

Strawberry R&D update

Welcome to the 2010 edition of the Strawberry R&D Update, bringing you the latest results of research and development from the strawberry team in the Department of Employment, Economic Development and Innovation in Queensland.

Topics covered in this edition include:

Plant breeding . . . 3

- How are some of the new cultivars performing in commercial strawberry fields on the Sunshine Coast?
- Key attributes of new cultivars Aussiegem, Sunblushgem, Suncoast Delight and Redgem
- What factors influence fruit production costs for each strawberry cultivar?

Agronomy . . . 7

- What was the quality of 'Festival' and 'Florida Fortuna' plants supplied to Sunshine Coast growers in 2010?
- What is the relationship between transplant quality and temperature conditions in the different nursery-growing areas in Australia?
- What is the relationship between plant quality and reserves stored in the new transplants?

Entomology . . . 16

- What is the nature of the insect vector responsible for introducing the strawberry lethal yellows disease organisms into healthy plants?
- What strategies can be used to limit the impact of lethal yellows in commercial strawberry plantings?



Know-how for Horticulture™



Plant pathology . . . 20

- What is the source of infection of strawberry plants with crown rot caused by *Colletotrichum gloeosporioides* (Cg) and related fungi?
- What are the best strategies to control fruit stem-end rot and grey mould?
- Are infections with the bud and leaf nematode likely to affect strawberry production in southern Queensland?

Highlights

- **Plant breeding.** In 2010, transplants of promising new strawberry selections were distributed to several commercial growers on the Sunshine Coast. The best candidates among this group included 'Aussiegem', 'Sunblushgem' and 'Suncoast Delight', with their performance consistent with previous evaluations.
- **Agronomy.** Large transplants with crowns above 10 mm returned up to \$1.00 per plant more than small transplants with crowns below 10 mm. In contrast, plants sourced from southern Queensland were just as productive as those from southern Australia. On average, the leaves and the roots contained eighty-five percent of the carbohydrate reserves in new transplants. These results suggest that the leaves and the roots reflect nursery plant quality rather than the crown. The nursery industry needs to consider these factors when developing new quality standards for strawberry transplants.
- **Entomology.** Further data have confirmed that one of the leaf hoppers found on the Granite Belt is probably responsible for transmitting lethal yellows. The effect of trap plants and biopest oil to control these hoppers is currently being investigated.
- **Plant pathology.** We have collaborated with Bayer CropScience to generate residue data to facilitate an application for a permit to use prochloraz before the strawberry plants begin to flower and fruit, to control fruit rots. We are in the process of completing studies on the phytotoxicity of fenamiphos (Nemacur 400 EC®) to strawberry plants to assist our efforts to obtain a permit from the Australian Pesticide and Veterinary Medicines Authority (APVMA) for the use of this product to control the bud and leaf nematode in strawberry nurseries.

Plant breeding

Mark Herrington, Louella Woolcock, Michelle Paynter, Sam Price and Lien Ko

Overview

The main objective of our research is to breed new cultivars that consumers enjoy and that are profitable for commercial strawberry growers producing berries from May to October in southern Queensland. This industry is primarily based on the Sunshine Coast with annual production of about 15,000 tonnes worth \$140 million. Cultivars developed by DEEDI or introduced through our collaborators in Florida account for about seventy percent of commercial strawberry plantings in southern Queensland (see Table 1).

For consumers, qualities sought in new cultivars include flavour, sweetness and a long shelf-life. Growers are interested in these attributes along with productivity, earliness, and the ease of growing, harvesting and marketing. The specific characteristics evaluated in the new lines are given in more detail in the Strawberry R&D Update produced in 2008. The breeding program is guided by advice from the National Strawberry Varietal Improvement Steering Committee (NSVISC), which meets twice a year.



Strawberry plants used for cross-pollination in a glasshouse at Maroochy.

Table 1. The main strawberry cultivars grown in southern Queensland in 2010. Data are from the Queensland Strawberry Growers' Association.

Cultivar	Number of new plants (million)	Percent of total new plantings
Festival	15.2	45.4
Camarosa	8.7	26.0
Rubygem	3.5	10.4
Others	6.1	18.2
<i>Total</i>	33.5	

Evaluation of new cultivars by commercial growers

In 2010, transplants of promising new selections were distributed to several commercial growers on the Sunshine Coast. The material was distributed so that at least a few lines were seen on most of the co-operating properties. These cultivars were selected mainly on the basis of their eye appeal, size of the fruit, ease of harvesting and productivity. The best candidates among the advanced group included 'Aussiegem', 'Sunblushgem' and 'Suncoast Delight', with the performance of these cultivars consistent with previous evaluations.

Sam Price harvesting berries from the breeding plots at Maroochy.



These lines, and small quantities of a number of other advanced selections from this group are available from the strawberry nurseries at Stanthorpe for commercial evaluation. Some of the new material showed exceptional promise in 2010, and were highly productive and well-liked by consumers. Important details of the new cultivars are shown in Table 2.

‘Florida Fortuna’, introduced from the United States under a separate program in 2008, also performed well in many of the evaluations on the Sunshine Coast. Plant Breeders Rights (PBRs) are being finalised for all these new cultivars in preparation for their commercial release.

Table 2. Key attributes of some of the new strawberry cultivars produced at Maroochy.

Cultivar	Key attributes appealing to growers	Key attributes appealing to consumers
Aussiegem (2006-019)	High productivity and large fruit contributing to a relatively low cost of harvesting	Large, juicy fruit, with low to medium acidity
Sunblushgem (2005-188)	Uniform fruit contributing to a relatively low cost of packing	Juicy, flavourful fruit, with low to medium acidity
Suncoast Delight (2006-475)	High productivity, with uniform fruit contributing to a relatively low cost of harvesting and packing	Juicy, flavourful fruit, with a strong red flesh
Redgem (2006-215)	High productivity contributing to a relatively low cost of harvesting	Distinctive flavour

Early generation selections

About five-thousand seedlings were evaluated for fruit quality,

productivity and plant type in the field at Maroochy Research Station in 2010. At the end of the season, 300 lines were selected for further evaluation.

Collaboration with the University of Florida

Mark Herrington attended *The International Strawberry Conference* at the University of Florida in January 2010. Areas of interest included strengthening the link between the two subtropical breeding programs at Nambour and Wimauma, with continued exchange of strawberry germplasm. There was also interest in the development of cultivars with resistance to crown rot caused by *Colletotrichum* spp.



Mary Grace and Sharon Anning assessing some of the new strawberry breeding lines.

Resistance or tolerance of strawberry cultivars to plant diseases

As we progress toward selecting for resistance to fusarium wilt caused by *Fusarium oxysporum*, we evaluated the resistance of cultivars to pathogenic isolates of the fungus collected from strawberry plants growing in Queensland and Western Australia. This work confirmed that 'Festival' was highly resistant to this disease.

A review of fruit production costs

We are in the process of more formally reviewing the effect of plant characteristics on the production and efficiency of strawberry growing to guide plant selection in future breeding efforts. Early indications are that as well as plant characteristics, some field design and procedures have a strong effect on costs. Of particular importance was how often and how far pickers need to travel to unload their fruit.



Mark Herrington checking berries for rain damage.

Future developments

About three of the selections from 2008 are being propagated by the plant nurseries on the Granite Belt and will be available for on-farm testing on the Sunshine Coast over the coming season. In preparation for 2011, approximately 20,000 seeds have been planted. These seedlings will be evaluated and selected to progress towards exciting new cultivars.

Our research is continuing under the breeding project, BS09013 supported by DEEDI (formerly DPI&F), Horticulture Australia Limited, and Strawberries Australia. We appreciate the significant input of

these agencies along with the support of co-operating nursery and fruit growers. We visited the Western Australian industry in October to develop a better understanding of their situation, especially the need to develop cultivars with resistance to the major diseases affecting strawberries in this environment.

Other extension activities included participating in the Hilton Masterclass in Brisbane in July, and reporting to the NSVISC in February and October.

Mary Grace and Jeremy Rousham counting berries from the breeding plots at Maroochy.



Edward Woolcock checking the quality of some of the new strawberry lines.



Runner quality

Chris Menzel and Lindsay Smith

Overview

Research has shown that the quality of planting material has a strong effect on the profitability of strawberry fields in southern Queensland. Inferior transplants grow and crop poorly after planting, reducing monetary returns to producers. A ten percent loss of production on the fruit farms on the Sunshine Coast is equivalent to a loss of about \$14 million for the local strawberry industry. These issues also affect growers in the southern parts of Australia.

As in previous years, in 2010 we assessed the quality of plant material from different strawberry nurseries on the Granite Belt. This survey differed from the earlier research in that we included information on the new cultivar, Florida Fortuna, from the United States.

In other activities, we reviewed data collected from previous glasshouse and field experiments. In the first set of experiments, strawberry plants were grown at different temperatures, and the impact of plant growth and dry matter production determined. In the second set of experiments, strawberry plants were obtained from different nurseries in Australia and grown on the Sunshine Coast. We were interested in determining whether differences in temperature conditions in the nurseries in Australia are likely to affect transplant quality.

Finally, we examined the relationship between nursery plant quality and the concentration of stored reserves in the transplants. Material was sourced from different growing areas and at different times during the nursery-growing period. These experiments were conducted over two years.



Healthy strawberry nursery plants growing on the Granite Belt over summer.



Lindsay Smith with freshly harvested berries.



Planting systems have been developed for the production of 'Festival' on the Sunshine Coast.

Wide variation in the size of 'Festival' and 'Florida Fortuna' plants in 2010

We studied the variation in the quality of transplants from southern Queensland last year. Samples of the two main cultivars, Festival and Florida Fortuna, were collected on each of three digging dates from early April to late April or early May.

The 'Festival' plants were larger than the 'Florida Fortuna' plants on all digging dates (see Tables 3 and 4). For instance, the average dry weight of the 'Festival' plants was about two times greater than that of the 'Florida Fortuna' plants. This was due to the larger leaf,

crown and root masses of the 'Festival' plants.

In both cultivars, there was no clear effect of digging date on plant development, with similar mean crown diameter, leaf production and plant dry weight in the transplants dug at different times from early April to early May (see Tables 3 and 4).

Table 3. A comparison of mean plant quality in 'Festival' strawberry plants sourced from Stanthorpe at different times of digging in 2010. Data in parenthesis show the ranges in crown diameter, leaf production and plant dry weight. Plant dry weight includes the mass of the leaves, crown and roots.

Time of digging	Diameter of the crown (mm)	Number of leaves per plant	Plant dry weight (g)
Early April	9.7 (6-15)	4.6 (3-8)	5.1 (1.2-12.8)
Mid-April	10.0 (6-16)	4.5 (3-8)	4.3 (1.6-12.0)
Late April	9.2 (6-14)	4.4 (3-7)	4.3 (1.9-12.3)

There was a large variation in the quality of the plants from the same nursery. For instance, the dry weight of some of the smaller plants was less than twenty percent of the dry weight of the larger plants. The same was true for the data collected in 2007, 2008 and 2009. The 'Florida Fortuna' plants were particularly variable, with many small transplants in the consignments. There was a strong correlation between the weights of the different plant parts (see Figures 1 and 2). The plants with the largest crowns tended to have the largest root and leaf weights. In other words, there was a co-ordination of growth in the nursery material.

Table 4. A comparison of mean plant quality in ‘Florida Fortuna’ strawberry plants sourced from Stanthorpe at different times of digging in 2010. Data in parenthesis show the ranges in crown diameter, leaf production and plant dry weight. Plant dry weight includes the mass of the leaves, crown and roots.

Time of digging	Diameter of the crown (mm)	Number of leaves per plant	Plant dry weight (g)
Early April	8.3 (6-11)	4.0 (3-5)	2.7 (1.1-7.0)
Late April	7.6 (5-13)	4.0 (2-5)	2.4 (0.9-6.1)
Early May	7.0 (5-11)	4.5 (3-5)	3.4 (1.2-7.3)

All of the ‘Festival’ transplants met the minimum standard relating to the diameter of the crowns and the number of functional leaves. In contrast, some ‘Florida Fortuna’ transplants did not meet the minimum standard.

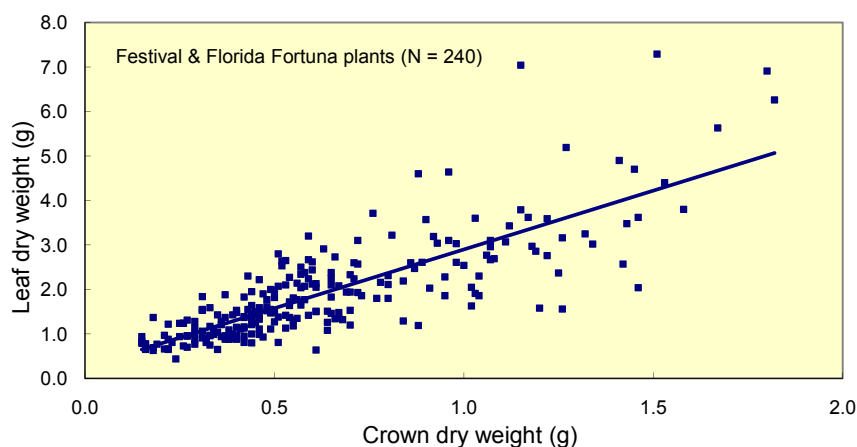


Figure 1. The relationship between leaf and crown dry weight in the ‘Festival’ and ‘Florida Fortuna’ strawberry transplants in 2010.

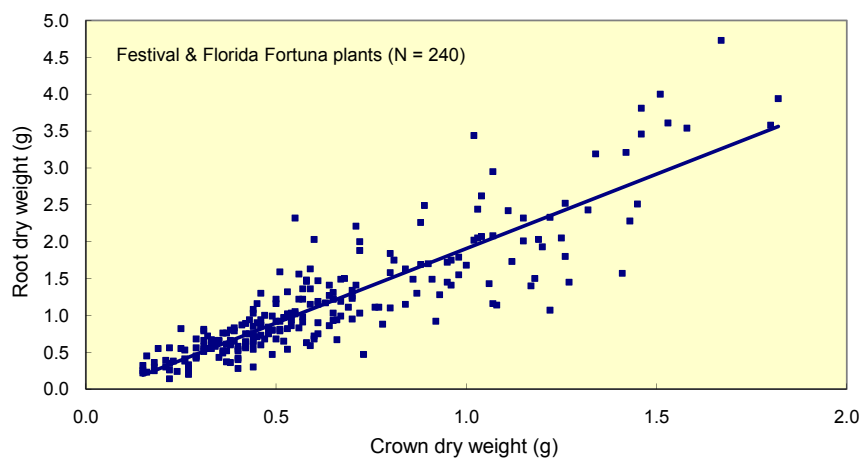


Figure 2. The relationship between root and crown dry weight in the ‘Festival’ and ‘Florida Fortuna’ strawberry transplants in 2010.



Lindsay Smith weighing berries from experimental plots at Maroochy.

About fifteen percent of the 'Festival' transplants had crowns smaller than 8 mm, and about fifty percent had crowns smaller than 10 mm. A similar analysis of the 'Florida Fortuna' plants, showed that about fifty percent of the transplants had crowns smaller than 8 mm, and about eighty percent had crowns smaller than 10 mm. At this stage, the reason for the small size of the 'Florida Fortuna' plants is unknown.

It would be expected that the small size of some of the plants would affect their productivity on the Sunshine Coast. It is important that planting material of 'Florida Fortuna' is not harvested before early April when grown on the Granite Belt.

Yield, plant quality and chilling in strawberries

In California, the bulk of the new strawberry transplants are produced in nurseries at high elevation, primarily in the Cascade Mountain range in the north-east of the state. Smaller numbers of transplants are also produced in nurseries in the Central Valley, primarily in the Northern San Joaquin and Northern Sacramento Valleys. Similarly, in Florida, the bulk of the nursery stock is produced in the northern United States or Canada.

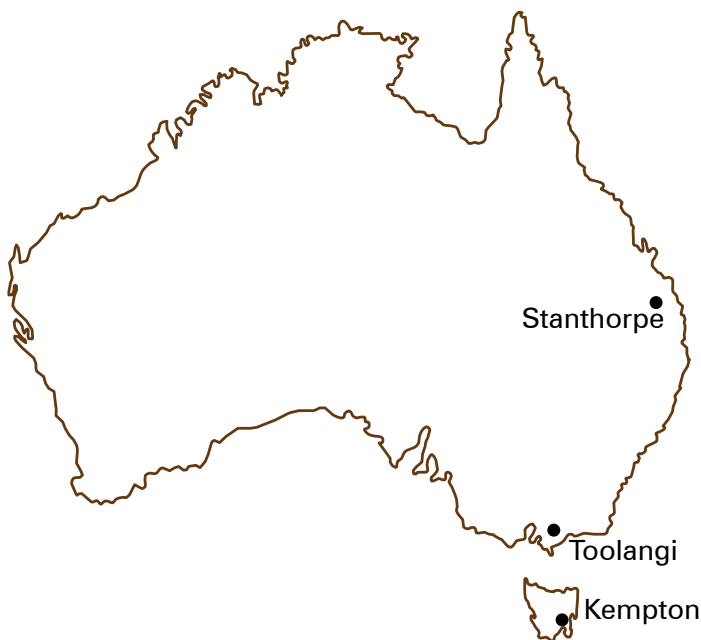


Figure 3. The location of the main nurseries supplying transplants to the commercial strawberry industry in Australia.

It is presumed that the cooler conditions in the northern nurseries provide better conditions for the new plants to produce and store essential carbohydrates, ensuring higher productivity when they are planted in southern-growing areas. The northern material also generally has fewer diseases.

An analysis of the effect of nursery-growing environment on the performance of strawberry plants in Florida shows that plants from northern or mid-latitude nurseries (Canada, Massachusetts, Oregon, California or North Carolina)

out-yielded those from southern nurseries (Alabama or Florida) in about half the cases. The northern areas are up to 10°C cooler in the weeks before digging compared with conditions in Florida.

Several authors have assessed the impact of low temperatures before planting on fruiting in Florida. The plants were cooled for two to four weeks (usually two weeks) at various temperatures, including 0.6°, 2°, 4.4°, 10°, 12° or 15°C. Temperatures close to freezing were provided by storing the freshly dug plants in cold-rooms. Higher temperatures were provided by potting the plants after digging, and growing them in glasshouses.

An analysis of these reports indicates that when the plants were stored at low temperatures after digging, 'chilling' had a mixed effect or no effect on yield. In contrast, when the plants were grown at low temperatures, 'chilling' generally resulted in higher yields.

In research conducted at Nambour over three years, bare-rooted 'Festival' plants from Queensland were just as productive as plants from Victoria or Tasmania (see Figure 3 and Table 5). The different stock was of similar size in terms of dry weight at planting, similar growth during the season and similar productivity. Average daily temperatures during plant development from January to April are about 3° to 5°C lower at Toolangi and Kempton compared with conditions at Stanthorpe. These differences in temperature are due to differences in daily minimums (10.7°, 6.5° and 13.3°C) and maximums (20.4°, 20.9° and 24.2°C).

Table 5. *The effect of nursery-growing environment on the yield (g per plant) of 'Festival' strawberry plants at Nambour over three years. The southern-grown plants came from Toolangi in Victoria or from Kempton in Tasmania.*

Year	Plant from Queensland	Plant from southern Australia
2007	700	628
2008	723	799
2009	661	649
<i>Average</i>	695	692

Research conducted in glasshouses showed that temperature had a strong effect on the growth of 'Festival' strawberry plants. Overall, plants grown at 15° or 20°C were superior to those grown at 25° or 30°C, in terms of a balance in root and shoot development needed for bare-rooted plants (see Table 6). Stanthorpe, Toolangi and Kempton have temperatures during nursery development similar to the 15° or 20°C regimes used in the glasshouse experiment.

Tanino and Wang (2008) found that the potential productivity of strawberry plants obtained from different nurseries in Canada and then grown in California was related to differences in diurnal temperatures at the various sites. It is apparent that the differences in temperature between Queensland and southern nurseries (mean daily temperature differences of 3° to 5°C or mean diurnal range differences of 0.8° to 2.6°C) are not great enough to affect production when the material is grown on the Sunshine Coast.

Table 6. The effect of temperature on dry matter production (g per plant) in 'Festival' strawberry plants grown in temperature-controlled glasshouses at Nambour. Data are the means from four harvests after five, nine, thirteen and nineteen weeks.

Temperature	Leaves	Crowns	Roots	Total
15°C	6.4	3.6	4.6	14.7
20°C	12.2	5.8	5.3	23.2
25°C	13.8	3.5	2.5	19.7
30°C	8.9	2.3	1.3	12.6

It can be concluded that strawberry plants sourced from southern Queensland are just as productive as those from southern Australia when they are grown on the Sunshine Coast. Differences in temperatures amongst the different growing areas are not large enough to influence production.

This analysis does not include the relative costs of growing the nursery material in the different locations. It is possible that some areas have a higher relative cost of production than other areas. This would relate to the relative rates of transplant production per unit growing area, and the relative cull-out after digging.

Nursery plant quality, stored reserves and chilling in strawberry

Several studies overseas have examined the relationship between nursery plant quality and the concentration of reserves in new strawberry plants. For instance, Kirschbaum *et al.* (1998) measured the concentration of

non-structural carbohydrates in bare-rooted plants grown in Canada (a cool site) or Florida (a warm site), and planted in Florida. The northern-grown plants had a slightly higher concentration of soluble sugars in the crown than the southern-grown plants, and a higher concentration of soluble sugars and starch in the roots. There were no differences in the concentration of reserves in the leaves. These authors concluded that the better performance of northern-grown plants in Florida is likely to be related to a greater concentration of carbohydrate in the plants, especially in the roots.

We examined the effect of digging date and nursery-growing environment on the reserves of non-structural carbohydrates in bare-rooted plants of 'Festival' grown on the Sunshine Coast. In the first experiment, the material was grown at Stanthorpe and dug at various times from early March to late April. The samples were then transported to the laboratory at Nambour and plant dry weight and the concentrations of soluble sugars and starch determined.



A 'Festival' transplant. Research has shown that most of the stored reserves in the plant are found in the leaves and the roots. The reserves stored in the crown are relatively less important.

In a separate experiment, plants were obtained from nurseries at Stanthorpe (a warm site) or from Toolangi in Victoria (a cool site) for a similar analysis. Each of the experiments was repeated over two years.

The main non-structural carbohydrates measured in the strawberry plants were glucose (mean concentration of 4.0 percent dry weight), fructose (3.2 percent), sucrose (1.1 percent), maltose (0.4 percent), and starch (2.1 percent), with lower concentrations of sorbitol (less than 0.1 percent). The mean concentration of all the sugars measured was 8.7 percent, and the mean concentration of the non-structural carbohydrates measured was 10.8 percent. Soluble sugars accounted for more than three-quarters of the total non-structural carbohydrates analysed.

The mean concentration of non-structural carbohydrates was highest in the roots (12.2 percent dry weight) followed by the leaves (11.1 percent) and the crown (9.1 percent). The leaves (9.8 percent) and the roots (9.0 percent) had higher concentrations of sugars than the crown (7.4 percent). There was a slightly different pattern with starch, which was higher in the roots (3.2 percent) than in the leaves (1.3 percent) or the crown (1.7 percent).

Table 7. *The effect of digging date on plant dry weight and the weight of non-structural carbohydrates in ‘Festival’ strawberry plants grown at Stanthorpe. Data are the means over two years.*

Time of digging	Plant dry weight (g)	Weight of non-structural carbohydrates (mg per plant dry wt)			
		Leaves	Crown	Roots	Plant
Early March	2.2	155	27	28	210
Late March	3.7	254	50	97	401
Early April	4.0	260	61	157	478
Late April	4.1	224	87	236	547

There were strong relationships between the concentration of non-structural carbohydrates in the crown and roots and the accumulation of chilling below 10°C in the plants dug at different times at Stanthorpe (see Figure 4). In other words, the plants accumulated sugars and starch in direct relationship to the fall in temperatures in the nursery. There was no relationship with the leaves, and no relationship with chilling below 7.2°C, the standard often used to estimate chilling in many overseas studies in strawberry.

The total weight of non-structural carbohydrates per plant increased as digging was delayed at Stanthorpe (see Table 7). This response was due to the presence of larger plants in the later harvests, and higher concentrations of non-structural carbohydrates in the crown and especially in the roots. The concentration of non-structural carbohydrates in the crown increased from 7.5 to 11.0 percent, and in the roots, it increased from 8.4 to 16.7 percent as digging was delayed.

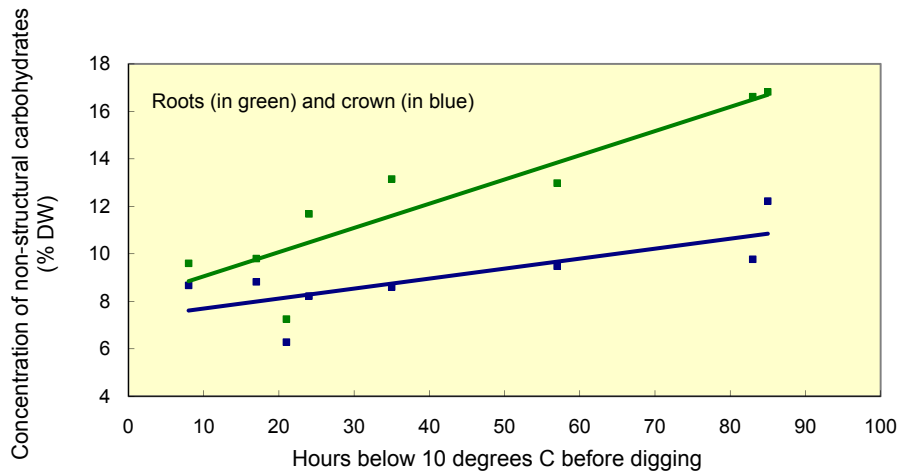


Figure 4. The relationship between the concentration of non-structural carbohydrates and chilling (temperatures below 10°C) at Stanthorpe as digging of the ‘Festival’ strawberry transplants was delayed.

Overall, the roots were more sensitive to digging date for the total weight of carbohydrates than the leaves or the crown (see Table 7). There was also a change in the distribution of the carbohydrates, with a decrease in the percentage stored in the leaves as harvesting was delayed, and an increase in the percentage stored in the roots (see Figure 5).

Table 8. The effect of nursery-growing area on plant dry weight and the weight of non-structural carbohydrates in ‘Festival’ strawberry plants. The plants were dug in early April. Data are the means over two years.

Nursery-growing area	Plant dry weight (g)	Weight of non-structural carbohydrates (mg per plant dry wt)			
		Leaves	Crown	Roots	Plant
Stanthorpe, Qld	2.1	260	61	157	478
Toolangi, Vic	1.8	175	63	87	325

The stock from Stanthorpe had a greater weight of non-structural carbohydrates per plant than the stock from Toolangi (see Table 8). This response was due to the presence of larger plants from Stanthorpe and slightly higher concentrations of non-structural carbohydrates in the leaves and roots. The concentration of non-structural carbohydrates in the leaves and roots was 12.0 percent and 13.2 percent in the plants from Stanthorpe and 9.8 percent and 11.2 percent in the plants from Toolangi, respectively.

The greater weight of carbohydrates in the plants from Stanthorpe was due to greater reserves in the leaves and the roots (see Table 8). In contrast, the weight of carbohydrates in the crowns of the plants from the two growing areas was similar.

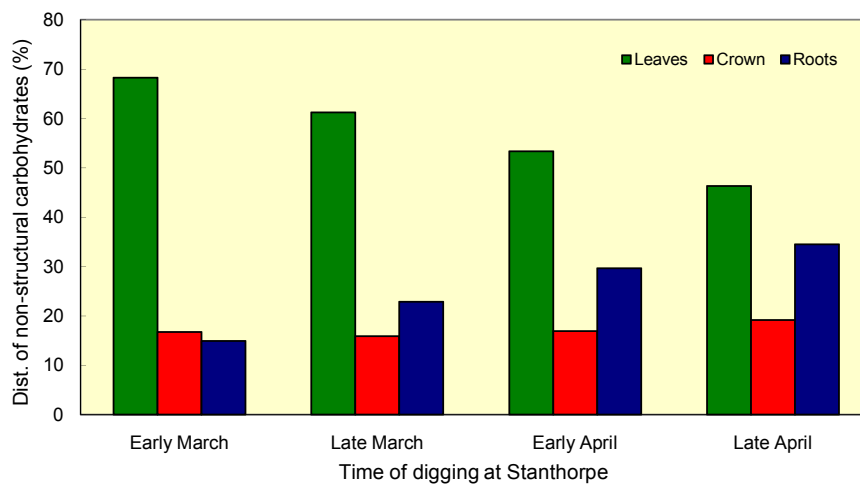


Figure 5. *The change in the distribution of non-structural carbohydrates in 'Festival' strawberry transplants from Stanthorpe as digging was delayed.*

The optimum time for planting 'Festival' on the Sunshine Coast is from mid-March to early April, with lower productivity resulting from earlier planting. It is apparent that the poorer performance of the material planted in early March is related to the small size of the plants and their lower concentration of non-structural carbohydrates. It is possible that larger nursery stock with a high concentration of stored reserves planted in early March might provide early production for growers in southern Queensland chasing niche markets. These could be supplied as containerized plants with intact root systems.

Strawberry growers on the Sunshine Coast obtain their new planting material from nurseries at Stanthorpe in southern Queensland or those from Toolangi in Victoria. It is about 2° to 3°C cooler in the southern-growing area during nursery plant development compared with conditions in the northern-growing area. Research has shown that the material from the two areas had similar productivity when grown on the Sunshine Coast. Our results reported here show that the plants from the two growing areas also have similar levels of carbohydrate reserves.

This work has also shown that the leaves and the roots were more sensitive to growing conditions than the crown. On average, the leaves and the roots contained eighty-five percent of the carbohydrate reserves in the plants. These results suggest that the leaves and the roots reflect nursery plant quality rather than the crown. The nursery industry needs to consider these factors when developing new quality standards for strawberry transplants.

Controlling strawberry lethal yellows

Jonathan Smith, Don Hutton, Matthew Neave and Karen Gibb

Overview

Strawberry lethal yellows (SLY) is a stunting and yellowing disease associated with a phytoplasma and a rickettsia found in the phloem of infected plants in the nursery and fruit farms in southern Queensland. Losses on fruit farms in most years are less than one percent, occasionally up to five percent, and rarely as high as thirty percent.



A strawberry field on the Sunshine Coast affected by lethal yellows.

Transplants infected with the rickettsia usually comprise the major component of infection for fruit farms on the Sunshine Coast. The phytoplasma also occurs at low levels on fruit farms, where it becomes apparent mainly as symptoms of the strawberry green petal disease. Transmission of the phytoplasma is thought to be by local vectors, probably leafhoppers of species different from those that transmit the rickettsia on the nursery farms.

Lethal yellows is easier to control in the strawberry nurseries than on the fruit farms. We believe symptoms of the disease appear within six to eight weeks of infection. We do not know when the major infection periods occur on the strawberry nurseries at Stanthorpe. However, plants infected within six to eight weeks of digging can appear to be healthy when sent to fruit farms on the coast.

The main strategies currently used to limit infection of the nursery plants with lethal yellows include regular applications of dimethoate to kill potential vectors before they can feed on the strawberry plants, and the removal of plants with obvious symptoms. However, these control options are not completely successful. Further research is required to better target insecticide applications to control the specific hoppers responsible for transmission of the disease. To do this, we need to know the identity and ecology of the candidate insect vectors, and their susceptibility to different chemicals that could be used for control.

In 2009/10, the leafhopper, *Austroagallia torrida*, which is now considered to be the likely vector, was collected from strawberry, lucerne and clover plants at Stanthorpe, and lucerne plants at Gatton. These were then tested for the phytoplasma and rickettsia associated with SLY. The rickettsia was found in seven out of eight samples collected from the strawberry plants, and nine out of nine samples collected from the lucerne and clover plants. A sample of juvenile hoppers reared in culture at Maroochy with no exposure to SLY also tested positive for the rickettsia, suggesting adult-to-juvenile transmission of the pathogen.

We have continued this work on lethal yellows. Further data were collected on the populations of the various hoppers on the Granite Belt and nearby areas. Preliminary transmission experiments to determine whether the hoppers are responsible for infecting healthy strawberry plants were also conducted.

Sampling of leafhoppers in 2010

We started sampling for the presence of leafhoppers on the Granite Belt in September. Samples were collected from both clover and lucerne plants. This initial sampling up until the end of November 2010, showed few leafhoppers were present compared with the populations recorded in 2009 (see Table 9).

We suspect that the hoppers originate in areas further south and west of Stanthorpe and migrate north-east in spring and early summer each year. However, these areas have been unseasonably wet over the past few months. It is possible that these favourable weather conditions have provided good growing conditions for the preferred hosts of the hoppers.

Under these conditions, they would be less likely to migrate. The hoppers are carried by the wind, and there were few westerly winds this past season. This would have reduced the migration of the insects as well. Conditions on the Granite Belt have been quite cool this season. This would be expected to slow the breeding of any hoppers that have arrived on the Granite Belt.

In the past, a low incidence of lethal yellows has been associated with wet conditions over winter and spring in southern Queensland. As indicated previously, above average rainfall was recorded for much of the area to the west and south-west of the Granite Belt late in 2010.

Sampling for the leafhoppers in lucerne growing in areas south and west of Stanthorpe indicated similar total populations of the insects as those obtained in areas around Stanthorpe. However, the number of *Austroagallia torrida* in the samples increased the further west the samples were collected. Overall, the number of insects collected this season was much lower than the number collected last season.



Close-up of the symptoms of strawberry lethal yellows, with the affected plant showing severe stunting of growth and poor fruiting.



Don Hutton assessing strawberry plants for lethal yellows and other diseases in a nursery at Stanthorpe.

Table 9. The numbers of the three main leafhoppers collected from sampling of lucerne growing on the Granite Belt in 2009 and 2010. Data are the average number of insects collected on each sampling date.

Date of sampling	<i>Austroagallia torrida</i>	<i>Orosius orientalis</i>	<i>Anzygina</i> spp.
2009			
22 September	9.6	6.1	104.3
7 October	52.4	8.0	186.3
23 October	60.2	11.6	83.2
6 November	26.7	15.7	40.8
<i>Average</i>	<i>37.2</i>	<i>10.4</i>	<i>103.7</i>
2010			
7 September	0.6	0	3.0
6 October	2.2	1.0	5.0
4 November	1.0	2.0	8.0
24 November	0	0	3.0
<i>Average</i>	<i>1.0</i>	<i>0.8</i>	<i>4.8</i>

Transmission experiments

To confirm that *A. torrida* is the vector of SLY, transmission studies are required. In October 2010, three insect-proof cages were set up with four strawberry plants in each at Maroochy. The plants were healthy with no obvious symptoms of the disorder, and specific laboratory tests confirmed that none of the plants was carrying the phytoplasma or rickettsia. The experiment included plants of 'Festival', 'Florida Fortuna', and the experimental line '2006-215'.

Leafhoppers were introduced into each of the cages on three occasions. The hoppers were seen to alight on the plants but did not feed. Subsequently, none of the plants showed any symptoms of lethal yellows. These results suggest that the hoppers do not feed readily on strawberry plants, and probably need other food sources such as lucerne to survive. This correlates with the incidence of infection in the field, and its relative rarity when the total hopper population is considered. Further transmission experiments are planned over the next few months. These studies are dependent on locating adequate populations of the suspect leafhoppers.

Current studies

We are currently investigating the effect of oil sprays, dimethoate and trap plants on the populations of the hoppers on the Granite Belt.

Ian Mungall from Red Jewel Nursery at Ballandean agreed to assist in an experiment to evaluate the effectiveness of biopest oil to control

the leafhoppers. It is anticipated that the oil will interfere with the feeding of the insects on the strawberry plants. Ian is providing two blocks of strawberry plants for the research. Half of each block is receiving a fortnightly application of 0.5 percent oil, in addition to the regular chemical regime used to control the potential insect vectors. The oil should have a much longer residual effect than the standard dimethoate applications. We will collect data on the number of leafhoppers in the plots, and on the number of plants showing symptoms of lethal yellows. We will also collect information on the toxicity, if any, of the sprays to the strawberry plants, and on nursery plant quality.



Geoff Waite collecting hopper samples at Stanthorpe.

Wally Sweet from Sweets Strawberry Runners also agreed to a similar experiment. In this case we are comparing plants sprayed with biopest oil at 0.5 percent with plants receiving no insecticides (no dimethoate).

We are also evaluating the potential of trap plants to control the disorder in the strawberry nursery plants. Trap plants are grown adjacent to a crop to attract insects to them and away from the crop, thus protecting the target crop from attack. Protection of the crop can then be achieved by preventing the pest from reaching it or by concentrating them in a certain part of the field, allowing a smaller area to be sprayed for their control. The principle of trap cropping rests on the fact that most pests show a preference for certain plant species, cultivars or crop stages.



Vegetation growing next to a strawberry nursery on the Granite Belt. The hoppers thought to infect strawberry plants with lethal yellows can be found on a range of plants growing in this area.

Suction sampling has shown that strawberry plants are not a preferred host for *A. torrida* and that the number of hoppers collected from lucerne and clover are much higher than those collected from strawberry. Lucerne is the preferred trap crop as it is easy to grow and conditions at Stanthorpe are ideal for its survival. In these experiments, we will have blocks of lucerne planted next to blocks of strawberry plants. Some of the plots will be sprayed as per normal nursery operations or with just dimethoate. Other plots will be left unsprayed.

Controlling crown rot and other diseases in Australia

Don Hutton, Apollo Gomez, Natalia Peres, Jonathan Smith and Lindsay Smith

Overview

Crown rot caused by the fungus, *Colletotrichum gloeosporioides* (Cg) and related pathogens, is the major disease affecting strawberry plants in southern Queensland. It is not known why low levels of infection in the nurseries can occasionally result in significant losses in strawberry fields on the Sunshine Coast. Prochloraz is routinely applied to the nursery beds at Stanthorpe in an attempt to limit infections of the plants and the impact of the pathogen on fruit production.



Apollo Gomez and Grant Bignell isolating the crown rot fungus from strawberry leaf samples.

We have been monitoring the level of infection of crown rot in the different stages of transplant production in an attempt to determine the source of the disease. We have been studying isolates of *C. gloeosporioides* to determine if the fungus is becoming resistant to prochloraz. We have also examined whether the fungus can carry over between successive nursery or fruit crops, and infect new plants.

In other studies, we have reviewed strategies to control fruit rots in strawberry plants. We collaborated

with Bayer CropScience to generate residue data to facilitate an application for a permit to use prochloraz before the strawberry plants begin to flower and fruit, to control these diseases.

In 2010, the bud and leaf nematode, *Aphelenchoides fragariae*, was found in Queensland strawberry plants. This new pest was responsible for losses of production in several fields on the Sunshine Coast. We are in the process of completing studies on the phytotoxicity of fenamiphos (Nemacur 400 EC®) to strawberry plants to assist our efforts to obtain a permit from the Australian Pesticide and Veterinary Medicines Authority (APVMA) for the use of this product in strawberry nurseries.

Reducing the incidence of crown rot

Crown rot caused by the fungus, *Colletotrichum gloeosporioides* (Cg) and related pathogens, is the major disease affecting strawberry plants in southern Queensland. Prochloraz (Octave®), and cyprodinil plus fludioxonil (Switch®) are routinely applied to the nursery beds on the Granite Belt in an attempt to limit infections of the plants and the impact of the disease on fruit production on the Sunshine Coast.

Our research has shown that *Colletotrichum gloeosporioides*, *C. fragariae* and *Glomerella cingulata* are all associated with this type of crown rot in Australia.

We have been monitoring the different sectors of the Queensland nursery industry for the presence of the crown rot fungi in symptomless petioles, and in plants with crown rots.

The crown rot organism was not detected in petioles from the tissue-culture growing-on nursery at Cleveland in 2010; this compared with 0.013 percent of petioles infected in 2009 and with nil to 0.06 percent of petioles infected in the years since 2001. We found the crown rot fungus was present in 0.004 percent of about 500,000 mother plants at Stanthorpe, but it was not present in a similar number of mother plants at Ballandean. Losses of five to thirty percent occurred on the Sunshine Coast in transplants consigned from two fields at Stanthorpe.

The crown rot fungi are distributed with the new transplants, and possibly from infected buried trash or alternative hosts near the strawberry nurseries or fruit farms (see Table 10).

We have identified two more plant species that are hosts of the fungi: *Ozothamnus diosmifolius* (rice flower or pill flower) and *Acacia neriifolia* (silver wattle or oleander wattle).

The first species is distributed in open forests from central Queensland to southeast New South Wales. The second species is common in dry sclerophyll forests and woodlands, often on granite outcrops, chiefly on the Granite Belt and nearby areas.

We will continue to monitor vegetation surrounding strawberry fields for the presence of the crown rot fungi, and test any isolates for pathogenicity against strawberry.

Where appropriate, we will send isolates of the fungi collected from alternative hosts for genetic screening by our colleagues in Florida.



Lindsay Smith inoculating strawberry plants with the crown rot fungus.



Lindsay Smith assessing strawberry plants inoculated with the crown rot fungus.

Table 10. The probable source of infection of strawberry plants in southern Queensland with crown rot caused by *Colletotrichum gloeosporioides* (Cg) and related fungi.

Source of infection	Probability of infection
<i>Infection of plants in commercial nursery</i>	
Tissue-culture plants	Low
Buried strawberry trash	Very low
Alternative host plants including weeds	Low
<i>Infection of plants in commercial fruit farms</i>	
Commercial nursery plants	Low
Buried strawberry trash	Very low
Alternative host plants including weeds	Low

We investigated the survival of the main crown rot fungus in the soil over the summer of 2009/10 on the Sunshine Coast. Crowns infected with the fungus were buried in the soil and the survival of the fungus determined over several months. These experiments showed that the fungus was recovered from about one percent of the infected crowns after two months. This is comparable to the previous study at the same location. Our results suggest that there is only a remote chance of the crown rot fungus surviving through this pathway over summer on the

Granite Belt and on the Sunshine Coast. It is also unlikely that the fungus could survive over winter on the Granite Belt. Conditions for survival would be improved by a mild, dry summer at either location or a long cold, winter at Stanthorpe.

We continue to work with our colleague, Professor Natalia Peres from the University of Florida. She is currently identifying thirty isolates of the crown rot fungi collected in Australia. Previous work showed that there were four genotypes in the first consignment of 30 isolates of the fungi. These genotypes or strains are noted as Cg8, Cf1, Cf2

and Gc2, and relate to *C. gloeosporioides*, *C. fragariae* and *Glomerella cingulata*.

There is a strong relationship between genotype and the locations of the strawberry nurseries in Australia. Most of the genotypes are unique to one or two growing areas. The Gc2 strain has been the main genotype recorded since the early 1990s when transplants were first grown on the Granite Belt. This genotype was also associated with crown rots in plants from Crows Nest near Toowoomba in the 1980s. The Cf1 strain has been associated with transplants from Esk in 1991 and 1992, while the Cf2 strain was associated with transplants from Delaney's Creek in 1996 to 1998. To the best of our knowledge, the Cg8 strain originated in



The bud and leaf nematode, *Aphelenchoides fragariae*.

Victoria. We are currently evaluating the pathogenicity of the various genotypes on a range of strawberry cultivars.

Reducing the incidence of bud and leaf nematode

The bud and leaf nematode, *Aphelenchoides fragariae*, was found in Queensland strawberry plants in 2010. One grower estimated losses of production at more than 30 percent, while other growers were less severely affected. The source of the nematode is not known, but it was present on a number of fruit farms on the Sunshine Coast. However, it was not found in the plant nurseries or on a wide range of weeds sampled on the Granite Belt.

The nematode was identified by Jenny Cobon and Wayne O'Neill from DEEDI (formerly QDPI&F), and this has since been confirmed by a taxonomist from the Department of Agriculture in South Australia. This nematode is different to the crimp nematode, *Aphelenchoides besseyi*, which commonly infects strawberry plants (see Table 11).

The bud nematode lives as an ectoparasite on young buds and leaflets in the crowns and in leaf axils. It can be found in the soil in buried crowns or leaves, or when it has been washed there by rain or irrigation. Affected plants are often stunted and produce poor crops. Often, the only obvious symptom of infection is a loss of production in a part of the strawberry field. The pest attacks a range of plants including several annual ornamentals, ferns, some aquatic plants, and a number of weeds.

These foliar nematodes move from the soil up to the surface of the strawberry plants when free moisture is present. They infect the leaves and the crowns, entering through the stomata. The females lay eggs inside the host leaves. The juveniles that hatch continue feeding on the host cells. The life cycle can be completed within two weeks, with several generations completed per year.

Ms Cobon and Mr O'Neill have demonstrated pathogenicity of the bud nematode on six commercial cultivars. We have shown that the nematode is killed by the application of two sprays of fenamiphos (Nemacur 400 EC®) applied at the standard label rate. We are in the process of completing studies on the phytotoxicity of that chemical to strawberry plants. These studies will assist our efforts to obtain a permit from the APVMA for the use of this product in the nurseries on the Granite Belt.



Jenny Cobon and Wayne O'Neill checking strawberry plants for the presence of bud and leaf nematode.

Table 11. The main characteristics of the bud and leaf nematode (*Aphelenchoides fragariae*), and the crimp nematode (*Aphelenchoides besseyi*). Information provided by Jenny Cobon and Wayne O'Neill.

Feature	Bud and leaf nematode	Crimp nematode
Relative importance in southern Queensland	Widespread in 2010; serious losses on one farm on the Sunshine Coast. This is a new record for Queensland strawberry plants.	Rarely seen in southern Queensland.
Main symptoms of infection	When a plant should be in full production, it is smaller than its neighbours and has few fruit attached. The disease is characterised by stunting and distortion of the fruit and leaf buds.	Plants are compact, with darker green, deformed and sometimes strap-like leaves. Flowering is delayed and the berries small and deformed.
Main habitat	It flourishes in humid, moist or wet areas in the crown of the plant, and can survive for years under these conditions. Carryover from one season to the next may be prevented when the crop is sprayed out with a desiccant before removal of the plastic.	It can survive in the soil from one crop to the next. Commonly found in leaves and leaf litter.
Size	Microscopic, approximately 0.5 to 1.0 mm long.	Microscopic, approximately 0.5 to 1.0 mm long.
Optimum environmental conditions for growth	The life cycle takes 10 to 11 days at 18°C.	The life cycle takes 8 days at 23°C.
Other host plants	A range of ornamentals, including many ferns.	Found in the seed heads of elastic grass (<i>Eragrostis tenuifolia</i>), African love grass (<i>Eragrostis curvula</i>), and green panic grass (<i>Panicum maximum</i> var. <i>trichiglime</i>).
Main method of managing infestations	Use of clean transplants.	Use of clean transplants.

Reducing the incidence of soft fruit rots

Fruit stem-end rot and leaf blotch caused by *Gnomoniopsis fructicola* (previously known as *Gnomonia comari*) affected commercial strawberry producers on the Sunshine Coast in 2008 and 2009, but was not an issue in 2010. This fungus first infects the calyx, with the disease eventually spreading into the fruit as a rot. Seemingly healthy green and ripe fruit are infected. Infected fruit ripen prematurely and turn pale red to brown. They remain firm, but are often invaded by other soft rot pathogens such as grey mould. The fungus is difficult to control, and is favoured by cold, wet weather.

We are hoping to develop better strategies to control this disease. In collaboration with Bayer CropScience, we have generated residue data to facilitate an application for a permit to use prochloraz before the strawberry plants begin to flower and fruit. We are also conducting studies in conjunction with Dr Scott Mattner and Mr Rajendra Gounder from DPI Victoria at Knoxfield, to examine the effect of chemicals applied to the nursery plants.

Grey mould caused by the fungus, *Botrytis cinerea*, was a major issue on the Sunshine Coast in the latter part of the 2010 season, with average losses of about thirty percent across the industry. Losses occurred both in the field and after harvest.

Strategies for the chemical control of soft fruit rots such as grey mould mainly focus on protecting the leaves and the flowers from infection, or reducing the production of spores on infected material. It is generally considered important to apply the fungicides as soon as the plants begin to flower. The currently available chemicals for the control of the fruit diseases include captan (Captan®), pyrimethanil (Scala®), fenhexamid (Teldor®), iprodione (Rovral®), thiram (Thiram®), myclobutanil (Systhane®) and trifloxystrobin (Flint®). However, there are several problems with these fungicides and their current use. Some of these chemicals appear to be ineffective during wet weather, have limits on the number of applications allowed in a season, or may become ineffective in the long-term because of the development of resistance in the fungi.

Bayer CropScience is testing a range of isolates of the grey mould fungus for resistance to the main chemicals used to control the disease. Continuing wet weather during 2010 favoured the disease in many locations on the Sunshine Coast. It is possible that frequent sprays with fungicides, or dimethoate for the control of Queensland fruit fly distributed spores of the fungus.



Symptoms of bud and leaf nematode in a commercial strawberry field on the Sunshine Coast.



Don Hutton (left) checking a commercial strawberry field on the Sunshine Coast for the presence of the bud and leaf nematode.

Profiles of team members



Chris Menzel

Chris, a principal horticulturist, has conducted research for Australian horticultural industries for 27 years, especially on tropical fruit. He is undertaking research to assess the performance of different planting material for the strawberry industry and is also leader of the runner quality project.



Mark Herrington

Mark is a principal horticulturist with DEEDI. He has over thirty years experience in breeding horticultural crops, with direct involvement in strawberry, tomato, capsicum, melon, zucchini, cucumber and pumpkin. Mark has released more than 26 cultivars and breeding lines, and published 90 refereed and conference papers. He leads the subtropical component of the Australian strawberry breeding program, where he is focussing on delivering cultivars accepted by growers, marketers and consumers.



Louella Woolcock

Louella has worked with the strawberry team at Maroochy since 1999, and provides technical assistance to the breeding program. Louella is responsible for the day-to-day operations of the breeding work, including maintenance of the parent material used in crossing, along with the pollination and germination of new seed. She collects yearly data on the yield and quality of the new seedling lines and potential new cultivars, along with information on the performance of the current industry standards.



Lien Ko

Lien is a scientist with a degree in Horticulture and experience in plant molecular markers and tissue culture. She has over 20 years experience in the application of these techniques to improve the production of ornamentals, sugarcane, cereals and tropical fruit. Lien has been instrumental in developing the first genetically-engineered pineapples with blackheart resistance and controlled natural flowering. She is currently involved in the assessment of these new pineapples in the field, and is assisting the strawberry plant breeding team develop new cultivars, and the pathology group to better diagnose plants with lethal yellows.



Jonathan Smith

Jonathan has worked as an experimentalist at Maroochy for more than ten years, supporting research on the biology, ecology and control of pests and beneficial insects in citrus, passionfruit, custard apple, mango and grape. His main focus has been on the control of mites and scales affecting citrus orchards in Queensland, and he has been involved in the evaluation of numerous species imported from overseas to control these insects. Jonathan also has experience in the pests of strawberry fields, having assisted crop consultants working with the industry on the Sunshine Coast. He is working closely with Don Hutton on lethal yellows and other strawberry diseases.



Don Hutton

Don is a senior experimentalist with DEEDI. He has conducted research on plant pathology for over 40 years. Don's primary interest has been in integrated disease management of strawberries where he has developed control strategies for the main diseases, including black spot, grey mould and powdery mildew, and also for managing crown rot in the runner beds. He has assisted strawberry growers adopt soil fumigants that are alternatives to methyl bromide, which was phased out for most sections of the industry in 2005.



Apollo Gomez

Apollo is an experimentalist, and has over 10 years experience in research and development with DEEDI in Nambour and Cairns, and the Commonwealth Scientific Industrial Research Organisation (CSIRO) in Darwin. He has provided technical assistance across a range of disciplines within horticulture, including breeding, propagation, orchard and nursery management, crop protection, diagnostics, quarantine and eradication. Apollo has worked on a variety of crops, including strawberry, macadamia, mango and cashew. Apollo currently provides technical support for glasshouse and field research on strawberry diseases at Maroochy.



Loraine Chapman

Loraine has 20 years experience in publications as a designer, desktop publisher and editor for DEEDI. She has published more than 35 Agrilink crop information manuals and numerous crop field guides on growing and marketing of horticulture crops. Other publications include scientific reports, presentations and CDs for Maroochy research and extension staff. She has also developed web sites, and edited/published agricultural books, manuals and reports for international projects, ICRAF, FAO (United Nations) and the Department for International Development, UK (DFID).



Natalia Peres

Dr Peres has been an Assistant Professor of Plant Pathology at the Gulf Coast Research and Education Center at the University of Florida since 2004. Natalia earned her Ph D degree in Plant Pathology, M Sci degree in Horticulture, and B Sci degree in Agronomy from the Sao Paulo State University in Botucatu in Brazil. Her research and extension programs have focused on improving our understanding of strawberry and citrus diseases. Of particular interest has been the development of models to assist growers in scheduling fungicide applications for the control of major diseases in these crops. Natalia has developed models to predict the development of anthracnose and botrytis (grey mould) in strawberries.

Dr Peres has advised two M S students at the University of Florida and served as a member of the committee for two Ph D students. She has also provided training for many international students and visitors to Florida. Natalia is an active member of the American Phytopathological Society (APS). She is helping Don Hutton and the Plant Pathology team at Maroochy to develop strategies for the control of crown rot and other diseases in strawberries.



Lindsay Smith

Lindsay has been working at Maroochy Research Station as a Technical Assistant since the early 1990s. Initially, he worked on a project examining options for the control of banana weevil borer with Dan Smith and others. For many years, Lindsay helped with research on the control and management of insect pests in citrus, working with Dan, Jonathan Smith and Chris Freebairn. More recently, he has contributed to the strawberry program at the centre, and has been helping with the collection of yield data in trial plots. He has also been assisting with efforts to control the main pests and diseases affecting strawberry crops, including the work on lethal yellows and crown rot.



Mary Grace

Mary has been a Technical Assistant for the strawberry R&D team at Maroochy since 2005. Her main focus has been to help Mark Herrington and Louella Woolcock in the breeding program. Mary has been assisting with the regular harvesting and assessment of the breeding lines, along with the propagation of the new material. Mary has also contributed to the agronomic and plant pathology research at the station.



Warwick Grace

Warwick works as a Technical Assistant to the strawberry program at Maroochy, and has been a member of the team for more than five years. He has been responsible for the maintenance of field and glasshouse plants in the breeding experiments. Warwick has also helped out with the research to improve runner quality and the impact of crown rot and other diseases on strawberry production. Warwick has Certificates in Horticulture and the Application of Chemicals, and enjoys living on the Sunshine Coast where he also does contract mowing and spraying for strawberry growers and others.



Michelle Paynter

Michelle started work at Maroochy Research Station in Emerging Technologies, after completing three month's work experience with the University of Queensland. She graduated in 2007 with a B Appl Sci degree in Environmental and Horticultural Production. Michelle joined the strawberry team in 2008 to provide technical assistance in the breeding program. Her duties at Maroochy include the pollination of selected parents to produce the new breeding lines and germination of the new seed. Michelle is responsible for virus-indexing of the new material and for maintaining the breeding lines that are kept in tissue culture. She has also undertaken research into the screening of new cultivars for their tolerance or resistance to wilt caused by *Fusarium oxysporum*.



Sam Price

Sam graduated from the University of the Sunshine Coast in 2006 with a B Sci degree (Hons in Marine Ecology). He started at Maroochy in 2007, assisting research on the agronomy of persimmon, stonefruit and custard apple. Recently, he joined the strawberry breeding program and has helped assess the two new cultivars Florida Radiance and Parisienne Belle for approval for Plant Breeding Rights (PBRs). Sam is currently investigating various technologies to increase the capabilities of the breeding program.



Sharon Anning

Sharon completed a Dip Appl Sci with the Moreton Institute of TAFE in 2002. After graduating, she worked in a laboratory assisting with studies to improve the production of peanuts. Sharon has been helping the strawberry research team at Maroochy over the last couple of years, mainly working with the plant breeding and pathology groups. This year, she has been responsible for the preparation and analysis of strawberry samples for sugar and acid content.



Jeremy Rousham

Jeremy completed his High School studies in 2008, and has been working at Maroochy for the past year as a casual Technical Assistant to the strawberry research group. Jeremy has been mainly assisting the plant breeding team, and has been helping with the growing, harvesting and assessment of the new selections. He has spent some of his time over the past year preparing and analysing fruit samples for sugar and acids, and for fruit firmness.



Tali Grace

Tali is currently undertaking a school-based traineeship. She is enrolled for a Certificate II in Horticulture at the TAFE in Nambour. Tali likes working outdoors, and has been helping with the strawberry breeding program at Maroochy, assisting with planting, growing, harvesting and assessment of the new lines.



Geoff Waite

Geoff Waite has over 40 years experience as an entomologist. In 2007, Geoff retired from his position at Maroochy, but is still involved in the various strawberry programs at the centre. Over the past few years, Geoff has helped out with the editing and production of the Strawberry R&D Update.



Edward Woolcock

Edward completed his high school studies in 2009, and has been working at Maroochy for the past year as a casual Technical Assistant for the strawberry breeding group. He has been involved in planting, harvesting and assessment of the new selections. Edward has also provided help in the propagation and maintenance of the new planting material. Part of his time over the last strawberry season was spent collecting data on fruit colour, rain damage and fruit shape.

Industry extension

Queensland Strawberry Growers' Association Meetings. Members of the strawberry team attended the industry meetings held in February, May, July and October and provided local growers with an update on project activities.

Strawberries Australia Levy Payers' Meeting. Chris Menzel provided an overview of current and future activities in controlling plant and fruit diseases in strawberry fields. The event was held in Perth, Western Australia in October.

Don Hutton, Apollo Gomez and Jonathan Smith met with representatives of the Queensland strawberry nursery industry in August to develop protocols for the experimental work on crown rot and nematodes.

Mark Herrington and Louella Woolcock participated in the Hilton Masterclass in Brisbane in July. They handed out samples of wonderful fresh berries during the event, promoting the health benefits of the fruit. In October, Mark and Louella visited the Western Australian industry to develop a better understanding of their situation. The group at Maroochy is involved in efforts to develop new cultivars with better disease resistance suited to production in this environment.

Mark Herrington reported to the National Strawberry Varietal Improvement Steering Committee (NSVISC) in February and October where he gave an overview of the latest breeding efforts. Mark also attended *The International Strawberry Conference* at the University of Florida in January 2010. Areas of interest included strengthening the link between the two subtropical breeding programs at Nambour and Wimauma.



Louella Woolcock and Sam Price analysing data from the strawberry breeding project.



Garry Fullelove (left) and Mark Herrington (right) from DEEDI, with Ted Campbell, the Executive Director of the Florida Strawberry Growers' Association.

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Louella Woolcock and Mark Herrington at the Hilton Masterclass in Brisbane in July 2010.

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