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# Results of the Classical and Other Long-term Experiments 2021



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2021

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## 21/R/BK/1 - Broadbalk Winter Wheat

### Rothamsted Research

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## 21/R/BK/1 BROADBALK WINTER WHEAT

**Object:** To study the effects of organic manures and inorganic fertilisers on continuous winter wheat and wheat in rotation. From 1968 two three-year rotations were included: potatoes, beans, winter wheat and fallow, winter wheat, winter wheat. In 1979 the first rotation was changed to fallow, potatoes, winter wheat. In 1980 the second rotation reverted to continuous winter wheat. Since 1985 part of the second rotation was added to the first to extend the rotation to fallow, potatoes, winter wheat, winter wheat, winter wheat. In 1996 the fallow was replaced by winter oats and potatoes replaced by maize in 1997. In 2018 (175<sup>th</sup> year) winter beans (Be) replaced maize on the rotational sections and the rotation was changed to wheat, wheat, oats, wheat, beans. The new rotation includes two first wheats each year. Previously, only one first wheat was included in the rotation. This change has resulted in additional harvest sampling and analysis, to include both first wheats and the beans. The experimental diary below also includes the Broadbalk 'Wilderness' (R/BK/1W) – a 0.2 ha area of land at the west end of the field taken out of cultivation in 1882 and which now supports 'wooded', 'mown' and 'stubbed' sections.

2021 was the 178<sup>th</sup> year of the experiment, for previous years see 'Details' 1967 and 1973, Station Report for 1966, pp. 229-231; Station Report for 1968, Part 2; Station Report for 1982, Part 2, pp 5-44 and Yield Books for 74-20/R/BK/1.

### Areas harvested <sup>a</sup>:

|        |            |         |
|--------|------------|---------|
| Wheat: | Section    | ha      |
|        | 0          | 0.00305 |
|        | 1          | 0.00561 |
|        | 2, 3, 4, 6 | 0.00463 |
|        | 8, 9       | 0.00488 |
| Oats:  | 7          | 0.00463 |
| Beans: | 5          | 0.00463 |

<sup>a</sup> The new Haldrup combine has a slightly smaller cut width (2.0 m) than the previous Sampo combine (2.1 m). Consequently, from 2017 cereal yields are based on a 2.0 m cut width.

### Treatments:

In 2021 some of the treatments were changed. The treatments are now:

Whole plots

#### PLOT

|                 | Plot | From 2021       |
|-----------------|------|-----------------|
| 01 (FYM) N4     | 01   | (FYM) N4        |
| 2.1 FYM N3      | 2.1  | FYM N3          |
| 2.2 FYM         | 2.2  | FYM             |
| 03 Nil          | 03   | Nil             |
| 05 (P)KMg       | 05   | (P) K Mg        |
| 06 N1(P)KMg     | 06   | N1 (P) K Mg     |
| 07 N2(P)KMg     | 07   | N2 (P) K Mg     |
| 08 N3(P)KMg     | 08   | N3 (P) K Mg     |
| 09 N4(P)KMg     | 09   | N4 (P) K Mg     |
| 10 N4           | 10   | N4              |
| 11 N4PMg        | 11   | N4 (P) Mg       |
| 12 N1+3+1(P)KMg | 12   | N1+3+1 (P) K Mg |
| 13 N4PK         | 13   | N4 (P) K        |
| 14 N4PK*(Mg*)   | 14   | N4 (P) K* (Mg*) |
| 15 N5(P)KMg     | 15   | N5 (P) K Mg     |

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|               |    |               |
|---------------|----|---------------|
| 17 N1+4+1PKMg | 17 | N1+4+1 P K Mg |
| 18 N1+2+1PKMg | 18 | N1+2+1 P K Mg |
| 19 N1+1+1KMg  | 19 | N1+1+1 K Mg   |
| 20 N4KMg      | 20 | N4 K Mg       |

Winter wheat – single N to wheat

N1, N2, N3, N4, N5, N6: 48, 96, 144, 192, 240, 288 kg N as 33.5% N; to be applied at the same time as the second dressings in the split N plots for wheat.

– Split N to wheat

N1+1+1, 1+2+1 etc: Rates as above, but in 3 splits. Timings: first two weeks of March, GS31 or mid-April (whichever comes first), and GS37/mid-May.

Winter oats – single N application

½ N1, ½ N2, ½ N3, ½ N4, ½ N5, ½ N6: 24, 48, 72, 96, 120, 144 kg N as 33.5%N; applied at half the rate for wheat in a single application in mid-April; oats received no N from 1996 to 2017.

Winter Beans (Be) No N applied.

All crops P, K, Mg & FYM applications as shown below:-

P: 35 kg P as triple superphosphate

(P): No P since 2001 or 2021 (under review)

K: 90 kg K as potassium sulphate

K\*: 90 kg K as potassium chloride

Mg: 12 kg Mg as kieserite

(Mg\*): No Mg since 2001 (under review)

FYM: Farmyard manure at 35 t (fresh weight) to wheat and oats in autumn; no FYM applied to beans (oats received no FYM from 1996 to 2017)

**Previous treatment:**

Whole plots

**PLOT**

Fertilizers and organic manures:-

|           | Plot | Treatments until 1967 | Treatments from 1968 | Treatments from 1985 – 2000    | Treatments from 2001-2020      |
|-----------|------|-----------------------|----------------------|--------------------------------|--------------------------------|
| 01 DN4PK  | 01   | -                     | D N2 P K             | D N4 P K                       | N4                             |
| 2.1 DN2   | 2.1  | D                     | D N2                 | D N2                           | FYM N3 <sup>(1)</sup>          |
| 2.2 D     | 2.2  | D                     | D                    | D                              | FYM                            |
| 03 0      | 03   | Nil                   | Nil                  | Nil                            | Nil                            |
| 05 F      | 05   | P K Na Mg             | P K (Na) Mg          | P K Mg                         | (P) K Mg                       |
| 06 N1F    | 06   | N1 P K Na Mg          | N1 P K (Na) Mg       | N1 P K Mg                      | N1 (P) K Mg                    |
| 07 N2F    | 07   | N2 P K Na Mg          | N2 P K (Na) Mg       | N2 P K Mg                      | N2 (P) K Mg                    |
| 08 N3F    | 08   | N3 P K Na Mg          | N3 P K (Na) Mg       | N3 P K Mg                      | N3 (P) K Mg                    |
| 09 N4F    | 09   | N*1 P K Na Mg         | N4 P K (Na) Mg       | N4 P K Mg                      | N4 (P) K Mg                    |
| 10 N2     | 10   | N2                    | N2                   | N2                             | N4                             |
| 11 N2P    | 11   | N2 P                  | N2 P                 | N2 P                           | N4 P Mg                        |
| 12 N2PNA  | 12   | N2 P Na               | N2 P Na              | N2 P Na                        | N1+3+1 (P) K Mg <sup>(2)</sup> |
| 13 N2PK   | 13   | N2 P K                | N2 P K               | N2 P K                         | N4 P K                         |
| 14 N2PKMG | 14   | N2 P Mg*              | N2 P K Mg*           | N2 P K Mg*                     | N4 P K* (Mg*)                  |
| 15 N5F    | 15   | N2 P K Na Mg          | N3 P K (Na) Mg       | N5 P K Mg                      | N5 (P) K Mg                    |
| 16 N6F    | 16   | N*2 P K Na Mg         | N2 P K (Na) Mg       | N6 P K Mg                      | N6 (P) K Mg                    |
| 17 N1+3FH | 17   | N2 (A)                | N2 ½[P K (Na) Mg]    | N1+3 ½[P K Mg] <sup>(A)+</sup> | N1+4+1 P K Mg                  |
| 18 N0+3FH | 18   | P K Na Mg (A)         | N2 ½[P K (Na) Mg]    | N0+3 ½[P K Mg] <sup>(A)+</sup> | N1+2+1 P K Mg                  |
| 19 (C)    | 19   | C                     | C                    | (C) (since 1989)               | N1+1+1 K Mg                    |
| 20 N2KMG  | 20   | N2 K Na Mg            | N2 K (Na) Mg         | N2 K Mg                        | N4 K Mg                        |

(1) N2 2001-2004

(2) N1+3+1 (P) K2 Mg2 2001-2005

(A) Alternating each year

+ This change since 1980. Treatments shown are those to winter wheat; autumn N alternates. Maize received N3 ½[PK Mg] on both plots 17 and 18. These treatments shown incorrectly in 1999-2002 Yield books.

Winter oats; Nitrogen and dung were not applied, 1996-2017.

- N1, N2, N3, N4, N5, N6: 48, 96, 144, 192, 240, 288 kg N as sulphate of ammonia until 1967, except N\* which was nitrate of soda. All as 'Nitro-Chalk' in spring from 1968 to 1985, as 34.5% N since 1986.
- N0+3; N1+3: None in autumn + 144 kg N in spring; 48 kg N in autumn + 144 kg N in spring.
- P: 35 kg P as triple superphosphate in 1974 and since 1988, single superphosphate in other years
- K: 90 kg K as sulphate of potash
- K2: 180 kg K as potassium sulphate (plus 450 kg K autumn 2000 only)
- Na: 55 kg Na as sulphate of soda
- (Na): 16 kg Na as sulphate of soda until 1973
- Mg: 12 kg Mg from 2001, previously 35 kg Mg every third year 1974-2000 (applied at 30 kg Mg in 1991, 1994, 1997 and 2000 and at 15 kg Mg on half rate treatments), and 11 kg Mg until 1973. Mg\* indicates plot 14 applications of 26 kg Mg 1990 to 2000, previously 30 kg Mg 1974-1989, and 31 kg Mg until 1973.
- All Mg applied as kieserite since 1974, previously as sulphate of magnesia until 1973.
- Mg2: 24 kg Mg as kieserite (plus 60 kg Mg, autumn 2000 only)
- D: Farmyard manure at 35 t (fresh weight)
- (C): Castor meal to supply 96 kg N until 1988, none since
- F: Full rate P K (Na) Mg as above
- H: Half rate of above.

Strips of sub-plots: Until 1967 wheat alone was grown on the experiment, with some bare fallowing. From 1968, the experiment was divided into 10 sections with the following cropping:

#### SECTION

| Section | 1 | 9 | 0* | 8+ | 6** | 5 | 3 | 7  | 4  | 2  |
|---------|---|---|----|----|-----|---|---|----|----|----|
| Year    |   |   |    |    |     |   |   |    |    |    |
| 1968    | W | W | W  | W  | F   | W | W | P  | W  | BE |
| 1969    | W | W | W  | W  | W   | F | W | BE | P  | W  |
| 1970    | W | W | W  | W  | W   | W | F | W  | BE | P  |
| 1971    | W | W | W  | W  | F   | W | W | P  | W  | BE |
| 1972    | W | W | W  | F  | W   | F | W | BE | P  | W  |
| 1973    | W | W | W  | W  | W   | W | F | W  | BE | P  |
| 1974    | W | W | W  | W  | F   | W | W | P  | W  | BE |
| 1975    | W | W | W  | W  | W   | F | W | BE | P  | W  |
| 1976    | W | W | W  | W  | W   | W | F | W  | BE | P  |
| 1977    | W | W | W  | W  | F   | W | W | P  | W  | BE |
| 1978    | W | W | W  | W  | W   | F | W | BE | P  | W  |
| 1979    | W | W | W  | W  | W   | W | F | W  | P  | F  |
| 1980    | W | W | W  | W  | W   | W | W | F  | W  | P  |
| 1981    | W | W | W  | F  | W   | W | W | P  | F  | W  |
| 1982    | W | W | W  | W  | W   | W | W | W  | P  | F  |
| 1983    | W | W | W  | W  | W   | W | W | F  | W  | P  |
| 1984    | W | W | W  | W  | W   | W | W | P  | F  | W  |
| 1985    | W | W | W  | W  | W   | F | W | W  | P  | W  |
| 1986    | W | W | W  | W  | W   | P | F | W  | W  | W  |
| 1987    | W | W | W  | W  | W   | W | P | W  | W  | F  |
| 1988    | W | W | W  | F  | W   | W | W | F  | W  | P  |
| 1989    | W | W | W  | W  | W   | W | W | P  | F  | W  |
| 1990    | W | W | W  | W  | W   | F | W | W  | P  | W  |
| 1991    | W | W | W  | W  | W   | P | F | W  | W  | W  |
| 1992    | W | W | W  | W  | W   | W | P | W  | W  | F  |
| 1993    | W | W | W  | W  | W   | W | W | F  | W  | P  |

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| Section             | 1 | 9 | 0* | 8+ | 6** | 5  | 3 | 7  | 4  | 2  |
|---------------------|---|---|----|----|-----|----|---|----|----|----|
| Year                |   |   |    |    |     |    |   |    |    |    |
| 1994                | W | W | W  | F  | W   | W  | W | P  | F  | W  |
| 1995                | W | W | W  | W  | W   | F  | W | W  | P  | W  |
| 1996                | W | W | W  | W  | W   | P  | O | W  | W  | W  |
| 1997                | W | W | W  | W  | W   | W  | M | W  | W  | O  |
| 1998                | W | W | W  | W  | W   | W  | W | O  | W  | M  |
| 1999                | W | W | W  | W  | W   | W  | W | M  | O  | W  |
| 2000                | W | W | W  | W  | W   | O  | W | W  | M  | W  |
| 2001 <sup>†</sup>   | W | W | W  | F  | W   | M  | O | W  | W  | W  |
| 2002                | W | W | W  | W  | W   | W  | M | W  | W  | O  |
| 2003                | W | W | F  | W  | W   | W  | W | O  | W  | M  |
| 2004                | W | W | F  | W  | W   | W  | W | M  | O  | W  |
| 2005                | W | W | W  | W  | W   | O  | W | W  | M  | W  |
| 2006                | W | W | W  | W  | W   | M  | O | W  | W  | W  |
| 2007                | W | W | W  | W  | W   | W  | M | W  | W  | O  |
| 2008                | W | W | W  | F  | W   | W  | W | O  | W  | M  |
| 2009                | W | W | W  | W  | W   | W  | W | M  | O  | W  |
| 2010                | W | W | W  | W  | W   | O  | W | W  | M  | W  |
| 2011                | W | W | W  | W  | W   | M  | O | W  | W  | W  |
| 2012                | W | W | W  | W  | W   | W  | M | W  | W  | O  |
| 2013                | W | W | W  | W  | W   | W  | W | O  | W  | M  |
| 2014                | W | W | W  | W  | W   | W  | W | M  | O  | W  |
| 2015 <sup>++</sup>  | W | W | W  | F  | W   | O  | W | W  | M  | W  |
| 2016                | W | W | W  | F  | W   | M  | O | W  | W  | W  |
| 2017                | W | W | W  | W  | W   | W  | M | W  | W  | O  |
| 2018                | W | W | W  | W  | W   | W  | W | Be | O  | W  |
| 2019                | W | W | W  | W  | W   | O  | W | W  | W  | Be |
| 2020 <sup>++†</sup> | W | W | W  | W  | W   | W  | O | W  | Be | W  |
| 2021                | W | W | W  | W  | W   | Be | W | O  | W  | W  |

W = winter wheat, O = winter oats, P = potatoes, BE = spring beans, F = fallow, M = forage maize, Be = Winter Beans

\* Straw incorporated since autumn 1986. \*\* No sprays except herbicides since 1985.

+ No herbicides.

++ Spring Wheat in 2015, 2020

† Spring Oats in 2001, 2020

**NOTES:**

- (1) For a fuller record of treatments see 'Details' etc.
- (2) From autumn 1975 to autumn 1986, chalk was applied at 2.9 t each autumn to all plots in sets of Sections on a three-year cycle. Year 1: Sections 1, 2, 3. Year 2: Sections 6, 7, 8, 9. Year 3: Sections 0, 4, 5. From autumn 1988 until autumn 1992 a five-year cycle was used. Year 1: Sections 1, 3. Year 2: Sections 2, 8. Year 3: Sections 7, 9. Year 4: Sections 4, 6. Year 5: Sections 0, 5 (omitted). No chalk was applied after autumn 1991 until autumn 2007 when differential amounts were applied to selected plots (see "Results 2008"). Chalk was applied again to selected plots in autumn 2013 and 2018, see 14/R/BK/1 and 19/R/BK/1 diary information.
- (3) In 2003 and 2004 section 0 was used for an experiment (CS/595) investigating different herbicides to control *Equisetum arvense*.
- (4) In 2013 the wheat variety changed from Hereward to Crusoe, but it was sown very late (22 February 2013) because of the very wet autumn and winter of 2012-2013.
- (5) Spring wheat (var Mulika) and winter oats (var Gerald) were sown in March 2015, instead of in autumn/winter 2014, because the very wet soil conditions in autumn 2014 prevented sowing of a winter crop. The whole site was spring-tine cultivated in March 2015 instead of being ploughed. Spring wheat (var Tybalt) was sown in March 2020 because the wet autumn and winter of 2019-2020 prevented sowing of a winter crop.

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- (6) Section 8 was left in bare fallow in 2015 & 2016 and had two in-season cultivations (inversion ploughing) each year to control weeds.
- (7) No Triple Superphosphate applied to Strips 11, 13 and 14: After reviewing amounts of available P in soil it was decided not to apply TSP from 2021 (under review).

**21/R/BK/1 Experimental Diary:**

| Date                |   | Application                                                                                                                                                    | Rate  | Unit  |
|---------------------|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|
| <b>All Sections</b> |   |                                                                                                                                                                |       |       |
| 16/09/2020          | p | Sprayed Samurai (16238) using NH T6030, Knight 24m Sprayer                                                                                                     | 3     | L/ha  |
| 16/09/2020          | p | Sprayed Buffalo Elite using NH T6030, Knight 24m Sprayer                                                                                                       | 1     | L/ha  |
| 16/09/2020          | a | Rolled; 6m Flexicoil Cambridge Roll, JD6230                                                                                                                    | -     | -     |
| 21/09/2020          | f | Applied Triple Superphosphate (TSP) using Cascade Spreader: Strips 17, 18                                                                                      | 171   | kg/ha |
| 22/09/2020          | f | Applied Farmyard manure (FYM) using Tym T503, Muck spreader – international: All sections except 5, Strips 2.1, 2.2;                                           | 35    | t/ha  |
| 22/09/2020          | f | Applied Muriate of Potash (MOP): Strip 14; Cascade Spreader                                                                                                    | 181   | kg/ha |
| 22/09/2020          | a | Topping plot boundaries using Batwing Topper, JD6230: paths between plots before ploughing due to weed growth.                                                 | -     | -     |
| 23/09/2020          | a | Cultivation: Ploughed Tillage 15 cm; NHT7210, KV Five Furrow Plough: Thrown S                                                                                  |       |       |
| 01/10/2020          | p | Sprayed using Tym T503, Tecnomat 12m Sprayer: Pontos (17811);                                                                                                  | 1     | L/ha  |
| 01/10/2020          | p | Sprayed using Tym T503, Tecnomat 12m Sprayer: Firestarter (18422)                                                                                              | 0.3   | L/ha  |
| 01/10/2020          | p | Sprayed using Tym T503, Tecnomat 12m Sprayer: Velomax                                                                                                          | 0.4   | L/ha  |
| 02/12/2020          | p | Sprayed using Knight 24m Sprayer, NH T6030: Hallmark with Zeon Technology: Sections 0, 1, 2, 3, 4, 6, 7, 8, 9                                                  | 50    | mL/ha |
| 30/03/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: X-Clude;                                                                                                           | 0.25  | L/ha  |
| 30/03/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: Cintac;                                                                                                            | 0.5   | L/ha  |
| 30/03/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: Cogent                                                                                                             | 1     | L/ha  |
| 04/04/2021          | a | Ploughed Tillage 0 cm down paths only; Rotavator Howard, Tym T503                                                                                              |       |       |
| 12/05/2021          | f | Applied Kieserite with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 5, 6, 7, 8, 9: Strip 05, 06, 07, 08, 09, 11, 12, 15, 16, 17, 18, 19, 20                | 80    | kg/ha |
| 14/05/2021          | f | Applied Sulphate of Potash (SOP) with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 5, 6, 7, 8, 9: Strip 05, 06, 07, 08, 09, 12, 13, 15, 16, 17, 18, 19, 20 | 217   | kg/ha |
| 03/06/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: Samurai (16238): Section 0, 1, 2, 3, 4, 5, 6, 7, 9                                                                 | 3     | L/ha  |
| 03/06/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: Buffalo Elite: Section 0, 1, 2, 3, 4, 5, 6, 7, 9                                                                   | 1     | L/ha  |
| 26/06/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: Caramba 90                                                                                                         | 0.359 | L/ha  |
| 26/06/2021          | p | Sprayed using Knight 24m Sprayer, NH T6030: Simveris                                                                                                           | 0.4   | L/ha  |

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| 26/06/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Cytokin P                                                                                                | 1         | L/ha                 |
| 26/06/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Laser                                                                                                    | 0.75      | L/ha                 |
| 26/06/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Zarado                                                                                                   | 1         | L/ha                 |
| 08/07/2021                                                   | a | Wild Oat Count by hand: Section 0, 1, 2, 3, 4, 5, 6, 7, 8, 9: Strip 01, 2.1, 2.2, 03, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | -         | -                    |
| 13/07/2021                                                   | a | Power harrowed Paths                                                                                                                                 | -         | -                    |
| <b>W Wheat</b>                                               |   |                                                                                                                                                      |           |                      |
| 28/09/2020                                                   | s | Drilled Zyatt with JD6830, Accord Combination Drill No. 4 : Section 0, 1, 2, 3, 4, 6, 8, 9                                                           | 350       | seeds/m <sup>2</sup> |
| 02/03/2021                                                   | f | Applied Nitram with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 12, 17, 18, 19                                                   | 139       | kg/ha                |
| 20/04/2021                                                   | f | Applied Nitram with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 06, 19                                                           | 139       | kg/ha                |
| 20/04/2021                                                   | f | Applied Nitram with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 07, 18                                                           | 278       | kg/ha                |
| 20/04/2021                                                   | f | Applied Nitram with Exactomatic, Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 08, 12, 2.1                                         | 417       | kg/ha                |
| 20/04/2021                                                   | f | Applied Nitram with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 01, 09, 10, 11, 13, 14, 17, 20                                   | 556       | kg/ha                |
| 20/04/2021                                                   | f | Applied Nitram with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 15                                                               | 696       | kg/ha                |
| 20/04/2021                                                   | F | Applied Nitram with Cascade Spreader, JD6830: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 16                                                               | 835       | kg/ha                |
| 21/04/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Cortez: Sections 0, 1, 2, 3, 4, 8, 9                                                                     | 0.5       | L/ha                 |
| 21/04/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Moddus: Sections 0, 1, 2, 3, 4, 8, 9                                                                     | 0.1       | L/ha                 |
| 21/04/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Moddus: Section 6: Strip 01, 03, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 2.1, 2.2    | 0.1       | L/ha                 |
| 12/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Lentyma XE: Section 0, 1, 2, 3, 4, 8, 9                                                                  | 1         | L/ha                 |
| 12/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Retengo 200: Section 0, 1, 2, 3, 4, 8, 9                                                                 | 0.4       | L/ha                 |
| 26/05/2021                                                   | f | Applied Nitram: Section 0, 1, 2, 3, 4, 6, 8, 9: Strip 12, 17, 18, 19                                                                                 | 139       | kg/ha                |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Plexeo 60: Section 8                                                                                     | 1.25      | L/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Velogy Plus: Section 8                                                                                   | 0.63      | L/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Presite SX: Section 6                                                                                    | 60        | g/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Hurler: Section 6                                                                                        | 0.6       | L/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Presite SX: Section 0, 1, 2, 3, 4, 9                                                                     | 60        | g/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Plexeo 60: Section 0, 1, 2, 3, 4, 9                                                                      | 1.25      | L/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Velogy Plus: Section 0, 1, 2, 3, 4, 9                                                                    | 0.63      | L/ha                 |
| 27/05/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Hurler: Section 0, 1, 2, 3, 4, 9                                                                         | 0.6       | L/ha                 |
| 10/06/2021                                                   | p | Sprayed using Knight 24m Sprayer, NH T6030: Cello: Section 0, 1, 2, 3, 4, 8, 9                                                                       | 1         | L/ha                 |
| 27/08/2021                                                   | a | Harvest; Haldrup C-85 2m cut: Section 0, 1, 2, 3, 4, 6, 8, 9                                                                                         | -         | -                    |

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|                |   |                                                                                                                                 |      |                      |
|----------------|---|---------------------------------------------------------------------------------------------------------------------------------|------|----------------------|
| 02/09/2021     | a | Straw weights – Wheat using Amazone Grass Harvester - Flail Mower Collector, JD5070: Section 1, 3, 4, 8                         | -    | -                    |
| <b>W Oats</b>  |   |                                                                                                                                 |      |                      |
| 28/09/2020     | s | Drilled Miscani : Section 7                                                                                                     | 350  | seeds/m <sup>2</sup> |
| 20/04/2021     | f | Applied Nitram with Cascade Spreader, JD6830: Section 7: Strip 06                                                               | 70   | kg/ha                |
| 20/04/2021     | f | Applied Nitram with Cascade Spreader, JD6830: Section 7: Strip 07                                                               | 139  | kg/ha                |
| 20/04/2021     | f | Applied Nitram: Section 7: Strip 2.1 by hand                                                                                    | 209  | kg/ha                |
| 20/04/2021     | f | Applied Nitram with Cascade Spreader, JD6830: Section 7: Strip 08, 19                                                           | 209  | kg/ha                |
| 20/04/2021     |   | Applied Nitram with Cascade Spreader, JD6830: Section 7: Strip 09, 10, 11, 13, 14, 18                                           | 278  | kg/ha                |
| 20/04/2021     | f | Applied Nitram with Cascade Spreader, JD6830: Section 7: Strip 12, 15                                                           | 348  | kg/ha                |
| 20/04/2021     | f | Applied Nitram with Exactomatic, Cascade Spreader, JD6830: Section 7: Strip 16, 17                                              | 417  | kg/ha                |
| 12/05/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Presite SX: Section 7                                                               | 60   | g/ha                 |
| 12/05/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Envoy: Section 7                                                                    | 1.5  | L/ha                 |
| 12/05/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Stefes CCC 720: Section 7                                                           | 1.5  | L/ha                 |
| 12/05/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Starane HI-Load HL: Section 7                                                       | 0.4  | L/ha                 |
| 08/06/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Cello: Section 7                                                                    | 1    | L/ha                 |
| 11/08/2021     | a | Harvest Winter Oats; Haldrup C-85 2m cut: Section 7                                                                             | -    | -                    |
| 14/08/2021     | a | Straw weights - Oats: Section 7                                                                                                 | -    | -                    |
| 20/08/2021     | a | Harvest; Haldrup C-85 2m cut: Section 7: Strip 01, 2.1, 2.2, 03, 05, 06, 07, 08, 09, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20 | -    | -                    |
| <b>W Beans</b> |   |                                                                                                                                 |      |                      |
| 08/03/2021     | a | Tines using Bomford Flexitine, JD6145R : Section 5                                                                              | -    | -                    |
| 08/03/2021     | a | Rolling using 6m Flexicoil Cambridge Roll, JD6230: Section 5                                                                    | -    | -                    |
| 08/03/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Samurai: Section 5                                                                  | 3    | L/ha                 |
| 08/03/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Buffalo Elite: Section 5                                                            | 1    | L/ha                 |
| 09/03/2021     | s | Drilled Tundra: Section 5                                                                                                       | 35   | seeds/m <sup>2</sup> |
| 20/03/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Nirvana: Section 5                                                                  | 4    | L/ha                 |
| 20/03/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Velomax: Section 5                                                                  | 0.4  | L/ha                 |
| 29/04/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Ninja 5CS: Section 5                                                                | 0.15 | L/ha                 |
| 28/05/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Hallmark with Zeon Technology: Section 5                                            | 75   | mL/ha                |
| 27/08/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Samurai: Section 5                                                                  | 3    | L/ha                 |
| 27/08/2021     | p | Sprayed using Knight 24m Sprayer, NH T6030: Buffalo Elite: Section 5                                                            | 1    | L/ha                 |
| 06/09/2021     | a | Harvest; Haldrup C-85 2m cut: Section 5                                                                                         | -    | -                    |



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|                   |   |                                                                                        |   |   |
|-------------------|---|----------------------------------------------------------------------------------------|---|---|
| 08/09/2021        | a | Straw weights using Amazone Grass Harvester - Flail Mower Collector, JD5070: Section 5 | - | - |
| <b>Wilderness</b> |   |                                                                                        | - | - |
| 05/01/2021        | a | Topping Stubbed Area; Tym T503, McConnel SE 6 Topper                                   | - | - |
| 19/04/2021        | a | Topping Mown Area; Iseki ISTH4335, Kilworth Topper                                     | - | - |
| 14/05/2021        | a | Topping Mown Area; Iseki ISTH4335, Kilworth Topper                                     | - | - |
| 07/06/2021        | a | Topping Mown Area; Iseki ISTH4335, Kilworth Topper                                     | - | - |
| 26/07/2021        | a | Topping Mown Area; Iseki ISTH4335, Kilworth Topper                                     | - | - |
| 31/08/2021        | a | Topping Mown Area; Iseki ISTH4335, Kilworth Topper                                     | - | - |
| 17/12/2021        | a | Topping Stubbed Area; Iseki ISTH4335, Kilworth Topper                                  | - | - |

NOTE: Samples of grain and straw were taken for chemical analysis. Unground grain and straw samples from selected treatments were placed in the Rothamsted Sample Archive.

## YIELDS

### WINTER WHEAT

Grain Tonnes/Hectare (85% DM)

Tables of means

| SECTION PLOT     | 3/W1  | 4/W1 | 2/W2 | 6/W44 | 0/W17 | 1/W55 | 9/W63 | 8/W5 | Mean |
|------------------|-------|------|------|-------|-------|-------|-------|------|------|
| 01 (FYM)N4       | 8.29  | 8.47 | 7.62 | 3.97  | -     | -     | -     | -    | 7.09 |
| 21 FYMN3         | 10.06 | 9.94 | 9.53 | 4.40  | 5.30  | 8.33  | 8.54  | 1.15 | 7.15 |
| 22 FYM           | 6.70  | 7.46 | 6.48 | 5.22  | 5.51  | 6.30  | 6.11  | 3.09 | 5.86 |
| 03 Nil           | 0.07  | 0.14 | 0.21 | 0.05  | 0.21  | 0.30  | 0.19  | 0.55 | 0.21 |
| 05 (P)KMg        | 0.06  | 0.79 | 0.21 | 0.05  | 0.21  | 0.15  | 0.24  | 1.13 | 0.35 |
| 06 N1(P)KMg      | 4.16  | 5.27 | 4.90 | 2.26  | 3.36  | 3.84  | 3.47  | 0.65 | 3.49 |
| 07 N2(P)KMg      | 6.24  | 6.76 | 6.45 | 2.47  | 3.88  | 5.14  | 4.85  | 0.45 | 4.53 |
| 08 N3(P)KMg      | 7.63  | 8.16 | 7.82 | 2.10  | 5.67  | 4.66  | 5.79  | 0.38 | 5.28 |
| 09 N4(P)KMg      | 7.81  | 8.04 | 8.93 | 2.41  | 5.36  | 5.70  | 6.28  | 0.79 | 5.67 |
| 10 N4            | 2.36  | 3.96 | 4.08 | 1.11  | 0.45  | 1.45  | 0.73  | 0.63 | 1.85 |
| 11 N4(P*)Mg      | 4.65  | 6.52 | 6.33 | 1.96  | 6.66  | 5.56  | 4.79  | 0.66 | 4.64 |
| 12 N1+3+1(P)KMg  | 8.17  | 9.63 | 9.54 | 2.83  | 7.18  | 7.94  | 8.08  | 0.74 | 6.76 |
| 13 N4(P*)K       | 7.36  | 8.24 | 8.35 | 2.62  | 6.05  | 6.71  | 6.39  | 0.37 | 5.76 |
| 14 N4(P*)K*(Mg*) | 5.07  | 6.43 | 5.90 | 2.60  | 5.40  | 5.31  | 4.54  | 0.80 | 4.51 |
| 15 N5(P)KMg      | 6.21  | 5.39 | 8.36 | 1.46  | 6.07  | 6.00  | 6.15  | -    | 5.66 |
| 16 N6(P)KMg      | 7.29  | 7.49 | 8.61 | 1.73  | 6.43  | 4.93  | 7.09  | 0.67 | 5.53 |
| 17 N1+4+1PKMg    | 9.27  | 7.73 | 9.36 | 3.18  | 7.15  | 6.99  | 7.30  | 0.73 | 6.46 |
| 18 N1+2+1PKMg    | 8.62  | 8.73 | 9.13 | 3.44  | 7.15  | 6.66  | 7.61  | 0.89 | 6.53 |
| 19 N1+1+1KMg     | 6.60  | 6.04 | 6.98 | 2.03  | 5.32  | 3.88  | 6.17  | 0.51 | 4.69 |
| 20 N4KMg         | -     | -    | -    | -     | 0.91  | 0.15  | -     | -    | 0.53 |
| Mean             | 6.14  | 6.59 | 6.78 | 2.42  | 4.64  | 4.74  | 5.24  | 0.83 | 4.72 |
| Grain Mean DM%   | 84.3  |      |      |       |       |       |       |      |      |

Results of the Classics and other Long-Term Experiments 2021

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Straw Tonnes/Hectare

Tables of means

| SECTION<br>PLOT  | 3/W1 | 4/W1 | 2/W2 | 6/W44 | 0/W17 | 1/W55 | 9/W63 | 8/W5 | Mean |
|------------------|------|------|------|-------|-------|-------|-------|------|------|
| 01 (FYM)N4       | 2.40 | 3.12 | -    | -     | -     | -     | -     | -    | 2.76 |
| 21 FYMN3         | 4.62 | 4.29 | -    | -     | -     | 3.67  | -     | 1.56 | 3.53 |
| 22 FYM           | 2.72 | 3.04 | -    | -     | -     | 3.01  | -     | 3.96 | 3.18 |
| 03 Nil           | 0.61 | 0.07 | -    | -     | -     | 0.05  | -     | 0.60 | 0.33 |
| 05 (P)KMg        | 0.06 | 0.34 | -    | -     | -     | 0.03  | -     | 0.01 | 0.11 |
| 06 N1(P)KMg      | 0.90 | 1.28 | -    | -     | -     | 1.14  | -     | 1.09 | 1.10 |
| 07 N2(P)KMg      | 1.70 | 2.01 | -    | -     | -     | 1.12  | -     | 1.48 | 1.58 |
| 08 N3(P)KMg      | 1.71 | 1.54 | -    | -     | -     | 0.41  | -     | 0.61 | 1.07 |
| 09 N4(P)KMg      | 1.90 | 1.8  | -    | -     | -     | 1.14  | -     | 1.76 | 1.65 |
| 10 N4            | 1.26 | 1.07 | -    | -     | -     | 0.55  | -     | 0.08 | 0.74 |
| 11 N4(P*)Mg      | 0.43 | 0.92 | -    | -     | -     | 1.50  | -     | 0.91 | 0.94 |
| 12 N1+3+1(P)KMg  | 3.06 | 3.69 | -    | -     | -     | 2.61  | -     | 2.68 | 3.01 |
| 13 N4(P*)K       | 0.44 | 1.81 | -    | -     | -     | 1.84  | -     | 0.58 | 1.16 |
| 14 N4(P*)K*(Mg*) | 1.04 | 0.66 | -    | -     | -     | 1.25  | -     | 1.59 | 1.13 |
| 15 N5(P)KMg      | 1.94 | 0.27 | -    | -     | -     | 0.71  | -     | 0.22 | 0.79 |
| 16 N6(P)KMg      | 1.35 | 0.96 | -    | -     | -     | 1.39  | -     | 1.55 | 1.31 |
| 17 N1+4+1PKMg    | 3.02 | 2.73 | -    | -     | -     | 1.97  | -     | 1.33 | 2.26 |
| 18 N1+2+1PKMg    | 3.94 | 3.24 | -    | -     | -     | 2.46  | -     | 2.33 | 2.99 |
| 19 N1+1+1KMg     | 0.64 | 0.76 | -    | -     | -     | 1.35  | -     | 1.35 | 1.02 |
| 20 N4KMg         | -    | -    | -    | -     | -     | 0.11  | -     | -    | 0.11 |
| Mean             | 1.78 | 1.77 | -    | -     | -     | 1.38  | -     | 1.32 | 1.56 |

Straw Mean DM% 86.00

WINTER OATS

Tonnes/Hectare (85% DM)

Table of means

| Plot | Treatment           | Grain | Straw |
|------|---------------------|-------|-------|
| 017  | 01 (FYM)1/2N4       | 8.24  | 3.17  |
| 217  | 02.1 FYM1/2N3       | 7.76  | 3.88  |
| 227  | 02.2 FYM            | 5.06  | 2.59  |
| 037  | 03 Nil              | 0.58  | 0.08  |
| 057  | 05 (P)KMg           | 1.46  | 0.30  |
| 067  | 06 1/2N1(P)KMg      | 3.20  | 0.70  |
| 077  | 07 1/2N2(P)KMg      | 4.13  | 1.50  |
| 087  | 08 1/2N3(P)KMg      | 5.08  | 1.57  |
| 097  | 09 1/2N4(P)KMg      | 7.34  | 2.78  |
| 107  | 10 1/2N4            | 5.01  | 1.91  |
| 117  | 11 1/2N4(P*)Mg      | 8.08  | 2.66  |
| 127  | 12 1/2N5(P)KMg      | 7.69  | 2.34  |
| 137  | 13 1/2N4(P*)K       | 7.22  | 2.76  |
| 147  | 14 1/2N4(P*)K*(Mg*) | 4.83  | 2.35  |
| 157  | 15 1/2N5(P)KMg      | 5.96  | 3.18  |
| 167  | 16 1/2N6(P)KMg      | 6.94  | 2.97  |
| 177  | 17 1/2N6PKMg        | 7.70  | 3.45  |
| 187  | 18 1/2N4PKMg        | 6.07  | 2.41  |
| 197  | 19 1/2N3KMg         | 4.07  | 1.49  |

Results of the Classics and other Long-Term Experiments 2021

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|                          |         |       |
|--------------------------|---------|-------|
| Mean                     | 5.60    | 2.22  |
| Mean DM%                 | 83.80   | 81.50 |
| Plot Area Harvested (ha) | 0.00463 |       |

**WINTER BEANS**

TONNES/HECTARE (85% DM)

*Tables of means*

| Plot | Treatment                | Grain   | Straw |
|------|--------------------------|---------|-------|
| 015  | 01 (FYM)[N4]             | 4.69    | 1.63  |
| 215  | 21 [FYMN3]               | 4.77    | 1.64  |
| 225  | 22 [FYM]                 | 4.66    | 2.19  |
| 035  | 03 Nil                   | 0.32    | 1.58  |
| 055  | 05 (P)KMg                | 3.04    | 1.86  |
| 065  | 06 [N1](P)KMg            | 2.59    | 1.51  |
| 075  | 07 [N2](P)KMg            | 3.15    | 1.08  |
| 085  | 08 [N3](P)KMg            | 2.10    | 1.41  |
| 095  | 09 [N4](P)KMg            | 1.89    | 1.43  |
| 105  | 10 [N4]                  | 0.37    | 0.33  |
| 115  | 11 [N4](P*)Mg            | 0.13    | 0.92  |
| 125  | 12 [N1+3+1](P)KMg        | 2.40    | 1.89  |
| 135  | 13 [N4](P*)K             | 2.54    | 2.35  |
| 145  | 14 [N4](P*)K*(Mg*)       | 1.71    | 2.03  |
| 155  | 15 [N5](P)KMg            | 2.07    | 2.16  |
| 165  | 16 [N6](P)KMg            | 2.10    | 2.10  |
| 175  | 17 [N1+4+1]PKMg          | 1.97    | 2.66  |
| 185  | 18 [N1+2+1]PKMg          | 3.11    | 2.50  |
| 195  | 19 [N1+1+1]KMg           | 2.21    | 2.85  |
|      | MEAN                     | 2.41    | 1.79  |
|      | Mean DM%                 | 83.80   | 89.10 |
|      | Plot Area Harvested (ha) | 0.00463 |       |

Section 8 Wheat Yields: Clean Grain (2.0-3.5 mm), tonnes/hectare, after removing weed seed

| YEAR              | 2021 |
|-------------------|------|
| SECTION           | 8/W5 |
| PLOT              |      |
| 01 (FYM) N4       |      |
| 2.1 FYMN3         | 1.08 |
| 2.2 FYM           | 2.82 |
| 03 Nil            | 0.52 |
| 05 (P)KMg         | 0.96 |
| 06 N1(P)KMg       | 0.56 |
| 07 N2(P)KMg       | 0.40 |
| 08 N3(P)KMg       | 0.34 |
| 09 N4(P)KMg       | 0.69 |
| 10 N4             | 0.53 |
| 11 N4(P)Mg        | 0.58 |
| 12 N1+3+1(P)K2Mg2 | 0.67 |
| 13 N4(P)K         | 0.31 |
| 14 N4(P)K*(Mg*)   | 0.64 |
| 15 N5(P)KMg       |      |
| 16 N6(P)KMg       | 0.56 |
| 17 N1+4+1PKMg     | 0.63 |

Results of the Classics and other Long-Term Experiments 2021

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|               |      |
|---------------|------|
| 18 N1+2+1PKMg | 0.77 |
| 19 N1+1+1KMg  | 0.43 |
| 20 N4KMg      |      |
| Mean          | 0.74 |

Note: All clean grain yields for section 8 are reported for the 2.0 - 3.5 mm grain size fraction, excluding grain <2 mm, as was the practice prior to 2012.