Grower Summary

Project number SF 137

Timing of nitrogen applications to optimise growth and yield without adversely affecting fruit storability and frost sensitivity

Annual 2014

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Project Number:	SF 137
Project Title:	**Timing of nitrogen applications to optimise growth and yield without adversely affecting fruit storability and frost sensitivity**
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Report:	Annual Report 2014
Publication Date:	9 September 2015
Previous report/(s):	Annual Report 2013
Start Date:	1 March 2012
End Date:	31 December 2015
Project Cost:	£50,044

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Headline

Based on results so far there would seem to be little benefit in using higher levels of nitrogen throughout the season in container grown blueberry.

Background and expected deliverables

To maximise the yield of blueberry bushes, optimum bush growth is required, with larger bushes having significantly greater potential yields. Although nitrogen application is important for encouraging growth it is not without potential problems. During fruiting, high nitrogen application has been shown to reduce fruit firmness and may also reduce storage life. Commercial experience has shown that damage to branches and developing flowers caused by frosts during autumn and winter can have deleterious effects on yield. Late nitrogen applications are believed to increase sensitivity to frost and therefore increase the risk of frost damage. Excessive nitrogen applications at the time of autumn flower initiation also have the potential to reduce flower number. Each of these effects will have a considerable influence on yields.

Research into the nutritional requirements of blueberries around the world has focussed on soil grown crops. However the majority of UK produced blueberries are currently grown in soil-less substrates in pot grown systems and less is known about the optimum nitrogen requirements of these. It is hoped that this project will benefit UK blueberry growers in the following ways:

- Improve our understanding of how to manipulate nutrient balance in pot grown blueberries.
- Provide growers with a better understanding of the optimum time to apply nitrogen in pot grown blueberries.
- Increase our understanding of the effect that nitrogen applications made immediately before harvest have on storage potential of blueberries.
- Improve our knowledge of manipulating nitrogen application to reduce the risk of frost damage occurring.

This project will investigate the application of nitrogen to pot grown blueberries at different times of the season to ascertain the optimum application timing to maximise yields whilst reducing the risk of frost or cold injury to bushes and flowers.

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The two main objectives of the work are:

Objective 1: Test the effect of three constant nitrogen levels on growth and yield (March 2012 - October 2012)

Objective 2: Examine the effect of increasing and decreasing nitrogen feed levels during three key phases of growth: early spring growth, fruiting and autumn flower initiation (October 2012 - October 2015)

Summary of the project and main conclusions

The project is being run at Brogdale Farm, Faversham, Kent. Three year old blueberry bushes of the varieties Duke and Aurora were sourced from Hall Hunter Partnership (HHP) in 25L pots on 6 March 2012. The variety Duke was sourced from Heathlands Farm, Wokingham and the Aurora was sourced from Tuesley Farm, Milford. The plants were selected for uniformity using a standard system. For Duke, the plants required three to five main structural branches and for Aurora, plants with two or three main structural branches were selected.

On arrival at Brogdale, the pots of the variety Duke were placed on a black Mypex floor covering, in a Spanish Tunnel. The tunnel was covered from bud break until the end of cropping at which point the plastic cladding was removed. The Aurora pots were placed outside on a black Mypex floor covering in line with commercial practice.

Objective 1: Test the effect of three constant nitrogen levels on growth and yield (March 2012 - October 2012)

Three feed solutions were supplied to plants with 60ppm N, 120ppm N or 180ppm N from March to October 2012. Ninety plants of each variety were arranged in a randomised block design with six plots per treatment. Irrigation was supplied to achieve a target of 60% substrate moisture content whilst maintaining EC within set limits. The nitrogen applied was in the form of 70% ammonium nitrogen and 30% nitrate nitrogen.

Shoot lengths of tagged and labelled shoots were recorded monthly from March to October 2012 to determine whether the nitrogen treatments stimulated different levels of growth. In addition, fruit were harvested weekly and the number and the weight of fruit were recorded for each plot. Fruit brix° was recorded from 20 fruit per plot twice during the cropping period of each variety along with shelf life.

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Objective 2: Examine the effect of increasing and decreasing nitrogen feed levels during three key phases of growth: early spring growth, fruiting and autumn flower initiation (October 2012 - October 2015)

A separate batch of 252 plants of each variety is being used for the nitrogen timing treatments. These were sourced from HHP in March as above and were grown on at Brogdale for four months at 120ppm N from April 2012 to August 2012. At this point, on 15 August, the first treatment applications started with the application of the autumn treatments until 15 October 2012 (autumn high and autumn low below). Timings are based on specific growth stages although approximate timings are shown below for reference.

The plants were arranged in a randomized block design with six plots per treatment and seven plants per plot. Three separate lines of irrigation for the three nitrogen treatments allowed the plants to be plugged into the correct nitrogen treatment at the three points during the season outlined below (all dates vary according to the season).

'Autumn High'. A nitrogen level of 180mg/L was applied from the end of harvest until 90% leaf fall (15 August to 15 October 2012) and then 120mg/L was applied from bud break until the end of harvest (17 April to 12 September 2013).

'Autumn Low'. A nitrogen level of 60mg/L was applied from the end of harvest until 90% leaf fall (15 August to 15 October 2012) and then 120mg/L was applied from bud break until the end of harvest (17 April to 12 September 2013).

'Spring High'. A nitrogen level of 120mg/L was applied from 15 August to 15 October 2012. 180mg/L was then applied from bud break until first green fruit (17 April to 1 July 2013) and then decreased again to 120 mg/L until 12 September 2013.

'Spring Low'. A nitrogen level of 120mg/L was applied from 15 August to 15 October 2012. 60mg/L was then applied from bud break until first green fruit (17 April to 1 July 2013) and then increased again to 120mg/L until 12 September 2013.

'Summer High'. A nitrogen level of 120mg/L was applied from 15 August to 15 October 2012 and from bud break until first green fruit (17 April to 1 July 2013). This was then increased to 180mg/L from first green fruit until the end of harvest (1 July to 12 September 2013).

'Summer Low'. A nitrogen level of 120mg/L was applied from 15 August to 15 October 2012 and from bud break until first green fruit (17 April to 1 July 2013). This was then reduced to 60mg/L from first green fruit to the end of harvest (1 July to 12 September 2013).

'Medium'. A standard nitrogen concentration of 120mg/L was applied from 15 August to 15 October 2012 and then from bud break until end of harvest (17 April to 12 September 2013).

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'Low'. A nitrogen concentration of 60mg/L was applied from 15 August to 15 October 2012 and then from bud break until end of harvest (17 April to 12 September 2013).

'High'. A nitrogen concentration of 180mg/L was applied from 15 August to 15 October 2012 and then from bud break until end of harvest (17 April to 12 September 2013).

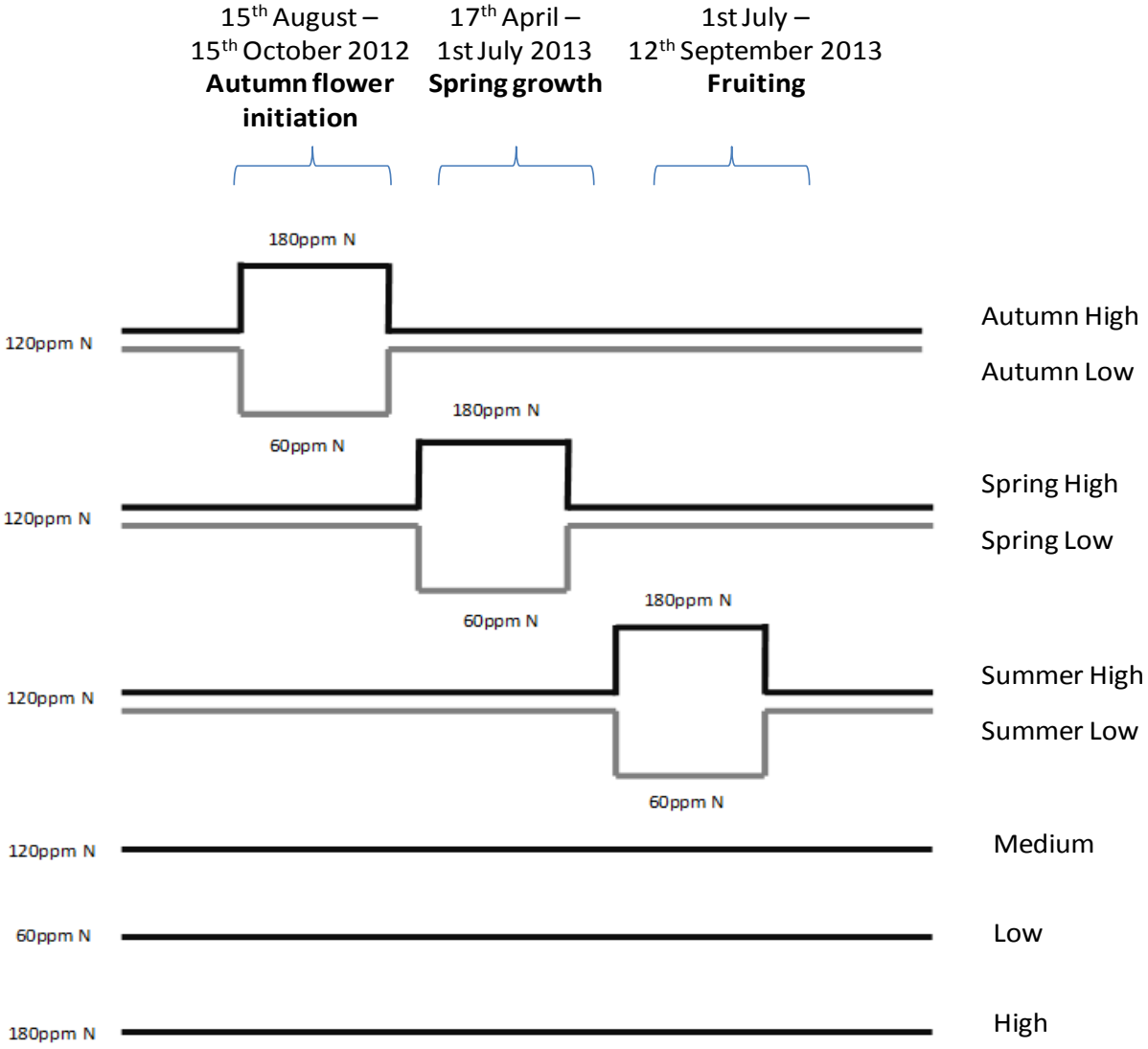

Figure 1 The treatments which were applied in Objective 2 of the project

From each treatment the growth, cropping and plant nutrition were assessed. These assessments began in 2013 apart from the growth measurements from the autumn high and autumn low treatments, which began in autumn 2012.

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The assessments which were made included:

Growth Shoot growth measured from labelled branches at the end of each of the three nitrogen application timings at the following timings – green fruit, end of cropping and 90% leaf fall.

Cropping Fruit was harvested, counted and weighed, separated into Class I, Class II and Waste fruit to determine the effect of treatment on yield and overall fruit quality.

Storability Both the Aurora and the Duke were placed into an air store at 2^{o}C at Brogdale and assessed fortnightly until deemed non-marketable. The Duke was also placed into a CA store at Hall Hunter Partnership on 1 August and assessed after four and eight weeks. Assessments made fortnightly were as follows:

- Percentage fruit with shrivel
- Weight loss during storage
- Fruit collapse
- Flavour
- Overall marketability based on commercial specifications supplied by HHP

Flower initiation The percentage of floral buds was calculated and the average number of flowers per bud was recorded.

Percentage bud break The percentage of buds which broke from each treatment was assessed.

Plant nutrition Leaf samples were taken and analysed for nutrient content on 11 July and 4 September. In addition, irrigation input and runoff was analysed on 16 July.

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Combined results for Objectives 1 and 2 in 2012 and 2013

Nitrogen usage by the plants varied according to treatment. There were differences observed in the total nitrogen in the inputs, runoff and also in the leaf analysis. There was a reduction in nitrogen in the leaf analysis taken in July for those treatments supplied with a low feed during the spring (low and spring low) and similarly, lower nitrogen was observed in the low and summer low samples in the September analysis. These levels of nitrogen are considered to be low when compared to industry leaf analysis ranges. Whether these levels are appropriate for all varieties of pot-grown blueberries in the UK remains to be seen.

There was a significant effect of treatment upon floral bud initiation in the Aurora whereby the low nitrogen treatment produced more floral buds. This suggests that increasing nitrogen concentration can inhibit floral bud production. Supplying low nitrogen levels during the autumn, when flower initiation occurs, resulted in some of the largest yields for both varieties, however these results were not significant. It is not clear as to whether these increases in yield were solely due to fruit size or fruit number.

Fruit quality was affected by nitrogen treatment, with significant differences seen in both Brix° and fruit size, dependent on nitrogen treatment. Although significant differences could be seen, the only consistent effect of treatment upon fruit diameter was that of the autumn low treatment, which was larger than most other treatments for both varieties. Although there were no significant differences seen in the percentage of non-marketable fruit following storage, there were differences in the cause of these losses. There were treatment differences in the losses from dehydration, collapse and *Botrytis*; the low nitrogen treatment particularly appeared to be more susceptible to fruit collapse and less prone to *Botrytis* than the other treatments.

Consistent with the results observed last year, the growth of Aurora shoots varied with nitrogen treatment, the low having significantly less growth than the other treatments. Although not significant, the Duke shoot growth also followed the same pattern. The low treatment showed reduced growth particularly during the summer and very little growth of any treatment occurred throughout the autumn. The high and medium nitrogen treatments produced similar amounts of vegetative growth, which may suggest that the medium treatment provides sufficient nitrogen for vegetative growth.

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Results for Objective 2 in 2013 and 2014

The effect of increasing and decreasing nitrogen levels at different growth stages was repeated from autumn 2013 until autumn 2014.

The decrease in shoot growth in Duke observed for the low N treatment in 2012 and 2013 was not seen in 2014.

The differing nitrogen levels did not have an effect upon overall yield for either variety; however the high nitrogen treatment did produce a significant increase in fruit number for Duke. It also produced the smallest fruit in comparison to other treatments, whilst the low treatment produced significantly larger fruit. The high treatment had large early picks in comparison to other treatments, whilst the low nitrogen treatment had larger picks towards the end of the picking season.

The nitrogen treatment had an impact on storage potential for Aurora; the low nitrogen treatment had the most marketable fruit following a storage trial, as was seen in 2013. In 2014 this improvement in storage life was largely as a result of fewer incidences of fruit collapse and *Botrytis.* The high and summer high treatments were amongst those with the greatest Brix (°) for Duke.

Winter 2013/2014 and the subsequent spring were unusually mild in the south east of England with no harsh frosts, so conclusions could not be drawn on the impact of nitrogen nutrition on frost hardiness.

Main conclusions drawn from 2014

- There were no treatment effects on overall yield or quality class for the variety Aurora.
- There were impacts of nitrogen treatment on storage potential for Aurora.
- There was no effect of nitrogen treatment seen on shoot growth or total yield (kg) in 2014.
- There was a significant difference in berry weight and fruit size between treatments for Duke.
- There was a significant difference in cropping profile between treatments for Duke.
- There were differences in Brix (°) as a result of nitrogen treatment for Duke.

The project will continue for another season and it is likely that any cumulative effects of repeating nitrogen treatments will become apparent.

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Financial benefits

The financial benefits of this project are very difficult to quantify with confidence at this stage. The reduced fertiliser costs and improved marketable yield through better storage life demonstrated in the work will offer some financial benefit. If the impact of low N on fruit size in Duke is repeated, it could offer a saving in picking costs.

Action points for growers

In view of the fact that this trial has one more season to run before completion, any conclusions and action points arising from them must be regarded as provisional. Based on results so far it would appear that:

- Low rates of nitrogen reduced growth rates in Duke during the first two years of the trial but had no effect in 2014. This effect on growth did not have any apparent impact on yield.
- The variety Aurora showed no response in terms of improved growth or yield to increasing levels of nitrogen.
- Low N reduced storage losses in 2013 and 2014.
- Increasing nitrogen levels to 180 mg/L during the summer gave higher Brix (º) in Duke berries in both 2013 and 2014.

Based on results so far there would seem to be little benefit in using higher levels of nitrogen throughout the season, though increasing N in the summer could improve Brix (º) levels in Duke. Lower nitrogen rates would lead to reductions in fertiliser costs and even less environmental impact.

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