RIRDC Ginger Program Report
Ginger Industry Association workshop & field day
17 June 2014

Finances

<table>
<thead>
<tr>
<th></th>
<th>2012-13 ($’000)</th>
<th>2013-14 ($’000) Projected to 30 June</th>
<th>2014-15 ($’000) Draft Budget</th>
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<tbody>
<tr>
<td><strong>Income</strong></td>
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<tr>
<td>Levies</td>
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<tr>
<td>Commonwealth contribution</td>
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<td>142</td>
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</tr>
<tr>
<td>Other</td>
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<tr>
<td><strong>Total</strong></td>
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<tr>
<td><strong>Expenditure</strong></td>
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<tr>
<td>Research projects</td>
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<td>255</td>
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<tr>
<td>Levy collection costs</td>
<td>11</td>
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<tr>
<td>Management fee</td>
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<tr>
<td>Other</td>
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<tr>
<td><strong>Total</strong></td>
<td>155</td>
<td>297</td>
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<tr>
<td><strong>Program Reserves</strong></td>
<td>31</td>
<td>71</td>
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</tr>
</tbody>
</table>

Note: the Australian Government contributes 50% of Program expenditure (less levy collection costs); the Department of Agriculture recover the cost of levy collection; and RIRDC charge a Management fee.

Research projects funded in 2013-14

<table>
<thead>
<tr>
<th>Research projects</th>
<th>Status</th>
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<tbody>
<tr>
<td>Controlling Pythium in Ginger: Phase 2</td>
<td>Mike Smith</td>
</tr>
<tr>
<td>Understanding the Domestic Market for Australian Ginger</td>
<td>Steve Sheppard</td>
</tr>
<tr>
<td>Assessment of Pythium diversity in ginger</td>
<td>Elizabeth Aitken</td>
</tr>
<tr>
<td>Improving Soil Health to Suppress Soilborne Diseases of Ginger</td>
<td>Mike Smith</td>
</tr>
<tr>
<td>Technical support, extension and minor use development for the Ginger Industry</td>
<td>Jann Bonsall</td>
</tr>
<tr>
<td>Extension, Education and Communication of R&amp;D for the Australian Ginger Industry</td>
<td>Jann Bonsall</td>
</tr>
<tr>
<td>Improved tissue culture production of ginger clean planting material</td>
<td>Sharon Hamill</td>
</tr>
<tr>
<td>Health benefits of ginger: a review of the peer reviewed scientific literature</td>
<td>Steve Sheppard</td>
</tr>
<tr>
<td>Global ginger market assessment - opportunities for Australian ginger producers</td>
<td>Corey Fisher</td>
</tr>
<tr>
<td>Best practice supply chain management information for the ginger industry</td>
<td>Doris Blaesing</td>
</tr>
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</table>

Note: progress on most projects will be reported by researchers at workshop & field day

Ginger Industry R&D Priorities and Strategies: 2012 to 2017 (revised in August 2013)

- The Ginger Program Advisory Committee will use this plan to guide future Ginger Program investment

Dave Alden
Senior Research Manager, RIRDC
**Industry Production & Gross Value**

![Graph showing industry production and gross value over years](image)

**Industry**

- **Governance**
  - AGIA is an effective and innovative PIB
  - Industry Levy:
    - principal source or RD&E funding for industry
    - high administration costs due to multiple collection points
  - Processor engagement is low

- **Industry Advisory Council**
  - RD&E project evaluation matrix
Situation Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td>Healthy consumer demand</td>
<td>Marketing; consumer awareness</td>
</tr>
<tr>
<td>Strong industry governance - ‘One Voice’</td>
<td>Industry Size</td>
</tr>
<tr>
<td>Government support</td>
<td>Grower expansion</td>
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<tr>
<td>Mechanisation</td>
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<td>RD&amp;E Capability</td>
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</table>

<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
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<tr>
<td>Market expansion; domestic and export</td>
<td>Imports</td>
</tr>
<tr>
<td>Innovation; semi processed product</td>
<td>Pest and Disease</td>
</tr>
<tr>
<td>Cost reduction</td>
<td>Resource availability</td>
</tr>
<tr>
<td></td>
<td>Cost of inputs</td>
</tr>
<tr>
<td></td>
<td>Climate variability</td>
</tr>
</tbody>
</table>

Strategies – Competitive or Collaborative

![Grow your slice](image)

- Compete on price
- Transactional relationships
- Opportunistic behaviour

![Grow the pie](image)

- Compete on value
- More sales per consumer
- More consumers
- Higher price

Strategies – Value Chain Management

Value creation is the objective of value chain management.

Two requirements:
1. Focus on adding value for target consumers
2. Strategic alignment/collaborative relationships with chain partners.

Summary

- Relatively healthy industry with strong consumer demand for product
- Industry decisions today will set the pathway for future generations
- Improvements require collaborative investment in RD&E to solve common problems
- Innovation is business driven, not government pushed.
PRJ-008532 - Improving Soil Health to Suppress Soilborne Diseases of Ginger

Tony Pattison¹, Wayne O’Neill¹, Jenny Cobon¹, Tegan Kukulies¹, Mike Smith¹ & Rob Abbas²
¹Department of Agriculture, Fisheries & Forestry, Horticulture & Forestry Science; ²Australian Ginger Industry Assoc.

Why soil health? Ginger growers in recent years have been experiencing increasing losses to soil borne diseases, caused by *Pythium* sp. (*Pyth*), *Fusarium oxysporum* f.sp. *zingiberi* (*Foz*) and root-knot nematodes *Meloidogyne javanica* (RKN). There is increasing evidence that soil borne disease can be suppressed by understanding the interactions that exist in the soil between the soil physiochemical environment, soil biology, pathogens and host plants. A project supported by the Australia Ginger Growers and the Rural Industries Research and Development Corporation (RIRDC) aimed to develop viable and sustainable ginger production systems through soil health improvements.

**Project objectives:**
- The identification of soil constraints that increase the incidence of soil borne diseases in ginger.
- To reduce losses caused by *Pythium* Soft Rot, Fusarium wilt and root-knot nematodes.
- To identify farm practices that improve soil health while minimising losses to soil borne diseases.

**Project methodology and results:**

*Survey*

The first phase of the project consisted of a grower survey, which asked growers to identify areas of good and poor production. Ten ginger farms, each with good and poor production sites, took part in the survey. Questions were asked on management, disease incidence as well as soil samples being analysed for physical, chemical and biological analysis. The good and poor sites could be identified with a 10% error rate through the knowledge of eight soil properties; aluminium, iron, nitrate-nitrogen and sulphur levels in the soil (chemical properties) and through an understanding of the fungivores, bacterivores and predators in the soil nematode community as well as the activity of the soil enzyme β-glucosidase.

As a range of soils and management systems were included in the survey, the 20 sites were reanalysed in respect to the key soil measurements to determine the relationships and similarities of sites. The sites included in the survey formed two large groups, one consisting of mostly sites with good ginger production (Group I, Figure 1) and the other with sites with mostly poor ginger production (Group II, Figure 1). However, there were a number of sites that did not fit into either of these groups, forming outlying farms (Outliers, Figure 1). Soil samples from sites representing the “good” (CaG) and “poor” (ReP) groups of farms and three outlying soils two “good” (RaG and ReG) and one “poor” (MeP) were re-sampled and included in an intensive glasshouse experiment to determine disease development when ginger was grown in the soil inoculated with the different pathogens.

![Figure 1: Similarity between ginger sites identified as “good (G)” or “poor (P)” productions sites based on eight soil chemical and biological parameters.](image-url)
Glasshouse experiment

Soil from each of the five fields was divided into two portions. One portion was pasteurised by free steaming at 98°C for 30 minutes (pasteurised soil), while the other portion was untreated (field soil). Ginger seed pieces were then planted into 150mm pots and placed in the glasshouse. Once all ginger plants had produced shoots, the pots were inoculated with Foz, Pyth, RKN or untreated. Each treatment was replicated 4 times, generating a total of 160 pots in the experiment (5 soils (CaG, ReP, RaG, ReG and MeP) x 2 steaming treatments (field / pasteurised) x 4 pathogen treatments (Foz, Pyth, RKN and control) x 4 replicates = 160 pots). Plants were rated for external disease symptoms on a regular basis according to the following scale: 0 = healthy green plant, 1 = mild yellowing, 2 = severe yellowing &/or dying stems and 3 = plant death. Plants displaying external disease symptoms during the experiment were sampled to determine the organism responsible. Plants were harvested 10 weeks after inoculation, continuing weekly until 12 weeks. Plant height and number of stems per pot were recorded at harvest. Bulked soil samples for each soil (+/− pasteurisation, total of 10 bulked samples) were sent for chemical analysis at the conclusion of the experiment. Roots of the RKN and control treatment had nematodes eggs extracted and nematode community and biochemical measurements were made on soil from all treatments.

The plants grown in RaG soil were significantly taller than plants grown ReP and MeP soils with the ReG and CaG having intermediate plant height (Table 1). Similarly the number of stems was significantly greater in ginger grown at ReG and RaG relative to MeP and ReP with CaG intermediate. The stem index was greatest at RaG, followed by ReG, and was significantly reduced in CaG, ReP and MeP (Table 1). There were no significant differences between the five farms in the number of plants which Pyth or Foz were isolated. However, there were significantly greater numbers of RKN recovered from the ReG site relative to MeP, ReP and RaG with CaG intermediate (Table 1).

Table 1: Growth, disease rating and pathogen recovery of ginger grown in soils from 5 farms in field or pasteurised soil, inoculated with either Fusarium oxysporum f.sp. zingiberi (Foz), Pythium sp. (Pyth) Meloidogyne javanica (RKN) or control (untreated).

<table>
<thead>
<tr>
<th>Farm</th>
<th>Stem height (cm)</th>
<th>Stem number</th>
<th>Stem index</th>
<th>Final disease rating</th>
<th>Pyth. (0-1)</th>
<th>Foz (0-1)</th>
<th>RKN (plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ReG</td>
<td>36.7 bc</td>
<td>2.3 b</td>
<td>124 bc</td>
<td>1.5 ns</td>
<td>0.22 ns</td>
<td>0.44 ns</td>
<td>1421 c</td>
</tr>
<tr>
<td>ReP</td>
<td>27.1 ab</td>
<td>1.3 a</td>
<td>77 ab</td>
<td>2.0 ns</td>
<td>0.22 ns</td>
<td>0.59 ns</td>
<td>79 ab</td>
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<tr>
<td>RaG</td>
<td>41.9 c</td>
<td>2.3 b</td>
<td>136 c</td>
<td>1.6 ns</td>
<td>0.19 ns</td>
<td>0.44 ns</td>
<td>93 ab</td>
</tr>
<tr>
<td>MeP</td>
<td>18.8 a</td>
<td>1.0 a</td>
<td>48 a</td>
<td>2.1 ns</td>
<td>0.22 ns</td>
<td>0.56 ns</td>
<td>14 a</td>
</tr>
<tr>
<td>CaG</td>
<td>33.2 bc</td>
<td>1.6 ab</td>
<td>86 ab</td>
<td>1.9 ns</td>
<td>0.25 ns</td>
<td>0.47 ns</td>
<td>316 bc</td>
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<table>
<thead>
<tr>
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<th>Stem number</th>
<th>Stem index</th>
<th>Final disease rating</th>
<th>Pyth. (0-1)</th>
<th>Foz (0-1)</th>
<th>RKN (plant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>44.1 b</td>
<td>2.4 b</td>
<td>147 b</td>
<td>1.3 a</td>
<td>0.00 a</td>
<td>0.40 a</td>
<td>8 a</td>
</tr>
<tr>
<td>Foz</td>
<td>22.1 a</td>
<td>1.2 a</td>
<td>51 a</td>
<td>2.3 b</td>
<td>0.00 a</td>
<td>0.88 b</td>
<td>-</td>
</tr>
<tr>
<td>Pyth</td>
<td>17.1 a</td>
<td>1.0 a</td>
<td>45 a</td>
<td>2.3 b</td>
<td>0.87 b</td>
<td>0.38 a</td>
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</tr>
<tr>
<td>RKN</td>
<td>43.0 b</td>
<td>2.3 b</td>
<td>136 b</td>
<td>1.4 a</td>
<td>0.00 a</td>
<td>0.35 a</td>
<td>2100 b</td>
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<table>
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<th>Soil pasteurisation</th>
<th>Stem height (cm)</th>
<th>Stem number</th>
<th>Stem index</th>
<th>Final disease rating</th>
<th>Pyth. (0-1)</th>
<th>Foz (0-1)</th>
<th>RKN (plant)</th>
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<td>Pasteurised</td>
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<td>72 a</td>
<td>2.0 ns</td>
<td>0.24 ns</td>
<td>0.55 ns</td>
<td>48 a</td>
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<tr>
<td>Field</td>
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<td>2.0 b</td>
<td>117 b</td>
<td>1.6 ns</td>
<td>0.20 ns</td>
<td>0.45 ns</td>
<td>391 b</td>
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</table>

Means in groups of columns with the different letter following are significantly different from one another (p<0.05). n.s. = no significant difference between means in the group (p > 0.05). - = data not taken
Plant height was significantly reduced when ginger was inoculated with Pyth or Foz relative to plants in control soil or inoculated with RKN. Similarly, Foz and Pyth reduced the number of stems and the stem index (Table 1). There was an increased disease rating in both the Foz and Pyth inoculated treatments relative to the control and RKN inoculated treatments (Table 1). Pythium was only isolated from plants that were inoculated with the disease. However, Foz was recovered from all treatments due to an introduction into the experiment through contaminated seed. The recovery rate was significantly greater in the Foz inoculated plants with no difference between other treatments suggesting that the disease was evenly distributed amongst treatments and at a lower level than when inoculated into the soil. RKN was found in greater numbers in the RKN inoculated treatment relative to the untreated soil (control). Recovery of RKN from Foz and Pyth treatments was difficult due to the high plant mortality in these treatments making it difficult to recover eggs from the root systems of affected plants.

Disease suppression
Disease suppression was estimated for each soil using a regression analysis of the disease ratings over the 12 weeks in the glasshouse experiment. The disease rating for plants in the pasteurised soil was subtracted from the disease rating from plants growing in the field soil at each time period. If the disease rating increased more rapidly in the pasteurised compared to the field soil, resulting in a positive slope, the soil was regarded as being suppressive to that pathogen (Table 2). If the disease rating increased in field soil more rapidly compared to the pasteurised soil, that is a negative slope, the site was regarded as being conducive, a site which encouraged the disease. If the disease ratings progressed at the same rate for the field and pasteurised soil, it had zero slope and was regarded as neutral, neither suppressive nor conducive.

Table 2: Disease suppression ratings of five ginger producing sites based on the rate of disease development in field and pasteurised soil inoculated with different pathogens

<table>
<thead>
<tr>
<th>Farm</th>
<th>Control</th>
<th>Pythium</th>
<th>Foz</th>
<th>RKN</th>
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<tbody>
<tr>
<td></td>
<td>Slope</td>
<td>Rating</td>
<td>Slope</td>
<td>Rating</td>
</tr>
<tr>
<td>CaG</td>
<td>0.03</td>
<td>Suppressive</td>
<td>0.02</td>
<td>Suppressive</td>
</tr>
<tr>
<td>MeP</td>
<td>0.04</td>
<td>Suppressive</td>
<td>-0.01</td>
<td>Conductive</td>
</tr>
<tr>
<td>RaG</td>
<td>0.03</td>
<td>Suppressive</td>
<td>0.01</td>
<td>Suppressive</td>
</tr>
<tr>
<td>ReG</td>
<td>0.01</td>
<td>Suppressive</td>
<td>0.00</td>
<td>Neutral</td>
</tr>
<tr>
<td>ReP</td>
<td>0.01</td>
<td>Suppressive</td>
<td>0.00</td>
<td>Neutral</td>
</tr>
</tbody>
</table>

Further work:
Further analysis of the soils from the glasshouse experiments is required to validate the soil properties that are associated with soil health and disease suppression, and this work is currently underway. Further validation of the risk of development of soil borne disease in ginger soil is required through the collection of soil samples from ginger farms. Soil samples would be given a risk rating based on the soil health parameters and validated with glasshouse inoculation and field results.

Conclusion:
The investigations of soil health for suppression of soil borne diseases in ginger has demonstrated that soils differ in their capacity to suppress Pythium sp., Fusarium sp. and roo-knot nematodes and that their suppressive potential can be predicted with the knowledge of eight soil properties.
Pythium spp. isolated from ginger fields in Australia

Duy Le Phu (U. Qld), Mike Smith (DAFF, Qld) and Liz Aitken (U. Qld)

World-wide Pythium soft rot (PSR) on ginger has been reported to be caused by at least 15 different species of Pythium. In Australia, PSR outbreaks on ginger were observed in 2007 when initially P. myriotylum was reported as the causal agent of PSR. Recently our research has indicated that P. zingiberis may also be involved. In quarantine conditions we have made comparisons in pathogenicity between isolates of P. zingiberis found in ginger fields here in Queensland with P. zingiberis and P. myriotylum from international culture collections. We have also examined the range of different Pythium isolates collected from ginger fields to determine if any other Pythium species present are capable of causing PSR symptoms.

One-hundred-and-fifty isolates of Pythium spp. were recovered from ginger fields either directly from ginger rhizome showing symptoms of PSR or from baiting the soil using excised carrots, ginger sections or sorghum seeds. Nine different Pythium species (P. aphanidermatum, P. diliense, P. graminicola, P. oligandrum, P. perplexum, P. spinosum, P. splendens, P. ultimum and putative P. zingiberis) were identified based on morphological characteristics and molecular analysis. Pathogenicity tests were conducted both in-vitro on excised ginger sticks and on seedlings of fourteen different hosts (oats, rye, wheat, millet, barley, buck wheat, beet root, spring onion, carrot, lettuce, cucumber, eggplant, alyssum and gypsophila) as well as in pot trials on living ginger plants.

The results showed that all representative isolates of these Pythium species, except for P. oligandrum and P. perplexum, were pathogenic in the in-vitro tests. However, in the pot trials on ginger plants, only the putative P. zingiberis was capable of causing PSR. These results support our previous observations that P. zingiberis is the main causal agent responsible for the PSR on ginger in Australia.

Comparisons were then made between one of the Australian isolates thought to be P. zingiberis with two “type” isolates: P. myriotylum and P. zingiberis which were obtained from international collections from the Netherlands and Japan respectively. The isolates were imported into Australia under quarantine. In culture the Australian isolate exhibited the highest optimal growth temperature at 35C compared with the two overseas isolates and when tested on ginger plants the Australian isolate appeared to be the most pathogenic although the quarantine isolate of P. zingiberis could also cause symptoms on ginger plants at high temperature.

Our results support the hypothesis that P. zingiberis is the main causal agent of PSR in Australian ginger with pathogenicity and morphological assessments showing that the causal agent of PSR in Australia is very similar to that of type specimen of P. zingiberis from Japan. However, molecular assessments based on conserved gene analysis so far show that P. zingiberis and P. myriotylum are over lapping therefore further analysis is being conducted using Next Gen sequence analysis in an attempt to distinguish these two species at a molecular level.
Improving Soil Health to Suppress Soilborne Diseases of Ginger

Mike Smith, Rob Abbas, Tony Pattison, Wayne O’Neill, Jenny Cobon, Tegan Kukulies

Efficacy of ethanedinitrile fumigant (EDN) against ginger diseases

Soilborne diseases that affect ginger can persist in soils for many years. In particular we have found that *Pythium* spp. are capable of causing disease outbreaks 5 years after infected paddocks have lain fallow. Because ginger is the main cash crop on most farms, it is extremely important that the land can be returned to profitable ginger production as soon as possible after a *Pythium* Soft Rot epidemic.

Ethanedinitrile (EDN) is a soil fumigant developed by CSIRO as an alternative to ozone depleting methyl bromide and has been shown to be effective in controlling soilborne diseases in other crops, in particular *Pythium* and plant-parasitic nematodes.

Two experiments have been established at DAFF Maroochy Research Station to test the efficacy of EDN to control *Pythium* Soft Rot, plant-parasitic nematodes and weeds in ginger production blocks that had a history of these problems. EDN was applied by mixing the chemical into two lines of irrigation t-tape under plastic at a rate of 30 g/m². BOC Ltd supplied the irrigation mixer, safety equipment and technical expertise for the EDN trials. One block (N-Block) was fallowed for two seasons and before being planted to ginger on 9 October 2013 was fumigated or left unfumigated, with and without compost; while the other block (O-Block) was fumigated and sown to forage sorghum on 9 October. Attempts will be made to restore the soil health of the latter block by cover cropping under no till conditions before planting to ginger in 2014. Both blocks have been used for *Pythium* Soft Rot trials in recent years and the soils were heavily infested with the pathogen.

Results indicate that the EDN treatment significantly suppressed weeds and parasitic nematode populations compared to the untreated control beds. They also suppressed microbial activity (Table 1).

With regard to weed control, a series of weed counts were taken from 1 m lengths of bed in N-Block as the ginger shoots were emerging on 7 November, 1 month after planting. A highly significant (P<0.001) suppression of weeds on the EDN treated beds was observed with an average of 24.7 weeds per 1 m length of bed on the untreated control beds, and only 0.5 weeds/m on the EDN treated beds. The weeds were sprayed with herbicide after counting and before the ginger shoots began to form leaves. In O-Block a similar finding was recorded with a highly significant (P<0.001) suppression of weeds on the EDN treated beds. An average of 23.4 weeds per 1 m length of bed were found on the untreated control beds, while only 1.1 were found on the EDN treated beds. Of further interest, the forage sorghum had better establishment after sowing because the removal of t-tape caused 2 furrows along the length of the bed in which the seed accumulated. The untreated beds had a much more irregular and erratic germination. Therefore, taking both blocks into account, the EDN treatment significantly suppressed the germination of both grasses and broad-leaved weeds, the only exception being nut grass (*Cyperus rotundus*). Although less nut grass had emerged in the treated vs untreated beds (0.4 vs 2.0) the result was not significant at the 5% confidence level. It was thought the underground tubers of this species, if large enough, presumably offered a certain degree of protection from the fumigant.

In terms of soil biology, the EDN treated beds suppressed total nematode populations by 90% and virtually eliminated populations of plant-parasitic nematodes. Microbial activity was also diminished as measured by the fluorescein diacetate (FDA) method (Table 1). However, in terms of establishment of the ginger crop, EDN had no significant effect on shoot emergence with an
average of 11.8 shoots per 1 m length of bed 7 weeks after planting compared to 13.5 for untreated beds (Table 2).

As the season progressed so too did the incidence of both Pythium Soft Rot and Fusarium Yellows, with the latter having been introduced in infected planting material. The EDN-treated beds had a significantly higher incidence of disease which caused heavier losses and significantly reduced yield (Table 2). The compost amended plots, however, significantly reduced disease and improved yield in both EDN treated and untreated beds. It is believed that while the fumigant may have reduced the amount of *Pythium* inocula in the soil, it also killed a large population of beneficial organisms that could have acted to suppress the disease, while the compost acted to boost numbers of beneficials increasing disease suppression.

It will be interesting to determine whether the rotation crops in O-Block will be enough to restore soil health to an extent that good ginger yields are possible. These concerns will be addressed over the 2014-15 season.

Table 1: Soil health biological measurements from two field trials at Maroochy Research Station using ethanedinitrile (EDN) as a soil fumigant

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Labile C</th>
<th>FDA</th>
<th>β-glucosidase</th>
<th>Lesion PN</th>
<th>Spiral PN</th>
<th>Reniform PN</th>
<th>Ring PN</th>
<th>Total Nematodes¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>N-Block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline²</td>
<td>0.25</td>
<td>12.3</td>
<td>7.8</td>
<td>42.5</td>
<td>6.3</td>
<td>0</td>
<td>4.5</td>
<td>110.5</td>
</tr>
<tr>
<td>+EDN³</td>
<td>0.14</td>
<td>13.2</td>
<td>6.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11.3</td>
</tr>
<tr>
<td>-EDN³</td>
<td>0.11</td>
<td>22.0</td>
<td>0.0</td>
<td>15.8</td>
<td>2.0</td>
<td>0</td>
<td>0</td>
<td>106.0</td>
</tr>
<tr>
<td>O-Block</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline²</td>
<td>0.30</td>
<td>31.3</td>
<td>11.8</td>
<td>0.5</td>
<td>2.5</td>
<td>2.8</td>
<td>0</td>
<td>203.5</td>
</tr>
<tr>
<td>+EDN³</td>
<td>0.23</td>
<td>25.3</td>
<td>5.3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>37.5</td>
</tr>
<tr>
<td>-EDN³</td>
<td>0.26</td>
<td>31.7</td>
<td>7.8</td>
<td>0</td>
<td>3.0</td>
<td>1.5</td>
<td>0</td>
<td>311.5</td>
</tr>
</tbody>
</table>

¹Average number of both free-living and PPNs per ml extracted sample; ²Soil sample collected 27 August 2013 before EDN applied; ³Soil sample collected 9 October 2013 after plastic cover removed and before ginger planted

Table 2: Effect of ethanedinitrile (EDN) and compost (OA) on growth and yield of ginger in N-Block.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>No weeds¹</th>
<th>Shoot emergence²</th>
<th>No shoots¹</th>
<th>% shoots infected³</th>
<th>Yield⁴ t/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>+EDN</td>
<td>0.5 a</td>
<td>11.8 ns</td>
<td>15.0 b</td>
<td>45.3 b</td>
<td>2.2 b</td>
</tr>
<tr>
<td>- EDN</td>
<td>24.7 b</td>
<td>13.5 ns</td>
<td>28.3 a</td>
<td>17.4 a</td>
<td>6.5 a</td>
</tr>
<tr>
<td>+OA</td>
<td>15.0 a</td>
<td>30.0 a</td>
<td>24.2 a</td>
<td>5.7 a</td>
<td></td>
</tr>
<tr>
<td>- OA</td>
<td>10.3 b</td>
<td>13.3 b</td>
<td>38.5 b</td>
<td>2.9 b</td>
<td></td>
</tr>
<tr>
<td>+EDN +OA</td>
<td>14.1 ab</td>
<td>19.9 b</td>
<td>37.6 b</td>
<td>3.7 bc</td>
<td></td>
</tr>
<tr>
<td>+EDN - OA</td>
<td>9.5 c</td>
<td>10.1 c</td>
<td>53.1 c</td>
<td>0.6 c</td>
<td></td>
</tr>
<tr>
<td>-EDN +OA</td>
<td>15.9 a</td>
<td>40.1 a</td>
<td>10.8 a</td>
<td>7.7 a</td>
<td></td>
</tr>
<tr>
<td>-EDN - OA</td>
<td>11.0 bc</td>
<td>16.5 bc</td>
<td>24.0 ab</td>
<td>5.3 ab</td>
<td></td>
</tr>
</tbody>
</table>

¹number of weeds in 1 m section of bed on 7 November 2013 (P<0.001); ²number of ginger shoots germinated in 1 m section of bed on 25 November 2013 (P<0.05); ³number of ginger shoots and percentage with disease symptoms from 1 m section of bed on 9 January 2014 (P<0.05; P<0.01); ⁴trial harvested on 18 March 2014 and yield was calculated from total weight of rot-free rhizome per plot (P<0.05).

7 stools of ginger showing symptoms of Pythium Soft Rot and/or Fusarium Yellows were collected on 3 February 2014; both *Pythium* and *Foz* combined were isolated from 3, *Pythium* alone from 3 and *Foz* alone from 1.
FUMIGATION USING TRI-FORM 60

Trials and field work conducted by R&R Fumigation contractors support the efficacy of Tri-Form 60 as the premium Soil borne disease fumigant.

Tri-Form 60 is a mixture of Di-Chloropropene and Chlorpycrin in liquid form supplied in 90 kg canisters.

Product injected under pressure into soil at 150mm centres and 400mm depth, whereby it moves into the soil as a gas.

Soil needs to be worked into a fine tilth and have adequate soil moisture levels to ensure even and thorough distribution.

Clods and organic trash will allow for gas escape.

As the product forms a gas on injection, some form of soil 'sealing' needs to occur to prevent gas escaping. Covering the soil with plastic mulch or rolling and watering immediately to reduce the movement of gas from profile are both effective.

Improved maintenance of product in profile will improve result.

Costs of contracting are $3000 acre to $3500 acre mulched.

Fumigation controls both soil borne diseases and beneficial organisms so work needs to be done to re-instate levels of beneficial s.

Yield results trial No1

<table>
<thead>
<tr>
<th>Yield early harvest</th>
<th>Pythium rating 1-5 [1=nil]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfumigated</td>
<td>15.3T/ac</td>
</tr>
<tr>
<td>Unfumigated + beneficial s</td>
<td>16.2T/ac</td>
</tr>
<tr>
<td>Fumigated Plastic</td>
<td>15.2T/ac</td>
</tr>
<tr>
<td>Fumigated Plastic + beneficial s</td>
<td>17.46T/ac</td>
</tr>
<tr>
<td>Fumigated / rolled / watered.</td>
<td>Left for late harvest</td>
</tr>
<tr>
<td>Fumigated / rolled / watered + beneficials</td>
<td>16.5T/ac</td>
</tr>
</tbody>
</table>

Conclusions:

1. Tri-form 60 had an effect on Pythium with ratings 1-1.5.
2. Beneficials seemed to provide yield and pythium effect.
3. Soil Health testing and results have indicated reduction of fungal activity and higher FDA result where a soil drench of Rhizo-max and subsequent applications of Loli-pepta where utilized.
4. Block had heavy pythium pressure.
5. The use of fumigation with biofilm product usage requires further work.
Comparison of Weight Loss of Bagged vs Unbagged 10kg Boxes of Late Season Ginger
Shipping Time Duration: Brisbane 1 day, Sydney 2 days, Melbourne 3 days, Adelaide 5 days, Perth 6 days.

Weight of Ginger (Kg)

Date Measurement Taken

9/01/2013 10/01/2013 11/01/2013 12/01/2013 13/01/2013 14/01/2013 15/01/2013 16/01/2013 17/01/2013 18/01/2013 19/01/2013 20/01/2013 21/01/2013 22/01/2013 23/01/2013 24/01/2013 25/01/2013 26/01/2013 27/01/2013 28/01/2013 29/01/2013 30/01/2013 31/01/2013

Unbagged #1 (Kg)
Bagged #4 (Kg)
# Ginger Shipping Bags Cost Reduction Ready Reckoner

## Delivery (%) | Price ($) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane</td>
<td>20</td>
<td>$7.50</td>
</tr>
<tr>
<td>Sydney</td>
<td>20</td>
<td>$7.50</td>
</tr>
<tr>
<td>Melbourne</td>
<td>20</td>
<td>$7.50</td>
</tr>
<tr>
<td>Adelaide</td>
<td>20</td>
<td>$7.50</td>
</tr>
<tr>
<td>Perth</td>
<td>20</td>
<td>$7.50</td>
</tr>
</tbody>
</table>

## Total Harvest in Kg's | 250,000 |

## Bag Cost ($) | 0.29 |

### City | Number of Kg's shipped to city PA | Number of 10Kg Boxes shipped PA | Existing Shipping Weight (Kg) | Bagged Weight Loss % | Bagged Weight Loss Kg (10Kg * BWL%) | New Shipping Weight (Kg) | Difference between Existing & Current Shipping Weights (Kg) | Cost ($/Kg) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Brisbane</td>
<td>50000</td>
<td>5000</td>
<td>10.5</td>
<td>0.52</td>
<td>0.05</td>
<td>10.1</td>
<td>0.4</td>
<td>$15,000.00</td>
</tr>
<tr>
<td>Sydney</td>
<td>50000</td>
<td>5000</td>
<td>10.5</td>
<td>1.29</td>
<td>0.13</td>
<td>10.2</td>
<td>0.3</td>
<td>$11,250.00</td>
</tr>
<tr>
<td>Melbourne</td>
<td>50000</td>
<td>5000</td>
<td>10.5</td>
<td>1.33</td>
<td>0.13</td>
<td>10.2</td>
<td>0.3</td>
<td>$11,250.00</td>
</tr>
<tr>
<td>Adelaide</td>
<td>50000</td>
<td>5000</td>
<td>10.5</td>
<td>1.71</td>
<td>0.17</td>
<td>10.25</td>
<td>0.25</td>
<td>$9,375.00</td>
</tr>
<tr>
<td>Perth</td>
<td>50000</td>
<td>5000</td>
<td>10.5</td>
<td>2.33</td>
<td>0.23</td>
<td>10.3</td>
<td>0.2</td>
<td>$7,500.00</td>
</tr>
</tbody>
</table>

**Gross Savings:** $54,375.00

**Less Bag Costs:** $7,250.00

**Nett Savings:** $47,125.00
The Pump House has been established since 1986 and has grown to become the largest pumping and irrigation company in Southeast Queensland. We are 100% Australian owned and our 4 store locations in Nambour, Gympie, Beerwah and Chinchilla ensure ready access and availability of our services right across this region.

**Irrigation**

Irrigation has been the life blood of The Pump House and has been the pinnacle of where it all started, it is still our main draw card and our passion for this industry is still as strong as the day we started.

The Pump House’s abilities in this industry are well known from BEGA to DARWIN due to being able to design and adapt to any situation that was required. Large Corporate companies have been an area that we have excelled at due to being able to deliver a quality turnkey solution.

- Design and construct turnkey operations
- Treatment plants
- Drip irrigation
- Centre pivots
- Lateral moves
- High pressure travelling irrigators
- Boom sprays
- Flood irrigation

**Applications for VFD Drive Pumps**

When using a VFD there are many benefits and cost saving possibilities for pumping applications in the irrigation sector.

It is important to look at a [VFD application](#) for a motor in conjunction with the curve of the pump. The hydraulics of the system need to be understood and best is to plot the curve onto a simulation program which can show how the varying speed influences the characteristics of the pump. This coupled with the change in kilowatts power consumed at the different duty points will allow the customer to make an informed decision.

The team at the Pump House can assist in Pump, Drive and Power selection to suit your needs. Our team can modify your current system or design a new system for your next project using the most up to date equipment and energy saving devices currently available.

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Rodney Meade (Gympie Branch) 5482 9911       Michael Bevege (Beerwah Branch) 5494 6166
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Burdekin & Lockyer Valley

Phone: 07 4132 5000
www.hortus.net.au
**Action on the Ground project 218 - a Federal Government funded program through the Carbon Farming Initiative**

**Improved fertiliser, soil and irrigation management in SEQ ginger production**

**Project Summary:**

The project will trial and demonstrate on-farm practices to reduce nitrous oxide emissions and increase soil carbon storage by trialling improved management of nitrogen fertiliser application practices including slow/delayed releases fertilisers and the use of compost in the production of ginger.

Further soil management trials will include fallow and legume cover crops combinations, seasonal fallow rotations and minimum tillage options in the production of ginger at trial sites on four ginger farms (12 trials) in south east Queensland. The project will run until June 2015.

**Results Summary**

1. The use of controlled release technology in ginger production offers both yield and labour saving.

2. The real benefits of controlled release fertilisers are:
   - Reduced nutrient runoff from fields. Nitrate losses greater than 25% for conventional programs.
   - Soil and SAP results showed conventional and controlled release programs to be similar with SR products providing improved late season levels due to reduction in nutrient runoff.
   - Nitrous oxide emission cumulative totals represented as kg/ha per treatment showed a 4.6% improvement from the controlled release treatments over a 14 week sampling period.
   - Labour saving for CR programs are substantial.
   - Yield data over 2 years of plot harvests have provided close to 20% improvement.
   - Biomass harvests from 3 sites have provided for an average 25% improvement.

3. The use of Fallow crops in ginger culture is important in supplying organic carbon. Soil organic matter and carbon are central to suppression of soil borne diseases through the improvement in soil characteristics and soil biology.

4. Fallow crops provide superior levels of organic carbon to pasture and weed fallows.

5. Winter fallow options include Oats and Oat/Brassica and Oat/Field pea mixtures. These provided dry weights of 8.65, 14.27 and 16.84t/ha respectively.

6. Summer fallow options include Sorghum and Sorghum/Lablab and Sorghum/Cowpea mixtures. These provided dry weights over 2 cuts of 19.0, 21.2 and 20.5t/ha respectively.

7. To compare an ungrazed improved pasture will provide around 4.2t/ha over a 4 year period. A weed fallow will provide very little and cause weed issues.
Photo showing an oats/brassica winter fallow mix sown at 15kg/ha saia oats and 10kg/ha brassica.

Photo showing a summer fallow mixture of Sorghum/cowpea mix sown at 10kg/ha bettagraze and 25kg/ha cowpea.
Nothing Else Comes Close To POLYON Fertilizer.

What makes one fertilizer better than another? In the case of POLYON® Controlled-Release Fertilizer (CRF) from Agrum Advanced Technologies, the answer includes several things.

With its many exclusive features and benefits—from special manufacturing and coating to extensive testing, to its unique release properties—POLYON fertilizer clearly offers you more... especially in the exceptional results it delivers for your nursery operation.

The POLYON Coating Technology

The advanced concept behind POLYON fertilizer is a patented process known as “Reactive Layers Coating™” (RLC). RLC is a breakthrough technology in which a ultra-thin, ultra-tough polyurethane membrane is formed from two monomers, right on the surface of the fertilizer being coated. Because the coating is thin, yet durable, POLYON fertilizer has controlled-release properties that can be programmed to suit the environmental and growing conditions in your given area.

It is this level of predictability that makes Agrum Advanced Technologies the leader in the field of coated-fertilizer technologies. In fact, Agrum’s research staff tests POLYON nutrient-release characteristics at various temperature extremes, including our 50°F test to ensure our products stand up to the rigors of warm, humid climates.

How POLYON Fertilizer Is Made—And Made To Be Better

The manufacturing of POLYON controlled-release fertilizer begins with fertilizer substrates (granules). These carefully selected substrates comprise the package of nutrients that will be fed over time to your plants.

Agrum selects raw materials based upon compatibility, or the receptiveness of the material to coating with the patented RLC technology. We work closely with only a few top industry suppliers to obtain granules that are round, smooth, hard, uniform in size and dust-free. Consistent roundness of shape and smoothness of substrate particle (fewer peaks and valleys in a granule’s surface) result in a more even coating, which promotes better nutrient delivery.

Upon arrival, each batch of substrate is thoroughly inspected for size and compatibility. Before the granular substrates are processed, a final inspection is conducted to remove dust and other extraneous materials. The granules then pass through a fluid bed heater where they are heated to 175°F Fahrenheit before coating.

Next, the heated fertilizer granules enter the coating chamber, where monomer A is applied to them. In this process, monomer A adheres directly to the surface of the substrate. Then, monomer B is applied to the surface of the granules and it chemically reacts and bonds with monomer A, co-polymerizing to create a superior polymer coating. Monomer B also contains a pigment that gives POLYON fertilizer its patented, trademark green color. The number of layers of monomer A and monomer B are determined by the final desired coating thickness.

The thickness of the polymer coating determines how long a POLYON product will last. A POLYON fertilizer can be made to release 100% of its nutrients from one month all the way up to 14 months.

It is our exclusive coating—which is different from any other polymer, polyurethane or even coating on the market—that makes POLYON the premier coated fertilizer in the world today.
Passing All The Tests

Agrium Advanced Technologies upholds the highest level of quality control and assurance. Our comprehensive product testing processes are unmatched in the industry, and we won’t sell products that do not measure up to your standards.

To produce the highest quality products every time, our quality-control experts put POLYON fertilizers through a series of meticulous inspections, ensuring that coating evenness, thickness and proper nutrient release have been achieved without fail.

POLYON nursery fertilizer products are thoroughly inspected using what we call the Hold, Test and Release method. In this process, all finished products are automatically put on Hold while various Tests are conducted.

Every batch is tested for a full seven days at realistically hot climate conditions (86°F or 30ºC) until top-quality results are achieved. After the products pass these tests—and only then—are they placed on Release for shipment.

These exacting steps ensure that every POLYON bag leaves our facilities with Agrium’s stamp of approval, and that you receive high-quality products with unprecedented performance. Because of our Hold, Test, Release method, you can expect consistency with no surprises.

Landmark and Agrium Advanced Technologies together have developed a specific fertiliser blend to supply the complete nutrient needs of ginger crops in South East Queensland. With an 8 to 9 month release period, an NPK of 20-2.5-11 plus Magnesium, and a Trace Element package matched to crop needs, Fertimax Ginger Blend is the ideal start, middle and finish to your ginger crop.

For further information please call

Landmark,
1 Steggall Road,
Yandina, Qld. 4561.

Paul Hinder Ph (07) 54467728.

Landmark
**RECOMMENDATIONS**

This sample, when compared against AS 4454 for Compost Analysis shows very high nutrient status particularly for N and P. This will be due to the very high manure content. The high EC is not due to salt but to very high ammonium and nitrate largely. Unfortunately this results in failures for ammonium, EC and toxicity. This is a little unfair however, it is like testing fertiliser and expecting it to comply with these criteria. The product can certainly be used at up to around 10% in soil mixes and organic soil improver. Otherwise it can be sold as a rich soil improver on its own right. Due to the high phosphate and phosphorus levels it should be considered unsuitable for sensitive native plants. The high zinc content does not meet the standard and again, this will be due to the high manure content.

This material should be marked as suitable for use on plant species tolerant of P due to high phosphorus and phosphate levels. The ammonium levels may result in plant burns if used at excessive levels. The ammonium will convert to nitrate over time but this will not result in a significant lowering of the EC. It is best sold as a small component in soil mixes and as a soil improver/steriliser in its own right.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Requirement</th>
<th>Result</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (1:5) in water</td>
<td>pH units</td>
<td>≥ 5.0</td>
<td>8.4</td>
<td>Pass - must determine CaCO₃</td>
</tr>
<tr>
<td>Electrical Conductivity (1:5)</td>
<td>dS/m</td>
<td>≤ 10</td>
<td>10.55</td>
<td>Fail</td>
</tr>
<tr>
<td>Phosphate-P</td>
<td>mg/L</td>
<td>≤ 5.0</td>
<td>47.7</td>
<td>Unsuitable for P sensitive plants</td>
</tr>
<tr>
<td>Phosphorus-P</td>
<td>mg/kg</td>
<td>No requirement</td>
<td>236</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorus (P) - Total</td>
<td>% dry wt</td>
<td>≤ 0.1¹</td>
<td>2.05</td>
<td>Unsuitable for P sensitive plants</td>
</tr>
<tr>
<td>Ammonium-N (NH₄)</td>
<td>mg/L</td>
<td>&lt; 200</td>
<td>263.3</td>
<td>Fail</td>
</tr>
<tr>
<td>Ammonium-N (NH₄)</td>
<td>mg/kg</td>
<td>No requirement</td>
<td>1266.4</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate-N (NO₃)</td>
<td>mg/L</td>
<td>No requirement</td>
<td>3.37</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate-N (NO₃)</td>
<td>mg/kg</td>
<td>≥ 10²</td>
<td>6.2</td>
<td>See Note 2</td>
</tr>
<tr>
<td>Plant Available N (NH₄ + NO₃)</td>
<td>mg/L</td>
<td>See Note 4 below</td>
<td>253.7</td>
<td>See Note 4 below.</td>
</tr>
<tr>
<td>Nitrogen (N) - Total</td>
<td>% dry wt</td>
<td>≥ 0.8¹</td>
<td>1.92</td>
<td>Pass - See Note 2 below.</td>
</tr>
<tr>
<td>Total Organic Carbon</td>
<td>% dry wt</td>
<td>≥ 20</td>
<td>23.8</td>
<td>Pass</td>
</tr>
<tr>
<td>Organic Matter</td>
<td>% dry wt</td>
<td>-</td>
<td>40.5</td>
<td>-</td>
</tr>
<tr>
<td>Carbon - Nitrogen Ratio</td>
<td>C : N</td>
<td>See Note 4</td>
<td>12.4</td>
<td>Level appropriate for application</td>
</tr>
<tr>
<td>Total CaCO₃ Equivalent</td>
<td>% CaCO₃</td>
<td>Report if pH &gt; 8.0</td>
<td>29.13</td>
<td>See Table 3.2 for application rate.</td>
</tr>
<tr>
<td>Wettability</td>
<td></td>
<td>&lt; 5</td>
<td>1.92</td>
<td>Pass</td>
</tr>
<tr>
<td>Particle Size Grading</td>
<td></td>
<td>&gt;10mm % Retained</td>
<td>20</td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≤5mm % Passing</td>
<td>No requirement</td>
<td>87.79</td>
</tr>
<tr>
<td></td>
<td>&lt;1.18mm % Passing</td>
<td>&gt;0% Vermicast only</td>
<td>0</td>
<td>No requirement</td>
</tr>
</tbody>
</table>

Notes:
1. For products that claim to be for phosphorus-sensitive plants. No requirement otherwise.
2. A contribution to plant nutrition is claimed.
3. No requirement for Raw Mulch or Pasteurised product.
4. Level appropriate for application specific products.

Tests performed under a quality system certified as complying with ISO 9001:2000. Results and conclusions assume that sampling is representative. This document shall not be reproduced except in full.
### Biological Stability and Plant Growth to Determine Compost Maturity

<table>
<thead>
<tr>
<th>Group A: Biological Stability Testing</th>
<th>Requirement</th>
<th>Result</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solvita Compost Maturity Index</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nitrogen Drawdown (NDI)</td>
<td>Index</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S.O.U.R.</td>
<td>mg O2/g BV/hr</td>
<td>&lt; 2.0</td>
<td>&gt; 0.5</td>
</tr>
<tr>
<td>Carbon Dioxide Respiration</td>
<td>mg CO2/g BV/hr</td>
<td>≤ 12</td>
<td>≤ 8</td>
</tr>
<tr>
<td>Dewar self heating test</td>
<td>°C above ambient</td>
<td>≤ 20°C</td>
<td>≤ 10°C</td>
</tr>
</tbody>
</table>

| Group B: Plant Growth Testing        |             |        |          |
| Biological Toxicity                  | mm root length | > 60  | NA       | < 5      | Not Fully Composted |
| Biological by TMECC-A                | % root elongation | > 80  | > 90    | Did not test |
| Biological by TMECC-B                | % relative growth | > 60  | > 90    | Did not test |
| NH4 : NO3 Ratio by TMECC             | Ratio       | < 3.0  | < 0.5   | 154.4   | Not fully composted |
| Solvita Ammonia                      | Solvita scale | ≥ 4   | ≥ 5     | Did not test |
| Volatile Fatty Acids                 | mol/g       | < 1000 | < 200   | Did not test |

### Unrestricted Use Upper Limits for Chemical Contaminants

<table>
<thead>
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Consultant: Alisa Bryce
Authorised Signatory: Simon Leslie
Date Report Generated: 10/01/2014

Tests are performed under a quality system certified with ISO 9001: 2008. Results and conclusions assume the sampling is representative. This document shall not be reproduced except in full.
Best practice supply chain management information for the ginger industry  
RIRDC project PRJ-009666  
June 2014

Background

Over the past years, the market for Australian grown processing ginger has declined due to cheaper imports from overseas. Locally grown ginger now has to be mostly sold fresh on the domestic market. Standards set by supermarkets are usually higher than those for processing ginger, and shelf life and presentation play are vital. Poor presentation of ginger, short shelf life or a food safety incident will most affect all growers and others in the supply chain because consumers do not distinguish between individual producers or merchants. Therefore all businesses that are growing, packing and selling fresh ginger have to work together to get every step right.

Project Goal

Improved knowledge and practices in the ginger supply chain so that new and old season ginger has:

- minimum waste along the supply chain
- the best possible sizing and packaging
- good shelf life, and
- high consumer appeal.

Improved supply chain practices should maintain or enhance profit margins. They should set a benchmark for Australian ginger that imported product cannot match.

Deliverables

Practical information and training materials designed with those who want to use it about:

- Quality parameters and sizing of roots
- How to reduce moisture loss, especially in new season ginger
- How to prevent yeasts and moulds
- Temperature management
- Improved packaging styles (e.g. long life packaging), including carton sizes appropriate for the size and type of product and time of year, which protects and maintains quality
Approach

Delivery of the project will be done using the following approach:

- **Establish Post Harvest Best Practice for Old and New Season Ginger**

  We will undertake a review of post harvest best practice for ginger, suitable long life packaging and carton sizes to fit the products (new season and old season ginger as well as different root sizes) and supply chain needs. This review will also consider the impact that production factors (e.g. calcium nutrition or field infections) can have on postharvest outturns (e.g. on breakdown or moulds).

- **Industry Consultation**

  We will find out what is needed to improve market outcomes by talking to growers, key staff and supply chain partners during field days, farm, shed and market visits, meetings (e.g. AGM) and by phone.

- **Carton / packaging trial**

  We will come up with trial protocols that allow demonstrating best practice such as shelf life testing using best bet packaging and temperatures to simulate supply chain conditions.

- **Preparing ‘Best practice’ information**

  Best practice materials will incorporate review and trial information and industry feedback. The focus will be on clear, practical guidance for all in the supply chain. The focus has to be on minimising risks and losses during grading, handling, packaging, transport and on the shelf.

At this stage we envisage that we will produce:

- Best Practice Handling, Packaging and Supply Chain Management core flute posters for all who need it (e.g. for sheds, staff rooms, offices)
- Self assessment guide for ginger producers / packers / merchants so they can understand in which areas they can improve (e.g. as a booklet or flip chart)
- Extension materials (e.g. factsheets, calendar, info to put on pallets or cartons) as required by growers and their supply chain partners.
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**Improved tissue culture production of ginger clean planting material project** was recently approved for funding and will commence soon.

Sharon Hamill (DAFF) and Elizabeth Aitken (UQ) will work together to improve production of ginger plants derived from tissue culture and to better understand the pathogen Fusarium with production of ginger plants from tissue culture.

*Supported by: Australian Ginger Industry Association (AGIA), Rural Industries Research & Development Corporation (RIRDC), Queensland Government, Dept. of Agriculture, Forestry & Fisheries (DAFF), The University of Queensland (UQ).*

**Summary**

Tissue cultured ginger is used to establish pathogen free mother blocks to produce the large quantity of clean seed needed by industry. The value of clean planting material to limit disease spread in infected farms and to avoid disease in new farms has been demonstrated but access to such material needs to be improved. One of the setbacks is the expense and time it takes for tissue culture production as material must be acclimatised in a nursery, which requires a year under shade often resulting in inferior rhizomes. Consequently it is only at the end of the second season that the rhizome reaches commercial size and can be used in the field. Therefore the main objective of this project is to improve this tissue culture process and in so doing consider methods that can be adopted by commercial TC facilities. At the end of the project, it is hoped that a detailed protocol for an improved tissue culture production system suited to commercial production will be available. This should assist industry to increase production and uptake of disease free material.

Growers are also concerned that tissue culture ginger plants are more susceptible to Fusarium than conventional rhizome seed. The second part of this research is to provide a better understanding of the Fusarium ginger pathogen to allow for improved practices in the ginger cycle. The research should provide a deeper understanding of the Fusarium pathogen (*Fusarium oxysproum* f.sp. *zingiberi* aka *Foz*) and ginger host relationship that will allow industry to better manage this disease.

**There are two main objectives**

1. **Firstly to improve production of ginger by tissue culture.**
   The objective is to first investigate the various steps in tissue culture production with the aim to increase the tissue culture micro-rhizome formation. The second phase to this research is after improving micro-rhizome, modify nursery production to increase rhizome size at the end of one year cycle. Tissue culture must be acclimatised in a glasshouse after production and is commonly grown in a nursery for a following year. This results in high nursery costs. Research will also explore the use of TC plants directly in the field. Overall the aim is to improve rhizome quality, reduce the time to achieve commercial size rhizome, reduce costs and develop a commercially viable process to produce clean TC ginger planting material.
2. **Investigate and improve resilience of TC derived ginger to Fusarium wilt.**

The use of TC derived ginger is an assured way of reducing the spread of both Fusarium and Pythium between fields. However if the TC plants have an increased susceptibility to *Foz*, the growers may then be reluctant to adopt TC plants. The objectives here are: i) to demonstrate whether or not the process of conducting TC in ginger increases susceptibility to *Foz* and if so; ii) to develop methods to reduce this susceptibility.

The apparent increased incidence of Fusarium wilt in ginger fields may also reflect changes in the population of *Foz* with the possible introduction of more virulent genotypes. Another objective of this study is iii) to get an indication of the presence of any novel genotypes of *Foz* within Qld ginger fields by assessing the profiles of pathogenicity genes known as *SIX* genes within sample isolates of *Foz*. If predicted virulent genotypes are present then action would be taken to curtail their spread.

Finally, it is important to know that crops used in rotation with ginger are not likely to introduce other strains of Fo (*Fusarium oxysporum*) that can also cause wilt on ginger; thus iv) challenging ginger in pot trials with a range of *Fo* genotypes known to be pathogenic on other crops will provide information relevant to the choice of rotation crops.
Lunch
Understanding the domestic market for Australian Ginger
Final stage milestone report overview and next steps

Prepared by Brand Story Pty Ltd
6th June 2014

Background to the project

Project commenced April 13 and ended December 2013.

The Australian ginger industry is facing a number of key issues:
• Lower yields in recent years resulting from disease (i.e.; Pythium) and adverse weather conditions
• The threat of imported fresh ginger. Currently an Import Risk Assessment is underway
• Low regular consumption of ginger by consumers. While 90% have tried it and 80% eat it at least once every 6 months, only 20% consume it with any regularity.

The market is potentially highly receptive to food offers such as ginger as evidenced through:
• An increase in Asian-style cooking
• A desire for and appreciation of new and exotic flavours
• A trend towards seeking foods with health benefits. There is a growing body of evidence linking consumption of ginger to:
  • improved digestive health
  • anti-emetic effects for those undergoing chemotherapy or suffering from morning sickness
  • alleviation of muscle and joint pain
  • positive impacts on the immune system and disease fighting properties
  • a metabolic ‘boost’ that can assist in weight management and general vitality

By increasing public knowledge of the key benefits of ginger, investing in education and product development activities to overcome potential barriers to uptake and ‘owning’ those messages in the minds of the public, the Australian Ginger Industry can begin to develop demand for ginger and preference for locally-grown product.

Key project objectives

• Develop domestic market understanding
• Explore the products, channels and messages providing the best opportunity for increased industry profitability and sustainability
Key recommendations

Four overarching areas recommended for consideration for market development:

1. **Area 1: Communication of Australian provenance**
   - Highly motivating to many Australian consumers
   - Of appeal to industry stakeholders if underpinned by a quality standard/COP

2. **Area 2: Public education about health benefits**
   - Highly motivating, new news that has been successfully implemented for many other foods
   - Broad wellness areas – digestion and metabolism - are preferred by consumers

3. **Area 3: Public education on selection, storage, preparation, utility**
   - Consumers have some significant knowledge gaps in respect of the optimal handling of ginger.

4. **Area 4: Invest in a retailer-focused strategy to optimise presentation at Point-Of-Sale**
   - Concerns about quality of product at POS and consumer desires for smaller sized pieces of ginger all indicate that this is an important area for investment

2014 projects in progress

Project - ‘Ginger Health Benefits’
Title: Health benefits of fresh and processed Ginger: A review of the peer reviewed scientific literature

Stage 1 – Literature review underway
- Journal databases used to date include PubMed, Thomson Reuters, JCR, Taylor and Francis Group, Elsevier and National Library of Medicine
- Journals viewed to date include: Phytomedicine, Food Science, Food Science and Nutrition, International Journal of Cardiology, Food Chemistry, Nutrition reviews and British Journal of Nutrition
- The findings to date:
  - Extensive animal testing conducted on the following health benefits: antioxidant property, anti-inflammatory property and nausea relief
  - Limited human testing available but those that are available show promising results
  - Limited reference to origin of ginger found so far
Summary of Disease Control

1. Best practice seed production.
   Run to waste treatments

2. Quarantine & hygiene programs

3. Fallow improvements, stubble & fallow crop root retention.
   More beneficials

4. Soil analysis. Improved programs. Focus on Ph, Calcium, OC, less ammonium, monitor potassium

5. Drainage improvements.
   Cross drains/ aeration/ no ponding

   Stress reduction

7. Precision pest/herbicide control.
   Placement.

8. Crop monitoring.
   Rouging and spot spraying.

9. Continued research & improvements to use infected soils

Soil disease control
Better soils
Higher yields
What is farm biosecurity?

The introduction or spread of new weeds, pests and diseases onto your property can reduce production and cost you time and money. The best defense is prevention, by implementing sound biosecurity practices. Quick and simple measures built into everyday practice will help protect your farm and your future. Farm biosecurity is your responsibility, and that of every person visiting or working on your property.

Top five tips for better biosecurity on your farm

1. Have a plan

Every farm is different. By developing a biosecurity plan, you can ensure you are addressing the priority issues for your farm and that it fits your work program.

- Familiarise yourself with the high-priority weed, pest and disease threats for your industry and region.
- Find out how you can reduce the risk of these threats and implement appropriate preventative measures.
- Know what endemic weeds, pests and diseases are already on your farm and how to manage them effectively. Inform visitors (if necessary) to prevent them from spreading further.
- Conduct regular active pest surveillance and monitoring of commercial crops and pastures and record results, even when nothing is found.
- Ideally, common areas (such as those around sheds and housing) should be well gravelled and kept free of weeds.
- Make sure anyone who visits your farm is aware of and adheres to your biosecurity plan.

2. Restrict movement

Anyone visiting your property can unknowingly introduce weeds, pests and diseases. There are some simple measures you can take to limit the biosecurity risk visitors pose to your farm.

- Limit entry points to the property.
- Where possible, restrict visitor vehicle access to clearly signed visitor parking areas.
- Ensure only on-site vehicles are used to transport visitors and equipment around your farm.
- Keep vehicles to designated roads, where possible.
- Limit visitor contact with livestock, crops or plant materials.
- If you run a business that has a tourism component, you should clearly indicate and enforce any entry requirements to all visitors prior to entry.

Contractor entry to a farm should be conditional on adhering to farm biosecurity plans and hygiene protocols. Therefore, it is important to display these instructions using clearly visible signage.
3. Come clean go clean

Weeds, pests and diseases can enter a farm and be spread by vehicles, machinery and equipment. They can be carried on vehicles by tyres, undercarriages, grills, floors and trays, and can also be present in plant material, soil or manure. It is important to maintain equipment hygiene and ensure all vehicles that visit your property are clean and well-maintained.

- If visitors or their vehicles require access to production areas, ensure all equipment, boots and clothing are clean and free from pests, weed seeds and plant material before entering or leaving.
- Special consideration should be paid to people who are returning or visiting from overseas to ensure clothing and footwear is free from contamination.
- Develop an effective clean-down area where farmers and contractors can clean and decontaminate all vehicles, machinery and equipment entering the farm. Use clearly visible signage to identify the clean-down facility to visitors.
- Make staff hygiene supplies available where appropriate (e.g. hand sanitiser, gloves, masks, disinfectant footbaths, disposable over-boots and overalls).
- Provide training to all farm staff in regard to biosecurity and farm hygiene practices.
- Advise contractors and visitors if a declared or notifiable weed, pest or disease has been confirmed on the property.
- It may be practical to assign equipment (including tools, clothing, and footwear) for use in weed, pest and disease affected areas.

4. Ensure all production inputs coming onto your farm are weed, pest and disease free

Farm inputs such as seed, fertiliser, feed and propagation material may contain weeds, pests or diseases.
- Ask for weed and pest-free certifications for any produce coming onto your farm.
- Ensure that animal manure and green waste is aged and thoroughly composted to destroy weed seeds and diseases.
- Isolate new stock in a holding paddock for seven days to contain any pests, diseases or digested weed seeds.

5. Keep records

Monitor and record all people, product and vehicle movements on and off your farm. These registers can be used in the case of a biosecurity emergency for tracing purposes.
- Place farm biosecurity signs at main entrances advising visitors to check-in (visitor registers should include phone numbers and/or UHF channel).
- Keep records of farm inputs, including supplier contact details, brand or cultivar and date of purchase.
- Keep records of produce harvested and sent off your farm.
- Keep a diary of spray herbicide, pesticide and fumigation treatments for crops and adhere to withholding periods.

For further information, or to report a suspected weed, pest or disease, call Biosecurity Queensland on 13 25 23 or visit www.daff.qld.gov.au
Come clean go clean

Vehicle and machinery hygiene is vital to reducing the spread of weeds on your farm

Weeds are a significant biosecurity concern for all farms. They reduce the carrying capacity of pasture, rob moisture and fertiliser from crops and cost producers time and money to control.

When vehicles and machinery enter a property or move from paddock to paddock, there is a risk that they will spread weeds along the way.

Vehicle and machinery movements are inevitable, but effective clean-down practices can reduce the risk of weed spread.

Developing an effective and dedicated clean-down facility

A clean-down facility is an area where farmers and contractors can clean and disinfect all vehicles and machinery entering or leaving the property. Effective farm clean-down facilities go a long way to reducing the chance of spreading weeds.

Clean-down activities can seem time-consuming but will substantially reduce the risk of new weeds entering your property, saving time and money in the future.

Features of an effective clean-down facility

- **Signposts** should be clearly visible with simple instructions so that visitors to your property understand the biosecurity practices you have in place.
- **Positioning** - the facility should be in an open area, preferably close to entry/exit points of the property. Keep it as far away as possible from any production areas. Keep drainage from the clean-down facility confined and away from access to drainage lines.
- **The size of the facility** should ensure there is enough room for large machines to move around.
- **Power and high-pressure water/compressed air cleaners** should be accessible, as this will make clean-down quicker, easier and more effective. If power is not available, a petrol powered pressure cleaner could be used instead.
Ideally, the surface should be sealed with concrete or bitumen. Compacted gravel can be used but is harder to rinse down. If the surface is grassed, it will require extra vigilance and regular treatment of germinating weeds.

A sump or waste water collection area is recommended for water, dirt and any contaminants to drain into. It’s important that this, and the surrounding area, is checked regularly and treated for weeds when necessary.

To stop the spread of weeds between paddocks, use mobile clean-down equipment such as a high pressure water cleaner or air compressor.

Mobile wash down equipment being used to clean a cane harvester

Four easy steps for an effective clean-down

1. Cleaning down

Clean all incoming and outgoing vehicles and machinery using a high pressure water hose or compressed air to remove any rubbish, plant debris and mud.

Pay careful attention to any crevices where mud or plant debris may be trapped including tricky areas like chassis rails, grills, tyre treads and wheel arches. Be sure to also clean floor mats and vehicle cabin floors to prevent weed seed contamination from footwear.

2. Decontamination

Apply a decontaminant solution (which is registered for use for the crop) to all surfaces where dirt and organic material may lodge. This includes tools, footwear, floor mats and other surfaces that may have come into contact with footwear (e.g. foot pedals).

Decontaminant solutions help loosen mud, oil and grease and include anti-bacterial, anti-fungal and antiviral agents to help stop the spread of specific plant diseases.

Decontaminants should be used in accordance with the product’s label recommendations.
3. Rinsing the wash pad

Before moving the vehicle, use high pressure water spray to clean the wash pad. Allow drying time before moving the vehicle off the wash pad to a dry surface – this avoids picking up too much dirt in the tyres. Clean the wash pad down so that any dislodged seeds are captured in the sump area where they are less likely to germinate or be spread by other vehicles, animals or wind.

4. Cleaning personal equipment

Ensure personal equipment and clothing is cleaned and decontaminated. A foot bath can be used to make sure boots are free of pests and pathogens.

Plan work activities so that work is conducted in weed free areas first and infested areas last to minimise the risk of weed spread.

For further information, visit www.daff.qld.gov.au or call Biosecurity Queensland on 13 25 23.
Help keep Queensland free of serious plant pests and diseases

What is a serious plant pest?

Plant pests or disease of plants that we don’t have in Queensland, and has the potential to cause serious consequences if they were to become established, e.g. banana bunch top.

Plant pests and diseases may enter Queensland in several ways, freight from overseas, tourists, interstate travellers and even the natural movement of a pest species.

Where might you see a plant pest?

- In, or on, fruit and vegetables you have bought
- In, or on, plants you have bought
- On roadside plants, bush and or rainforest
- In a nursery or orchard
- In your garden or backyard
- In pasture or crops
- On, or in, packaging, luggage etc that has come from another state or overseas

When do I report?

As soon as you realise that what you have is unusual, or seems like it could be a serious plant pest. Remember, you don’t need a firm diagnosis to report.

Why is it so important to report sightings immediately?

Early detection and reporting is vital to enable successful eradication or containment of new pests and diseases.

What do I look out for

It can be difficult to know what is a common pest or disease and what is a serious plant pest or disease. If you are unfamiliar with plants, ask someone who is.

Remember, if in doubt, call the Exotic Plant Pest Hotline on 1800 084 881.

- Is this the first time you've noticed this pest or disease?
- Is the pest or disease causing significant damage to the plant?
- Is the damage caused by the pest unusual?
- Are you unable to find the pest in any Australian gardening or pest management book?
- Does the pest or disease resemble any exotic plant pests or diseases that you are aware of?
What to do if you think you see a serious plant pest or disease

Leave the affected plants alone - taking a sample or moving could spread them. Call the Exotic Plant Pest Hotline on 1800 084 881.

If you have it, this information will be helpful when you report:

- Where you saw it. A street address and/or proximity to local landmarks is great, along with a GPS point (if you have a GPS unit).
- A photo of the suspect pest or disease and of any damage it might have already caused.
- If that isn’t possible, a description of what it looks like and what kind of damage, if any, it appears to have caused.
- What plants or plant parts are affected. If you don’t know the name, a photo or description of the affected plant/s would help.
- If it’s on fruit, vegetables or plants that you have bought, the name and address of where you bought them from.
- The growing situation, e.g. on the roadside, in an orchard, at a nursery, bushland etc.
- The level of infestation, e.g. just one plant, several plants, whether the infestation appears to have spread far etc.

What next?

Please mark the affected plant with surveyors tape, coloured string or waterproof spray paint so that we can find the exact plant again if necessary.

Remember, not to move the pest, plant or plant parts until you have consulted with Biosecurity Queensland staff and are sure that the pest or disease is not an emergency plant pest.

An exception to this would be if you saw hitchhiking pests in packaging, e.g. a shipping container, in which case you may be able to secure or contain them by simply closing the container again.

Precautions you should take

- Avoid or minimise touching or disturbing the affected plants.
- Clean and disinfect your hands and anything else that has been in contact with any affected plants.
- Clean any soil or plant material from your boots and outer clothing before you leave the site of the affected plants.

Thanks for your help

If you see something unusual, please report it. We do not expect you to be able to identify all the emergency plant pests. We have specialist scientists on staff to do that.

You will be doing your bit for Queensland and Australian biosecurity by alerting us to things you think might be emergency plant pests. For more information on emergency plant pests, visit www.daff.qld.gov.au or call 13 25 23.
The Team at AGIA would like to thank you all for coming along today and taking part in what we believe is the highlight of the year for your industry.

This page is dedicated to you to let us know if there is anything you believe we can do better. We’ve given you a couple of prompts with boxes to tick, and a section for you to fill in your comments.

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Other Comments: ____________________________________________________________________________________________
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Thank you and we’ll see you at the Christmas Party!