

# Arable Update


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## Herbage: Issue 85

### Plantain seed crop responses to spring nitrogen in Canterbury


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#### Background

Plantain has become an increasingly important component of pasture seed mixes, driven in part by heightened environmental concerns regarding nitrate leaching from grazed pastoral systems. Nitrogen (N) fertiliser management is widely regarded as the principal agronomic lever for increasing plantain seed yield, especially in environments with low inherent soil fertility. This project aims to improve the agronomy of plantain seed production by identifying optimal biological and economic N application rates.

#### Methods

Three randomised complete block trials were conducted over three growing seasons in plantain seed crops in the Selwyn district. Year 1 was established in a second-year 'AgriTonic' crop at the Kowhai Research Site, Lincoln, while Years 2 and 3 were conducted in commercial first-year 'Boston' crops near Southbridge. Treatments consisted of varying N application rates, including nil-N controls. Baseline soil mineral N was measured prior to treatment application (Table 1). Nitrogen was applied as Sustain<sup>®</sup> fertiliser and broadcast evenly by hand across plots.

Crop biomass and seed head density were assessed during reproductive development using quadrat cuts collected from the centre of each plot. Samples were analysed by Hill Laboratories for soil and plant N concentration to calculate N uptake. All trials were windrowed using modified small-plot windrowers and machine-harvested with plot combines. Seed sub-samples were retained for quality analysis.

Seed yields across the three years of the study varied widely. Therefore, seed yield was standardised by expressing the highest yield within each trial to 100% to allow comparison across trials.

#### Key points

- Spring-applied nitrogen (N) increased plantain seed yield.
- Optimum yield was achieved at a total available N level (applied N + soil mineral N) of  $147 \pm 11$  kg N/ha across all three trial years.
- Economic returns declined at higher nitrogen rates, with diminishing margin-over-costs occurring between total N rates of 155–186 kg N/ha across the trials.
- In high background soil N situations, additional nitrogen application reduced profitability, resulting in losses of up to \$800/ha compared with the untreated control.
- The strongest economic returns were in Trial 3, driven by seed yields of up to 3008 kg/ha.

**Table 1.** Spring soil mineral N and mineralisable N test results (Hill Labs) from three plantain seed production trials conducted in the Selwyn district, Canterbury, during the 2020–21 (Trial 1), 2021–22 (Trial 2), and 2023–24 (Trial 3) seasons.

Trial	Mineral N 0-30 cm	Mineral N 30-50 cm	Mineralisable N 0-30 cm	Total N
Trial 1	26	13	61	100
<sup>1</sup> Trial 2	30	74	60 <sup>2</sup>	164
Trial 3	17	27	63	107
Mean Total N	24	38	61	123

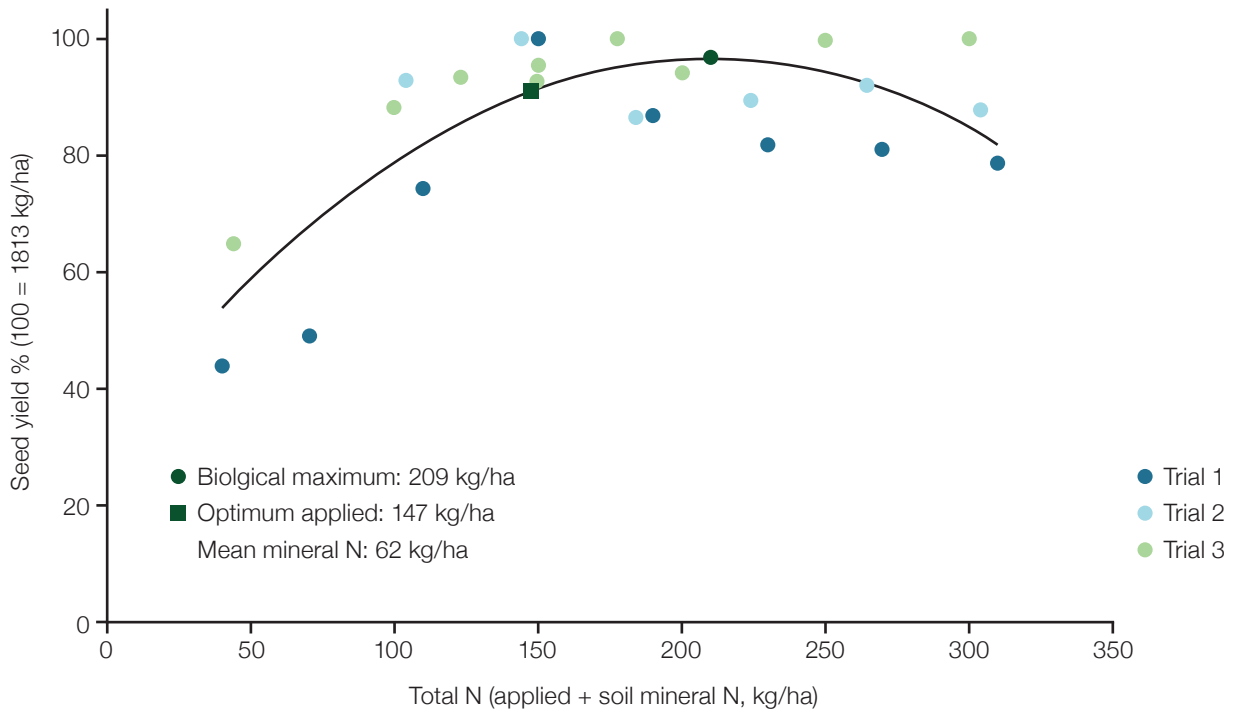
<sup>1</sup>Trial 2 is highlighted to emphasis the high background fertility of the site.

<sup>2</sup>Data for Trial 2 are estimated from N uptake in the untreated control plots at harvest.

#### Results and discussion

Seasonal effects were large across the three years of trials. Trial 1 (second-year plantain) was low yielding (283–649 kg/ha), with a seed yield breakpoint at 139 kg N/ha applied N. Trial 2 showed no seed yield response to applied N likely because of high background fertility (minimum N supply >104 kg N/ha, Table 1, highlighted in yellow for emphasis). Trial 3 was high yielding (1960–3010 kg/ha) and showed a strong response to N with a breakpoint of 160 kg N/h applied N.

Across all three trials, maximum seed yield was predicted at 209 kg N/ha total N (Figure 1), equivalent to 147 kg N/ha applied N plus 62 kg N/ha mean soil mineral N. Yield declined beyond this biological optimum rather than reaching a plateau. In the 2021–22 trial, soil mineral + mineralisable N was 164 kg N/ha, so there was no seed yield response to applied N. In all three seasons, treatments of approx. 125 kg total N were in the top statistical group for seed yield.

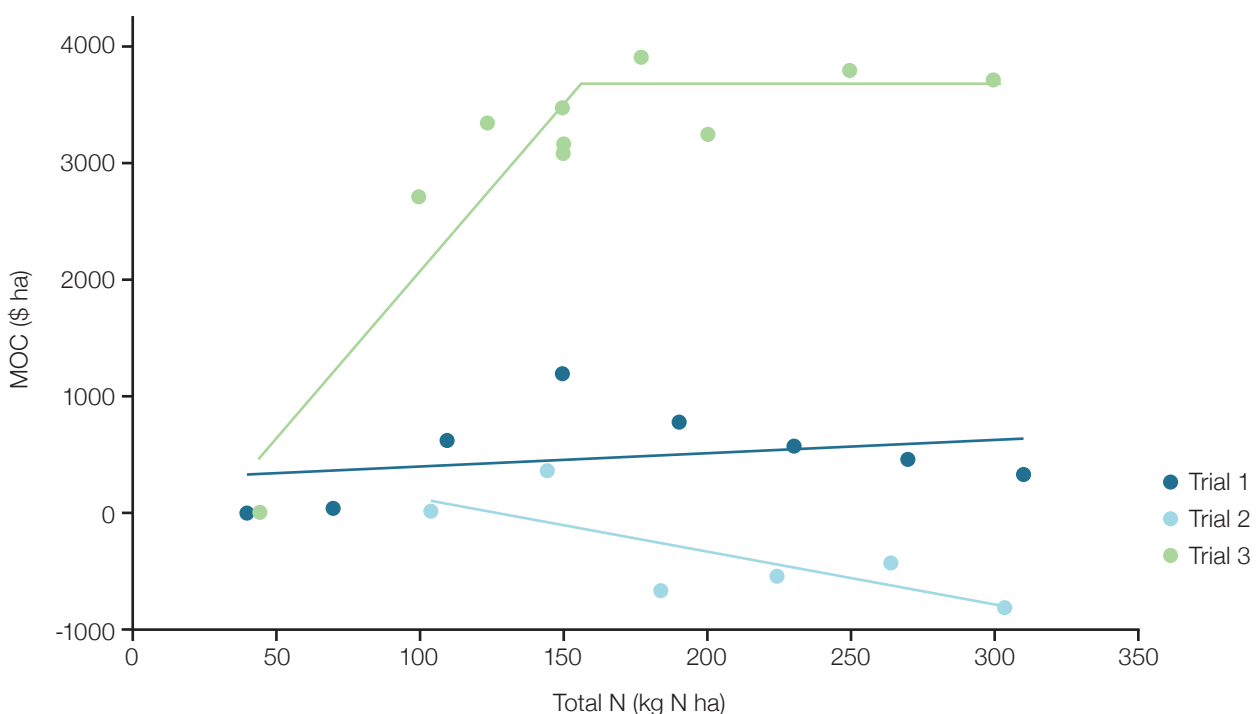


**Figure 1.** Response of calculated plantain seed yield to spring nitrogen (N) application. Data were collated from three trials in the Selwyn district, in the 2020–21, 2021–22, and 2023–24 seasons.

Trial 1 had substantially lower yield, biomass, and seed head density, largely because of greater *Phomopsis subordinaria* stalk disease. This was predominantly a result of being a second-year seed crop as well as being a different cultivar ('AgriTonic') to trials 2 and 3 ('Boston').

Seed yield was directly influenced by increasing seed head density ( $P = 0.003$ ) with diminishing returns at high canopy densities. Maximum predicted yield occurred at 1215 heads/m<sup>2</sup> (data not shown). No significant difference was observed in thousand seed weight due to applied N.

Above-ground biomass increased linearly with seed head density within each trial. The 2021–22 season (Trial 2) was relatively wet and promoted vegetative growth, with biomass ranging from 15-20 t/ha. High background soil fertility (>150 kg N/ha potentially available during the growing season) further amplified biomass production.



**Figure 1.** Margin over cost (\$/ha) for three plantain nitrogen trials conducted in the Selwyn district, Canterbury, during the 2020–21, 2021–22, and 2023–24 seasons. A plantain seed price of \$4.00/kg and a nitrogen cost of \$900/t (Sustain<sup>®</sup>) were used for all trials.

Margin over cost (MOC) showed a moderate quadratic response in Trial 1 ( $R^2=0.71$ ) with an economic optimum at 186 kg N/ha total N (Figure 2). Profitability declined beyond this point where diminishing seed yield and MOC returns resulted from increasing applied nitrogen. No economic optimum was identified within the tested range in Trial 2. MOC declined linearly with increasing total N ( $R^2 = 0.58$ ). The untreated control had access to >100 kg N/ha mineral N, with a further ~60 kg N/ha mineralisable N potentially becoming available during the season. This trial demonstrates that under high fertility conditions, additional fertiliser N can reduce profitability and the potential to capture excess soil N by testing in the spring. Trial 3 showed a strong economic response to N ( $R^2 = 0.86$ ). MOC increased up to a breakpoint at 155 kg N/ha total N, reaching a maximum of \$3664/ha. The high yields achieved in this season underpinned the strong economic response to spring applied nitrogen.

### **Implications for growers**

Plantain seed yield demonstrated a positive response to increasing nitrogen supply when soil available nitrogen was between 39-44 kg N/ha in the top 0-50 cm. Similar trends were observed for seed head density and dry matter.

A plantain seed price of \$4.00/kg and a nitrogen cost of \$900/t (SustainN<sup>®</sup>) were used for all trials. Based on these figures, the biological maximum seed yield was achieved at a total nitrogen input (soil mineral N plus applied fertiliser N) of  $209 \pm 11$  kg N/ha with an optimal applied nitrogen input of  $147 \pm 11$  kg N/ha.

This highlights the importance of accounting for soil N when determining fertiliser requirements. Testing soil mineral N below 30 cm is recommended, as substantial N reserves were detected at depth in some trials.

### **Acknowledgements**

This work was funded by the Seed Industry Research Centre (SIRC) and field work was managed by NZ Arable, Emelia Cox (FAR graduate), Aaron Lill (trial host).

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