

2012: Interim findings (year 2)



Sustainable use of nitrogen fertiliser on cider apple trees and the effect of partial replacement with TwinN, nitrifying bacteria

Interim report by Nigel Kitney, edited for HONE by Emily Durrant¹

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Findings for year 2 are represented here. For year one findings, see *Year 1 Findings – N*, available via download from <http://www.bulmerfoundation.org.uk/downloadcategory/hone-resources-for-growers>. The final report will be produced in 2013.



Background

Growers need to grow cider apples at minimal cost in order for the industry to remain viable. In practice, this means maximising yield whilst optimising inputs. Guidance for fertiliser use in orchards is included in DEFRA's RB209, which is currently being revised. The new RB209 will include provision for increased use of potassium to replace nutrients that have been removed by the crop but not change to the nitrogen requirements. Some nitrogen in the soil is accumulated from the air but most is released from the wetting and drying of organic matter. Excess rainfall can leach nitrogen from the soil.

Since it was last revised, apple yields have increased substantially (from 20 to 50+ tonnes per hectare). At least partially responsible for increases in yield, over the same period, growers in Herefordshire increased nitrogen application rates; many growers now apply 165kg of nitrogen per hectare or more, and often apply onto the herbicide strip, rather than the actual hectare (realistically increasing the rate two-fold, if not three).

Meanwhile, an over-dose of nitrogen is extremely undesirable can be harmful to the environment, not to mention wasted money. High rates of nitrogenous fertiliser have been linked to water pollution, often leading to eutrophication. Overdosing of nitrogen is also known to cause acidification of soils and subsequent imbalance of soil nutrients. The manufacturing process for nitrogen fertiliser also carries a hefty CO₂e footprint.

This trial aims to determine the optimal rate for cider apples for the three major Herefordshire soil types tested. In addition, it is hoped the study can determine the effects of partial replacement of conventional fertiliser with TwinN. This is a biological product that claims to be able to reduce the requirement for soil-applied nitrogen by 50%. Trials on cereals at Rosemaund near Hereford by ADAS have been very promising.

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Methodology

This trial was set-up on three of the local soil types and will try to measure the optimum soil nitrogen level for cider crops. This may vary for soil type. The nitrogen levels in the soil will be measured in the spring before fertilizing. Five different rates of nitrogen will be applied to enable a nitrogen response curve to be drawn. The experiment is repeated three times at each site to remove as much local variation as possible. It is expected that the level of nitrogen required will depend upon the crop potential and how much is provided by the soil, as well as seasonal factors.

At harvest the nutrient levels in the apples and leaves will be measured, in addition to any residual nitrogen in the soil. This will enable an assessment of the efficiency of fertilizer use. The pH of the soil, phosphorous, potassium and magnesium levels will be checked and corrected before the start of the trial. They will be retested and corrected each subsequent autumn.

The trial will be repeated for three years to remove the effect of seasonal factors. In addition to the five rates of nitrogen there will be two lower rates of nitrogen plus the foliar application of TwinN.

Experimental design

On each of the three farms, 7 plots are replicated 3 times within the same orchard. The location of plots within each set was randomised. Each plot contains 10 trees; apples are picked from the 4 most representative trees within the replicate 4 trees. The fertiliser for each plot was weighed-out and applied to the herbicide strip. In the first year this was done by hand, in the second and third years, by garden push along spreader. The application rate for each plot is as follows:

Table to show rates applied to the 7 plots at each site, including an EXPLANATION OF RATES

Plot	Nitrogen rate, Kg per Tree-hectare per year (all applied to the herbicide strip)*	Approximate equivalent rate Kg of N per applied Tree-hectare (as spread on the strip = about 33% of tree hectare area)
1	Control (no nitrogen)	0
2	50	150
3	100	300
4	150	450
5	200	600
6	50 + TwinN	150 + TwinN
7	100 + TwinN	300 + TwinN

** Note we use Kgs of N applied per Ha, rather than Kgs of product applied per Ha. Most growers use ammonium nitrate which provides about one third N by weight; i.e. 1st column 100kg/N (300kg Amm. Nit.) Second column 300kg N (900 kg Amm. Nit.)*

Results & Discussion

Full results are available in an excel format.

Problems encountered and possible impact on results:

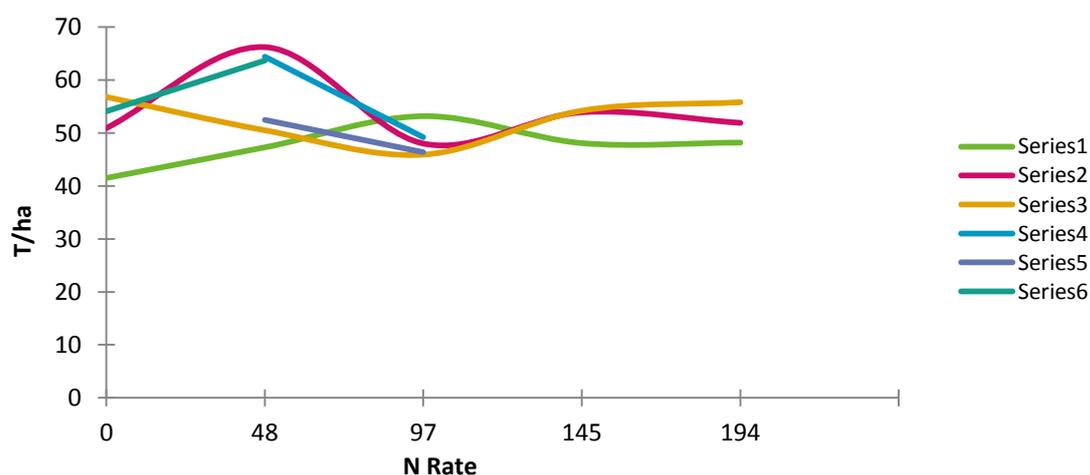
Due to a heavy frost killing blossom on the Lower Court Orchard we decided to drop the orchard from the trial as the lack of fruit was likely to affect nitrogen uptake. Thus, no results are available for Lower Court Orchard for 2011.

The shortage of rain fall has affected results for the second year running in spite of efforts to irrigate the orchards concerned. At Corse Court Farm the first row of the 3 trial sets had a much higher yield, possibly due to edge effect or receiving more water from irrigation somehow.

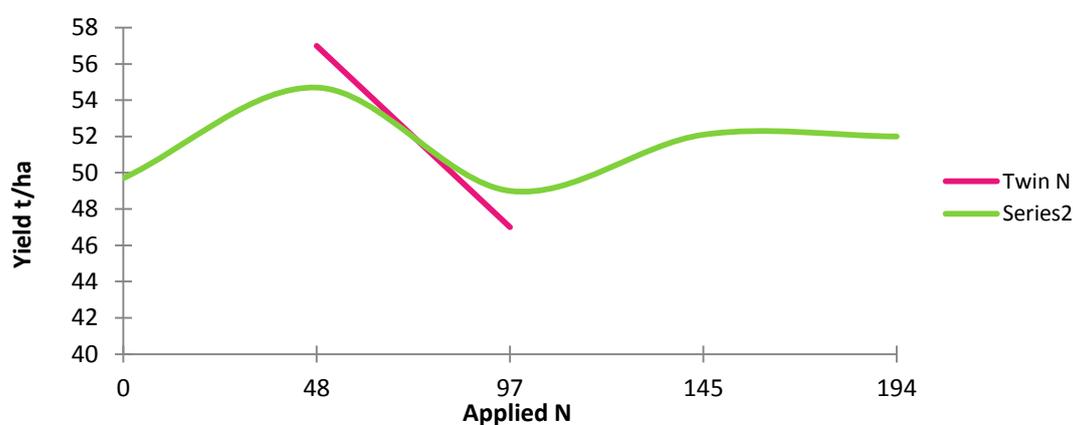
Yields:

The yields for 2011 at Corse averaged 51.5 t/ha while at Herridges it was 44 t/ha. While block average yields were similar at Corse at Herridges Block 1 averaged 54t/ha, Block 2 40t/ha and Block 3 39t/ha; this is many due to differences in trees size.

Yield Corse Court Orchard 2011



Corse Court Yield, 2011

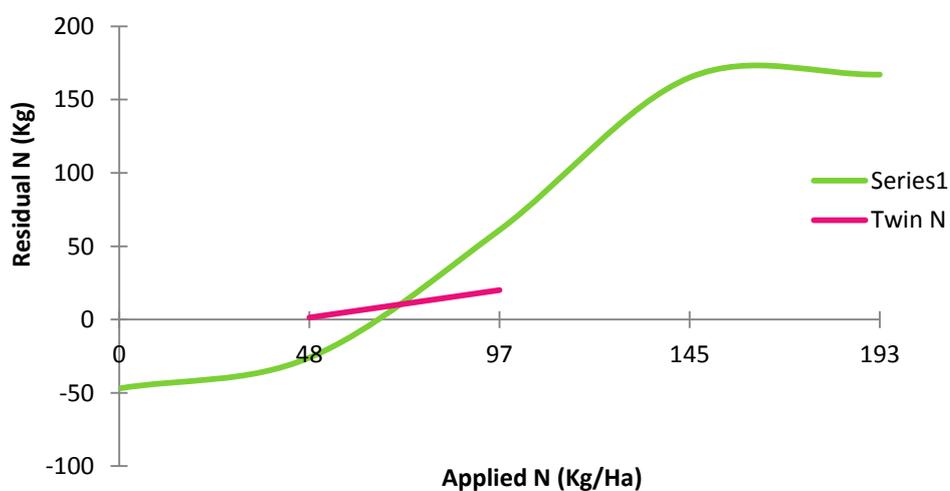


Nutrients:

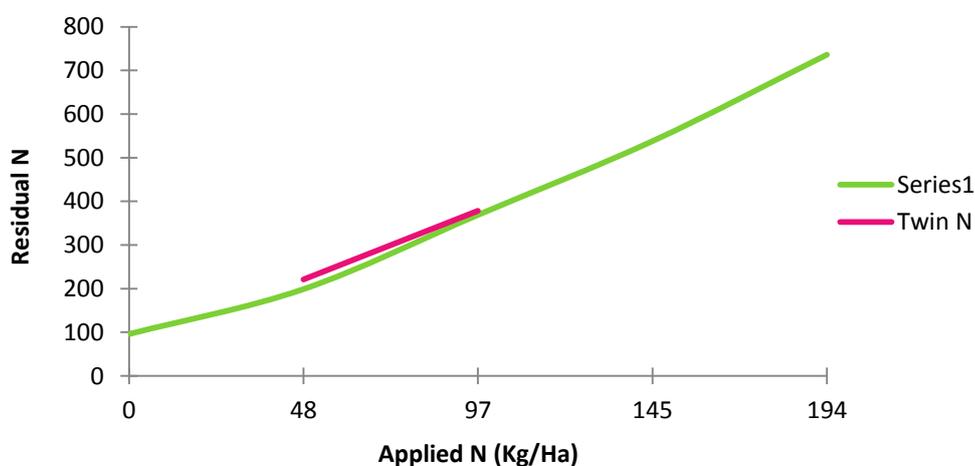
While lack of rain had inhibited uptake of all nutrients in 2010, irrigation at both sites aided uptake in 2011 but drought still had some effects – leaf phosphorous levels at Herridges averaged 0.12% against an optimum of 0.2 %. This suggests that additional foliar feeds of phosphorous would have been beneficial.

Soil residual nitrogen scores measured in spring 2011 indicated that the optimum maintained application rate at Herridges and Lower Court should have been 80kg/ha in 2010. However, due to poor uptake the optimum at Corse for 2010 was 0 kg/ha. For 2011 the optimum was 70kg/ha at Herridges and 40kg/ha at Corse (irrigation improved utilisation of available nitrogen).

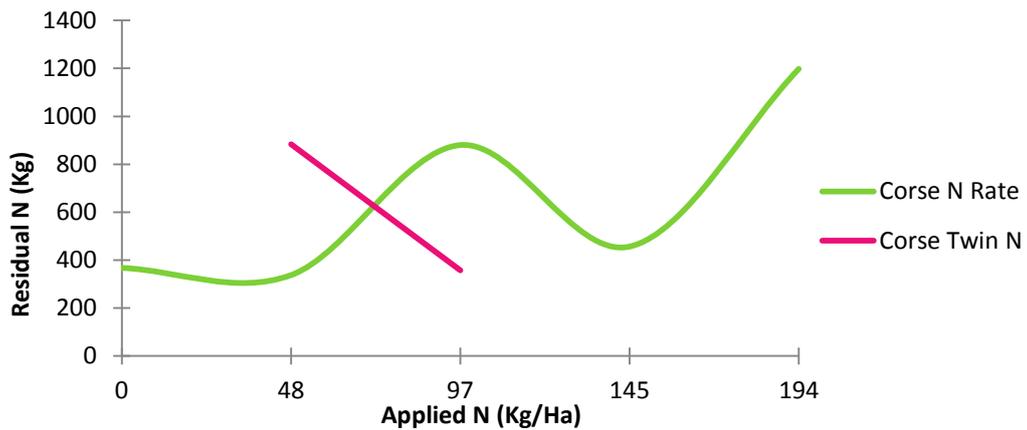
All Sites - Change in Soil Residual nitrogen 2010/2011



Herridges Residual Nitrogen, Autumn 2011

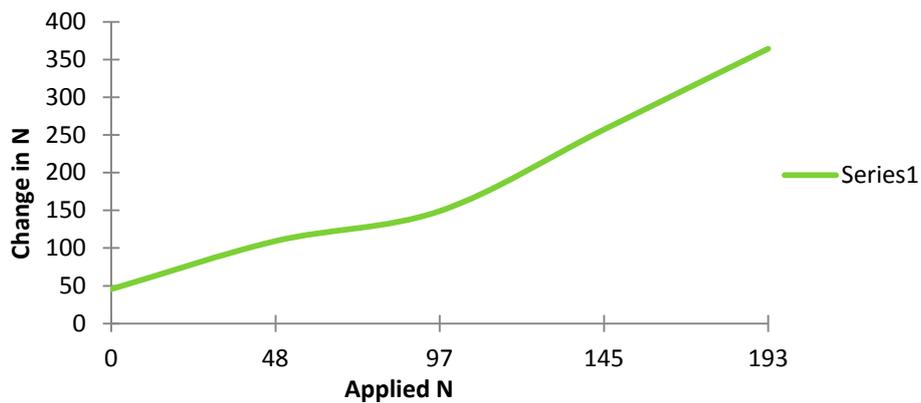


Corse Residual Nitrogen, Autumn 2011

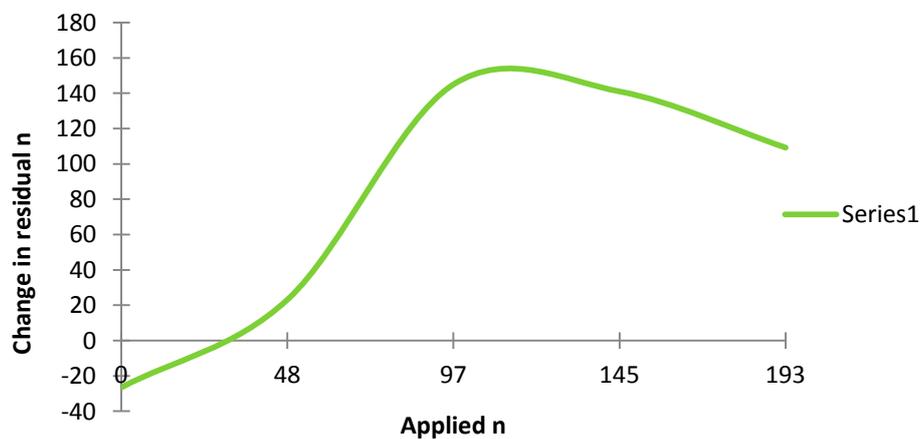


The residual nitrogen levels in spring 2012 are high due to lack of winter leaching suggesting that the optimum nitrogen rate will be lower this year than usual. Because of these results a number of growers have tested their orchards and most will be reducing their nitrogen application this year.

Herridges Change in Residual Nitrogen, 2011-2012

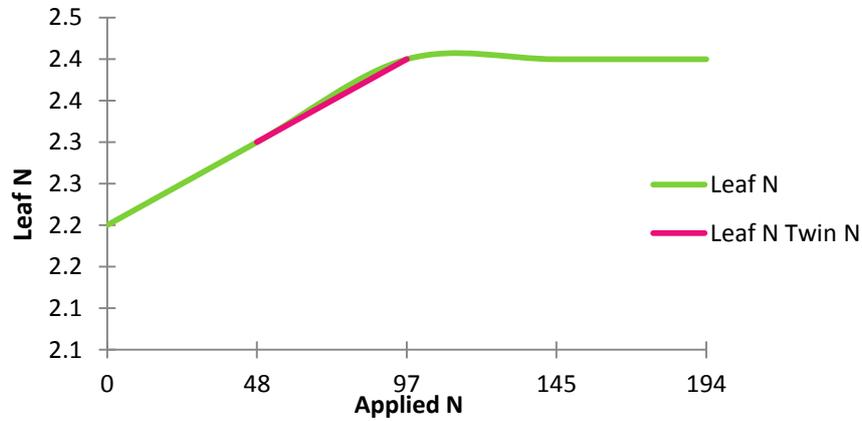


Corse Change in residual Nitrogen, 2011-2012

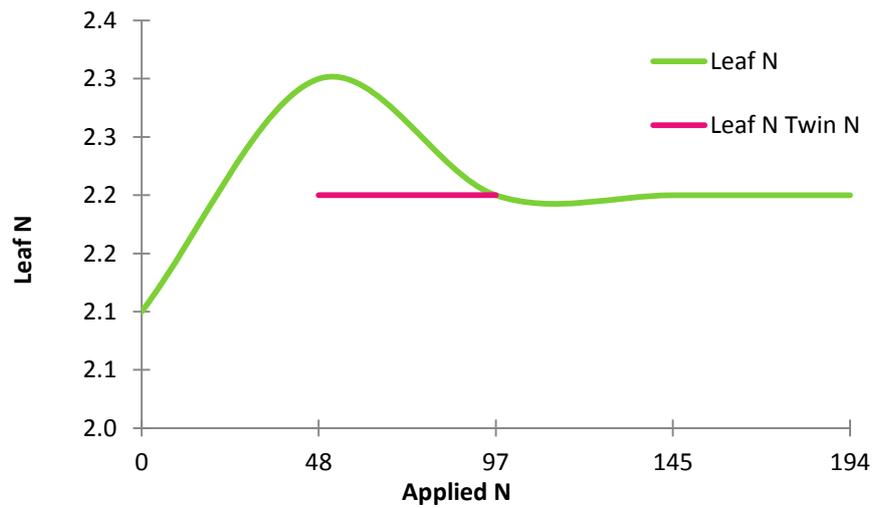


The results to-date suggest that rooting depth, available water, lime status and potash status are all more important than applied nitrogen and that considerable economies in nitrogen use could be made in orchards.

Herridges Leaf Nitrogen, 2011



Corse Court Leaf Nitrogen, 2011



Appendix

Operations carried out

The following table shows the work carried out. Note that in 2012, The Lower Court Farm Trial was dropped as frost severely affected the fruit set.

Date	Operation
25/03/2010	Soil samples taken
30/04/2010	Soil Analysis Report
12/04/2010	Fertiliser applied Lower Court Nitram 34.5% N
13/04/2010	Fertiliser applied Corse Court and Herridges. Nitram
19/04/2010	Lime applied Lower Court, 15Kg/plot on block 1, 5kg/ plot block 2(120Kg spread)took 50Kg for Corse Court. Spread 6kg/plot on block 2.
26/04/2010	TwinN application 7pm to10pm spraying prep TwinN during day. 6 plots sprayed on each farm. Applied 50ml TwinN mix in 1000lt water/ ha. Concerned about drift to other rows reduce pressure from 10 bar next time.
24/06/2010	Leaf samples taken
01/07/2010	2nd fertiliser application. Nitram
20/08/2010	3rd fertiliser application. Nitram.
02/09/2010	TwinN application9pm to 00.00 spraying prep TwinN during day. 6 plots sprayed on each farm. Applied 50ml TwinN mix in 1000lt water/ ha. Reduced preasure from 10 bar at lower speed.
12/10/2010	Nigel picked Herridges Plots
15to21/10/2010	Luke Picked Corse Court Farm Plots
23to24/10/2010	Nigel picked Lower Court Plots
01/12/2010	Soil sampling all plots
2011	Changed Fertiliser from 34.5%N Nitram to CAN. Yara Liva Tropocoto 15.5% N 26% CaO (Nitric Nitrogen 14.4% Amonical Nitrogen 1.1%, Calcium Oxide (CaO) Average water soluble Ca 26.3% / 18,8%Ca).
01/03/2011	Soil sampling all plots
14/04/2011	1st fertiliser application Corse Court Farm. CAN 27%N 15.5%CA Very dry so put 2500lt water on plots to help soak in.
29/04/2011	1st fertiliser application Herridges, rained after application
30/04/2011	1st fertiliser application Lower Court Farm
03/05/2011	TwinN Application 7.30pm to10.30pm all farms
30/06/2011	2nd fertiliser Application Corse Court and Herridges. Lower court Dropped due to Frost Damage.
30/08/2011	3rd fertiliser application
09/08/2011	TwinN application8.30 am to 10.30am spraying . 6 plots sprayed on each farm. Lower Court no longer in trial Applied 50ml TwinN mix in 1000lt water/ ha. Reduce pressure from 10 bar .
7 to20/10/2011	Luke Picked Corse Court Farm Plots
14/10/2011	Nigel picked Herridges Plots
08/12/2011	Soil sampling all plots