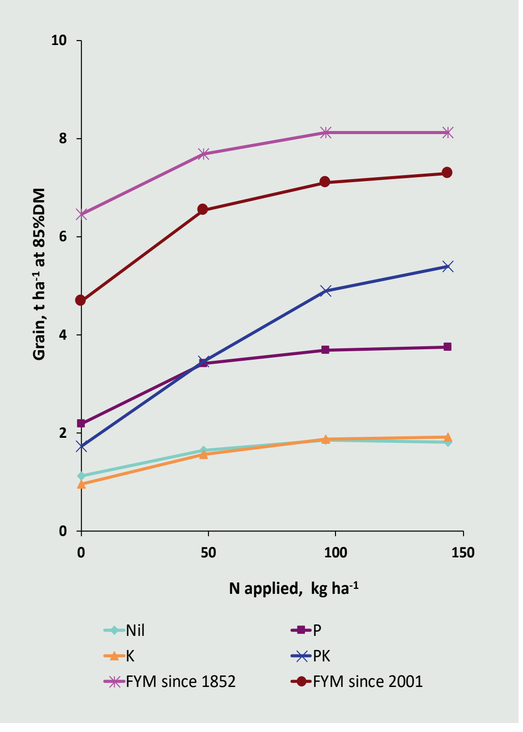


Fig. 8 Hoosfield; mean yields of spring barley grain (cv. Tipple), 2008-2015.

treated soils will be released at a time when it *cannot* be used by the crop and much will be lost by leaching as nitrate.

Sodium silicate, both as a fresh application and as a residue, continued to give substantial yield increases in the period 2008-15 on plots lacking P or K but had little effect on plots receiving these nutrients (Table 7). The mechanism for this is still not fully understood but is thought to be a soil rather than a crop effect.

**Table 7. Hoosfield; effects of silicate on the mean yield of spring barley, 2008-15**

| Treatment[1] | (-)- | (Si)- | (-)Si | (Si)Si |
|---|---|---|---|---|
| | Mean yields of grain, t ha$^{-1}$ at 85% DM | | | |
| N3 | 2.26 | 2.60 | 3.07 | 3.21 |
| N3 K | 2.07 | 3.41 | 3.18 | 3.84 |
| N3P | 4.43 | 4.94 | 4.51 | 4.32 |
| N3PK | 6.15 | 6.57 | 6.46 | 6.43 |

[1] See Table 6 for details

## Exhaustion Land

Unlike some 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, initially to wheat (1856-1875) then to 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. However, even in recent years (1992-2012) residues from P applied in FYM or as fertiliser more than 100 years ago, still supply more than twice as much P as the soil that has received no P input since 1856 (Table 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



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