



Potato Council Project R 459
Cultivations for potatoes
George Moate Tillerstar vs standard
destoning comparison

Mark Stalham



Background

- Conventional destoning
 - Stones and clods removed to adjacent wheeling
- Tillerstar
 - Stones and clods buried in trench below full width of bed
- Previous work
 - 2012 PCL R444 ADAS site at Telford comparing Tillerstar vs shallow and deep destoning
 - 2012 PCL R444 SRUK site in Scotland comparing Tillerstar vs shallow and deep destoning
 - 2013 PCL Slingsby Cultivation Demonstration
 - 2014 PCL Ormskirk Cultivation Demonstration
- Assess whether Tillerstar system
 - Is cost effective to implement
 - Affects soil properties

PCL R459 Tillerstar experiments 2014

- B & C Farming, Marsham, Norfolk
 - Oxnead 6 E (Brampton, Norfolk)
 - Clay loam (CL, 43 % S, 38 % Z, 19 % C, 2.1 % OM)
 - Maris Piper
 - Two machines (Grimme CS1500, Tillerstar 2-bed)
 - Three intended destoned bed depths (25, 30, 35 cm)
 - Booton 33 (Booton, Norfolk)
 - Sandy loam (SL, 73 % S, 14 % Z, 12 % C, 1.5 % OM)
 - Russet Burbank
 - Two machines (Grimme CS1500, Tillerstar 2-bed)
 - Three intended destoned bed depths (25, 30, 35 cm)

Experimental layout

- Randomised split-plot design
- Main plots (12 rows wide) laid out for two types of destoning machine (Grimme CS1500, Tillerstar)
- Sub-plots (60 m long in Oxnead 6 E, 30 m long in Booton 33) allocated to three depths of destoning (25, 30, 35 cm)
- Six replicates of each treatment

Primary cultivations

- Standard destoning
 - Two passes of primary cultivation on cereal stubble with Sumo Trio and John Deere 8335R tractor
 - Bedforming with John Deere 8335R tractor
 - Destoned with Grimme CS1500 towed by a John Deere 6170R tractor
- Tillerstar
 - Shallow cultivated (single pass) with Sumo Trio and John Deere 8335R tractor on cereal stubble
 - Destoned with 2-bed Tillerstar towed by a John Deere 8335R tractor

Fuel and rate of work measurements

- Rate of work (ha/h) and fuel usage of all operations recorded using on-board monitors on each tractor
- Tractors started each secondary cultivation with full fuel tanks and were refilled at end of cultivation. Fuel volume recorded

Cultivation and planting dates

- Oxnead 6 E
 - Primary 30 March 2014
 - Secondary 31 March 2014
 - Planting 31 March 2014
- Booton 33
 - Primary 8 April 2014
 - Secondary 9 April 2014
 - Planting 9 April 2014

Yield protocol

- Hand-dug
- 3 m of single row in centre of each plot
- Graded at NIAB CUF
- Harvest dates
 - Oxnead 6 22 September 2014
 - Booton 33 16 September 2014

Harvesting damage assessment

- Oxnead 6 E only
 - On 2 October, samples of 50 random tubers from each plot taken from the beginning of the cart elevator of a Grimme Varitron 220 self-propelled harvester
 - Depth of harvester share adjusted to match the destoned bed depth (25 cm = 68 %, 30 cm = 71 % and 35 cm = 76 % (standard commercial depth))
 - All stone and clod produced when harvesting one bed of each plot removed from picking table and weighed
 - Bruising assessments following rumble peeling made on 1 November

Actual vs intended bed depths

| Site | Oxnead 6 E | | Booton 33 | |
|---------------------|------------|------------|-----------|------------|
| Machine | Destoner | Tillerstar | Destoner | Tillerstar |
| Depth | | | | |
| 25 | 24.9 | 25.2 | 25.2 | 25.4 |
| 30 | 29.5 | 29.4 | 29.2 | 29.4 |
| 35 | 34.1 | 33.9 | 35.4 | 35.2 |
| S.E. (20 D.F.) | 0.58 | | 0.49 | |
| S.E. (same machine) | 0.55 | | 0.48 | |

- Actual achieved bed depths were close to intended

Spot rate of work and fuel consumption

Oxnead 6 E

| Depth | Destoning rate (ha/h) | | Destoning fuel (l/ha) | | Total fuel (l/ha) | | Fuel cost (£/ha) | |
|---------------------|-----------------------|--------|-----------------------|--------|-------------------|--------|------------------|--------|
| | D/ston | T/star | D/ston | T/star | D/ston | T/star | D/ston | T/star |
| 25 | 0.90 | 0.88 | 31.3 | 72.1 | 81.9 | 91.2 | 57 | 63 |
| 30 | 0.70 | 0.63 | 38.9 | 93.7 | 89.5 | 112.8 | 62 | 78 |
| 35 | 0.53 | 0.43 | 50.3 | 131.8 | 100.9 | 150.9 | 70 | 104 |
| S.E. (20 D.F.) | 0.029 | | 2.76 | | 2.76 | | 1.94 | |
| S.E. (same machine) | 0.032 | | 2.59 | | 2.59 | | 1.83 | |

- Comparison based on total fuel usage for primary and secondary cultivations for:
 - 2 single-bed conventional destoners
 - 2-bed Tillerstar

Summary: rate and fuel usage Oxnead 6 E

- Rate of destoning slower with Tillerstar than destoner, particularly at 30 and 35 cm
- Rate decreased as depth increased, being twice as slow at 35 cm than at 25 cm
- Tillerstar consumed 2.3 times as much fuel during destoning at 25 cm as conventional destoner and 2.6 times at 35 cm depth
- Total fuel consumption greater for Tillerstar than destoner system: 11 % at 25 cm and 50 % at 35 cm

Spot rate of work and fuel consumption

Booton 33

| Depth | Destoning rate (ha/h) | | Destoning fuel (l/ha) | | Total fuel (l/ha) | | Fuel cost (£/ha) | |
|---------------------|-----------------------|--------|-----------------------|--------|-------------------|--------|------------------|--------|
| | D/ston | T/star | D/ston | T/star | D/ston | T/star | D/ston | T/star |
| 25 | 0.94 | 0.92 | 28.8 | 57.1 | 79.4 | 76.2 | 55 | 53 |
| 30 | 0.75 | 0.75 | 35.8 | 70.6 | 86.4 | 89.7 | 60 | 62 |
| 35 | 0.64 | 0.56 | 41.9 | 93.2 | 92.5 | 112.3 | 64 | 77 |
| S.E. (20 D.F.) | 0.023 | | 1.48 | | 1.48 | | 1.02 | |
| S.E. (same machine) | 0.020 | | 1.50 | | 1.50 | | 1.03 | |

- Comparison based on total fuel usage for primary and secondary cultivations for:
 - 2 single-bed conventional destoners
 - 2-bed Tillerstar

Summary: rate and fuel usage

Booton 33

- Faster rates of work and lower fuel usage than heavier Oxnead 6 E site
- No effect of machine on rate of destoning
- Rate decreased as depth increased, being 35 % slower at 35 cm than at 25 cm
- Tillerstar consumed more than twice as much fuel during destoning as conventional destoner, particularly at 35 cm depth
- Total fuel consumption similar between machines at 25 and 30 cm but much more in Tillerstar at 35 cm

Planting depth (cm)

| Site | Oxnead 6 E | | Booton 33 | |
|---------------------|------------|------------|-----------|------------|
| Machine | Destoner | Tillerstar | Destoner | Tillerstar |
| Depth | | | | |
| 25 | 15.2 | 14.8 | 14.5 | 14.4 |
| 30 | 14.9 | 16.0 | 13.6 | 14.2 |
| 35 | 15.6 | 15.9 | 14.5 | 13.7 |
| S.E. (20 D.F.) | 0.76 | | 0.52 | |
| S.E. (same machine) | 0.49 | | 0.53 | |

- Actual achieved planting depths were close to intended (15 cm) and not affected by machine or depth of destoning
- Slightly shallower at Booton 33 than Oxnead 6E

Ridge density and ped size at harvest

Oxnead 6 E

| Machine | Depth | Bulk density (g/cm ³) | Mean ped size (mm) | % peds > 6 mm |
|---------------------|-------|-----------------------------------|--------------------|---------------|
| Destoner | 25 | 1.08 | 9.02 | 48.4 |
| | 30 | 1.03 | 9.15 | 46.0 |
| | 35 | 0.99 | 10.40 | 49.0 |
| Tillerstar | 25 | 0.99 | 9.00 | 42.3 |
| | 30 | 1.04 | 8.52 | 41.7 |
| | 35 | 1.04 | 7.15 | 41.6 |
| S.E. (12 D.F.) | | 0.041 | 0.770 | 2.24 |
| S.E. (same machine) | | 0.046 | 0.867 | 2.14 |

- Ridge bulk density not affected by machine or depth of destoning
- Tillerstar created beds with finer tilth than destoner

Ridge density and ped size at harvest

Booton 33

| Machine | Depth | Bulk density (g/cm ³) | Mean ped size (mm) | % peds > 6 mm |
|---------------------|-------|-----------------------------------|--------------------|---------------|
| Destoner | 25 | 1.18 | 6.05 | 32.3 |
| | 30 | 1.19 | 6.47 | 32.4 |
| | 35 | 1.08 | 4.70 | 24.3 |
| Tillerstar | 25 | 1.15 | 5.45 | 29.6 |
| | 30 | 1.18 | 5.62 | 28.8 |
| | 35 | 1.17 | 5.95 | 31.5 |
| S.E. (12 D.F.) | | 0.046 | 0.478 | 2.38 |
| S.E. (same machine) | | 0.044 | 0.452 | 2.23 |

- Ridge bulk density not affected by machine or depth of destoning
- Deep beds created with destoner had finer tilth than other treatments

Yield (Oxnead 6 E)

| Machine | Depth (cm) | Yield (t/ha) | | Tuber DM |
|------------|---------------------|--------------|--------|----------|
| | | Total | >40 mm | % |
| Destoner | 25 | 83.3 | 79.5 | 22.3 |
| | 30 | 81.4 | 77.8 | 21.5 |
| | 35 | 77.7 | 73.5 | 21.8 |
| Tillerstar | 25 | 80.7 | 77.4 | 21.9 |
| | 30 | 78.2 | 74.6 | 21.8 |
| | 35 | 78.8 | 75.6 | 21.7 |
| | S.E. (12 D.F.) | 1.87 | 2.04 | 0.49 |
| | S.E. (same machine) | 1.66 | 1.83 | 0.56 |

- No significant effect of machine on total or >40 mm yield or number of tubers
- 35 cm depth of destoning lower total yield ($P=0.048$) than 25 cm destoning
- No significant effect of depth on >40 mm yield
- No significant effect of machine on tuber dry matter %

Yield (Booton 33)

| Machine | Depth (cm) | Yield (t/ha) | | Tuber DM |
|------------|---------------------|--------------|--------|----------|
| | | Total | >40 mm | % |
| Destoner | 25 | 74.5 | 72.5 | 23.8 |
| | 30 | 74.3 | 72.2 | 23.8 |
| | 35 | 72.6 | 70.4 | 24.2 |
| Tillerstar | 25 | 74.5 | 72.2 | 23.9 |
| | 30 | 71.6 | 69.2 | 23.8 |
| | 35 | 71.4 | 68.5 | 23.8 |
| | S.E. (12 D.F.) | 2.70 | 2.89 | 0.65 |
| | S.E. (same machine) | 2.06 | 2.15 | 0.71 |

- No significant effect of machine or depth on total or >40 mm yield, number of tubers or on tuber dry matter %

Common scab and greening

Oxnead 6 E

| Machine | Common scab (% SA) | | Greening (%) | |
|---------------------|--------------------|------------|--------------|------------|
| | Destoner | Tillerstar | Destoner | Tillerstar |
| Depth | | | | |
| 25 | 1.69 | 1.43 | 10.4 | 9.2 |
| 30 | 1.88 | 1.17 | 7.5 | 6.2 |
| 35 | 1.04 | 1.74 | 9.1 | 10.6 |
| S.E. (20 D.F.) | 0.42 | | 2.56 | |
| S.E. (same machine) | 0.39 | | 2.57 | |

- No effect of machine or depth of destoning on common scab or greening

Harvesting damage

| Machine | Destoner depth | Bruising incidence (%) |
|------------------------------|----------------|------------------------|
| Destoner | 25 | 17.0 |
| | 30 | 21.4 |
| | 35 | 13.6 |
| Tillerstar | 25 | 13.1 |
| | 30 | 13.0 |
| | 35 | 17.8 |
| S.E. (12 D.F.) | | 2.88 |
| S.E. (12 D.F., same machine) | | 3.07 |
| Destoner | | 17.3 |
| Tillerstar | | 14.7 |
| S.E. (3 D.F.) | | 1.44 |

- Bruising incidence moderate during machine harvesting
- No effect of machine or depth of destoning on bruising or clod tare
- Harvester speed faster at 25 and 30 cm (3.8 km/h) than at 35 cm (3.4 km/h). No effect of machine

Summary

- Rates of destoning
 - Similar for 2-bed Tillerstar vs two-machine conventional destoner system on SL soil
 - Slower for Tillerstar vs destoner system on heavier CL soil, particularly at 35 cm
 - Decreased with depth
 - SL soil: 35 % slower at 35 cm than 25 cm
 - CL soil: 100 % slower at 35 cm than 25 cm
- Fuel consumption and costs
 - Destoning operation
 - SL soil: Tillerstar consumed more than twice as much fuel conventional destoner, particularly at 35 cm depth
 - CL soil: Tillerstar consumed 2.3 times as much fuel as conventional destoner at 25 cm depth and 2.6 times at 35 cm depth
 - Total fuel consumption
 - SL soil: total fuel consumption similar between machines at 25 and 30 cm but much more in Tillerstar than destoner at 35 cm
 - CL soil: Total fuel consumption greater for Tillerstar than destoner system: 11 % at 25 cm and 50 % at 35 cm
- Generally, finer tilth produced with Tillerstar than destoner
- No difference in yield between machines but shallow depth (25 cm) higher yield than 35 cm depth
- No effect of machine or depth on common scab or greening
- No effect of machine or depth on bruising during harvest



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