Grower Summary

HNS 171a

Cordyline and Phormium: Investigation of causes of tip burn and yellow leaf spot syndrome

Final 2014

Disclaimer

The results and conclusions in this report may be based on an investigation conducted over one year. Therefore, care must be taken with the interpretation of the results.

Use of pesticides

Only officially approved pesticides may be used in the UK. Approvals are normally granted only in relation to individual products and for specified uses. It is an offence to use non-approved products or to use approved products in a manner that does not comply with the statutory conditions of use, except where the crop or situation is the subject of an off-label extension of use.

Before using all pesticides check the approval status and conditions of use.

Read the label before use: use pesticides safely.

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GROWER SUMMARY

Headlines

Application of calcium nitrate (foliar feed) at up to 1520 mg/L calcium and potassium nitrate (liquid feed) at 200 – 300 mg/L potassium were found to reduce both tip burn and yellow leaf spot symptoms in *Cordyline* in some years.

Background

Cordyline yellow leaf spot syndrome and tip burn in both *Cordyline* and *Phormium* have been identified as major problems to the horticulture industry, affecting production with no clearly established causes, leaving growers unable to take reliable practical courses of action to address them (England 2009). An estimated 1 million and 1.24 million *Cordyline* and *Phormium* plants are grown each year respectively.

Tip burn

No clear cause has previously been established for tip burn in *Cordyline* and *Phormium*. Study HNS 171 estimated the value of *Cordyline* and *Phormium* crops affected by tip burn in excess of £1 million (England 2009). Leaf margin and tip browning symptoms in plants can be caused by nutrient imbalance including calcium, potassium and boron deficiency, and boron and fluoride toxicity, of which fluoride toxicity has been reported in *Cordyline* (Conover and Poole 1971), but not in *Phormium*. Typical macroscopic symptoms of fluoride toxicity are tip and margin necrosis (tip burn) with a distinct reddish-brown line separating it from healthy tissue in both monocotyledons and broad leaved plants (Fornasiero 2001).

***Cordyline* yellow leaf spot syndrome**

Cordyline yellow leaf spot syndrome is a condition of unknown cause that reduces the quality and profitability of these plants. The symptoms are unsightly yellow leaf spots, initially small raised pustules, apparently water soaked, that sometimes turn necrotic (Figure 1). Sales losses have been reported by nurseries throughout the UK, and HNS 171 estimated the loss across those *Cordyline* producers who responded to the survey, at £119,437 each year. Additional losses are likely to be incurred once plants are distributed to retail nurseries and garden centres as larger plants appear to be affected more than plugs and liners (England, 2009).

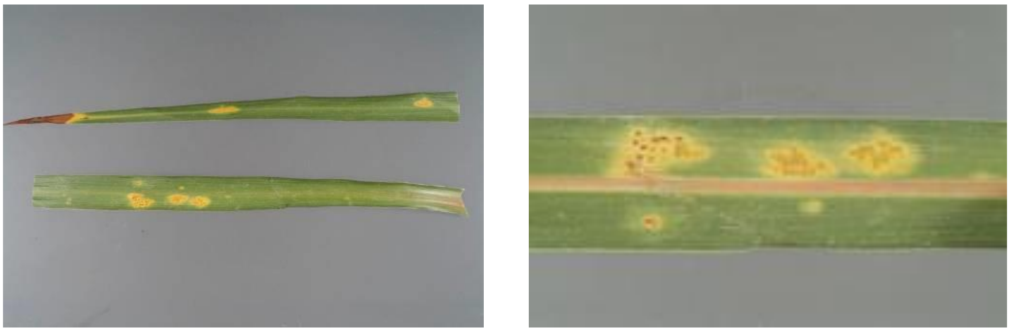

Figure 1. *Cordyline* leaf spot symptoms: raised pustules, initially chlorotic but becoming necrotic (Charles Lane, Fera).

Summary of the project and main conclusions

A single trial was carried out in the final year of this project which combined investigation of the involvement of nutrient imbalance on incidence of tip burn and yellow leaf spot syndrome in *Cordyline australis.*

***Cordyline* yellow leaf spot syndrome**

In year 1, 33 *Cordyline* samples were screened for the presence of three viral pathogens (Cucumber mosaic virus, CMV; Tomato spotted wilt virus, TSWV; and *Impatiens* necrotic spot virus, INSV), all commonly found in a wide range of ornamental species and potentially linked to leaf spotting, and virus particles (Transmission Electron Microscope followed by inoculation onto a standard range of bio-indicator plants to assess whether any 'transmissible' pathogens were present). None of the viruses screened for, nor virus particles were detected in any of the samples tested, with or without symptoms. It was concluded that there was no commonly identified viral cause for leaf spotting in *Cordyline*.

A controlled environment study of *Cordyline* in year 1 aimed to reproduce oedema symptoms in leaf segments. A range of environmental conditions were investigated, but none of the combinations of light, temperature and humidity used reproduced the symptoms.

In years 2-3, monitoring of environmental conditions during production of *Cordyline australis* crops at Stoneyfield Nursery and Palmstead Nurseries indicated that temperature and humidity fluctuated more, and over a greater range, at Stoneyfield Nursery than Palmstead Nurseries. However, the higher light levels at Stoneyfield Nursery may be implicated in the reduced level of leaf spot recorded, as they were above 200 $\mu M/m^2/s$ for approximately 75% of period that data was collected, whilst they only reached this level on one occasion at Palmstead Nurseries.

Tip burn

Nutrient feeding trials carried out in year 1 of this project proved inconclusive. A large proportion of the *Cordyline* and *Phormium* plants were damaged during severe cold weather experienced during the winter, before the final results could be recorded. In year 2-3 (year 2 treatments were continued into year 3), less tip burn developed in the calcium nitrate (liquid and foliar) and potassium nitrate (high dose rate) treatments, with the results generally following the same trend at all assessments. Fluoride toxicity did not appear to be implicated in causing tip burn under the conditions of this trial, therefore this aspect was not followed up in the final year of this project.

The impact of calcium, potassium and nitrogen (applied as urea) on tip burn and yellow leaf spot syndrome were further investigated via a nutrition trial in year 4. The trial was set up within an unheated polytunnel at East Malling Research, with treatments applied from 7 June 2013. Plugs of *Cordyline australis* were potted into 3 L pots; the variety was selected for its susceptibility to tip burn and *Cordyline* yellow leaf spot syndrome. Pots were placed on the ground and irrigated via drip irrigation, and by hand watering as necessary during the winter. Twelve treatments were applied, based on the results from this project, previous research and best commercial practice (Table 1).

Table 1. Nutrient feeding trial treatments

Treatments			Application method	Dose Rate (mg/L)
1	Ca low	$Ca(NO_3)_2$	Foliar feed	1520
2	Ca high	$Ca(NO_3)_2$	Foliar feed	3040
3	Ca low	$Ca(NO_3)_2$	Liquid feed	75
4	Ca high	$Ca(NO_3)_2$	Liquid feed	150
5	K low	KNO_3	Liquid feed	150
6	K high	KNO_3	Liquid feed	300
7	Ca high + K low	$Ca(NO_3)_2$+ KNO_3	Liquid feed	150 + 150
8	Ca high + K high	$Ca(NO_3)_2$ + KNO_3	Liquid feed	150 + 300
9	Ca low + K low	$Ca(NO_3)_2$+ KNO_3	Liquid feed	75 + 150
10	Ca low + K high	$Ca(NO_3)_2$ + KNO_3	Liquid feed	75 + 300
11	U	Urea	Liquid feed	107
12	C	Untreated control	Liquid feed	Water only

Treatments were applied weekly, with the calcium foliar feed applied under dull conditions. The liquid feed treatments were applied via Dosatron D3 Greenline injectors governed by Galcon DC-4S controllers.

Some tip burn had begun to develop after two weeks of treatment and continued to develop consistently across all treatments and plots through the season. However, the warm, dry summer and autumn delayed development of serious leaf spot and tip burn symptoms until early spring 2014 and the interim inspection was delayed until February 2014, by which time yellow leaf spot symptoms had developed further. There was no difference in incidence of tip burn between treatments or plots by either the interim or final assessments, therefore only yellow leaf spots were assessed.

Number of plants affected

The number of plants in each plot with yellow leaf spots was assessed after 35 and 42 weeks of treatment. After 42 weeks of treatment 1 (calcium nitrate, low rate, foliar feed) and treatment 6 (potassium nitrate high rate, liquid feed) had significantly fewer plants per plot with yellow leaf spots than the untreated control (Figure 2). All untreated plants had some degree of leaf spots.

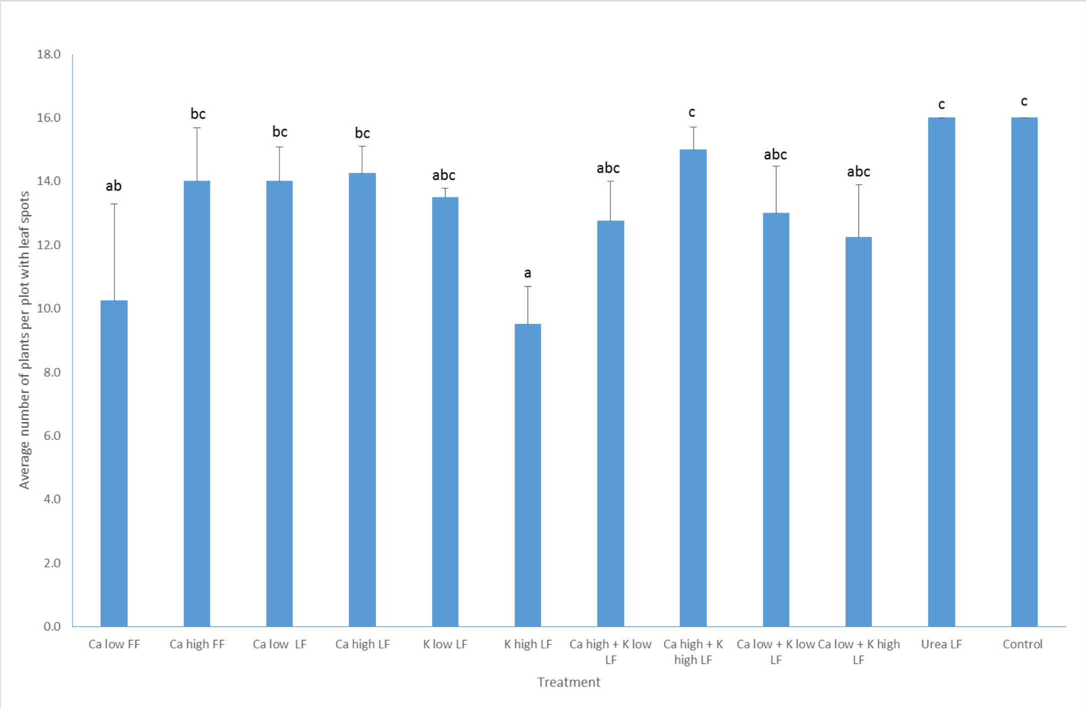

Figure 2. Average number of plants per plot with yellow leaf spots, 42 weeks after treatment: FF = foliar feed, LF = liquid feed Treatments identified by different letters (a, b, c) are significantly different.

Yellow leaf spot: whole plot scores

After 35 weeks of treatment the differences between treatments were not significant, primarily due to high within-plot variation. By 42 weeks after treatments, incidence of leaf spot had increased in all plots, and all treatments had significantly fewer leaf spots than the control, although where within-plot scores for treatments were high, the results were generally more variable. In some treatments the yellow leaf spots were often small and sparse, leading to low scores compared to the control in the whole plot assessment.

Plant quality

Plants were scored on a scale of 1-5, where 1 was a dead plant and those scoring 5 showed no tip burn or leaf spots, and plant size and leaf colour were unaffected. After 35 weeks of treatment, all plants were marketable. After 42 weeks, no plants scored either 1 or 5 for quality, plants in most treatments were generally marketable, although it may have been necessary to remove the tip burn prior to marketing. The exception was the untreated control where all plots were graded as mostly unsaleable, scoring 2, as they had more leaf spots, and tip burn and were generally paler. Leaf colour had a major influence on quality scores and the highest quality plants were found in treatment 10 (calcium nitrate, low rate, liquid feed + potassium nitrate, high rate), which had the best leaf colour. Treatment 4 (calcium nitrate, high rate, liquid feed), treatment 6 (potassium nitrate, high rate, liquid feed) and treatment 7 (calcium nitrate, high rate, liquid feed + potassium nitrate, low rate, liquid feed) generally had good leaf colour. Plant quality in the calcium nitrate (low rate, foliar feed) treatment was average mainly due to leaf colour even though leaf spot incidence was lower than other treatments. Treatment 11 (urea) produced smaller, slightly pale plants, and treatment 5 (potassium nitrate low rate, liquid feed) also produced slightly pale plants. Most plants were saleable, albeit with some tip burn and a degree of leaf spot.

Tissue analysis

Various leaf tissue analyses carried out at the start of the final year's trial (16 May 2013), at the start of year 2 (pre-trial, 12 October 2011) and at the end of the final year showed that plant tissue with both tip burn and yellow leaf spot symptoms had less leaf potassium and calcium, compared with tissue without symptoms.

Growing media analyses

Growing media samples from each treatment were analysed at the start of the trial and at the mid-trial and final assessments. At the mid-trial and final assessments the conductivity was generally high to excessive (>600 uS/cm), including the untreated control. This was due to high sulphate and chloride levels, particularly at the final assessment (after 42 weeks of treatment) where the highest level was found in treatment 11 (urea, 1504 uS/cm). This could have been affecting root health, thereby reducing nutrient uptake. As in year 2, salts appear to have built up over time; plants were irrigated via drip irrigation and the salts were not adequately flushed through the growing media.

Summary

Treatment 1 (calcium nitrate, low rate, foliar feed) and treatment 6 (potassium nitrate, high rate, liquid feed,) produced the best overall scores, with fewer plants affected and lower whole plot scores. Of these two treatments, plant quality was higher in treatment 6 (potassium nitrate, high rate, liquid feed), although plants submitted to treatment 1 (calcium nitrate, low rate, foliar feed) were not of poor quality. For treatment 11 (urea), although the whole plot scores indicated significantly less leaf spots than the control, plants were generally smaller and tended to be pale and of lower quality.

Financial benefits

- Control of tip burn in *Cordyline and Phormium* could save the horticulture industry an estimated £1 million annually.
- Control of *Cordyline* yellow leaf spot syndrome could result in savings estimated at £120,000.

Action points for growers

To reduce incidence of tip burn and yellow leaf spot:

- Apply calcium nitrate as a foliar feed. A dose rate of 1520 mg/L calcium was the upper effective limit in this trial.
- Apply potassium nitrate as a liquid feed, with a dose rate of 300 mg/L potassium.
- The best commercial option may be application of a combination of calcium nitrate (liquid feed, 75 mg/L calcium) + potassium nitrate (liquid feed, 300 mg/L potassium), as this treatment resulted in the best quality plants.