

Novel vegetables: Observations on a range of tropical crops grown in West Cornwall

A report on a preliminary investigation

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Introduction

This was a preliminary investigation on the potential of a range of tropical vegetables grown in Cornwall in order to evaluate their suitability for local production. The work was funded by a grant received from West Cornwall LAG, via Farm Cornwall, with the aim of providing information on alternative crops that may assist farmers in West Penwith. The project was intended as a “look see” so as to identify crops that may have commercial potential. It is intended that promising crops would be trialled further, subject to funding.

Crops were trialled at two locations at: Duchy College, Rosewarne; and Polmennor Farm, Heamoor. At the Duchy College site crops were grown under three different production conditions: a greenhouse, a polytunnel and an organically certified field. The site at Polmennor Farm involved a field within the well known and fertile ‘Golden mile’ and in a polytunnel.

Whilst the crops were tested for their cropping suitability, some assessment of “marketability” was also conducted. The term ‘marketable’ has been used in this report with respect to the suitability of vegetables for a large international wholesale market and also, where appropriate, for local vegetable sales, such as door to door vegetable box schemes.

All seeds were supplied by Tozers. The sweet potato slips were supplied by Thomson and Morgan.

List of vegetables grown at Rosewarne

Crop	Site
Amaranth	greenhouse, polytunnel, field
Mooli	polytunnel
Charentais melon	greenhouse and polytunnel
Aubergine	greenhouse
Chilli	polytunnel and field
Dudhi	polytunnel
Karella	polytunnel
Winter squash	polytunnel and field
Pumpkin	field
Borlotti beans	greenhouse and field
Sweet potato	greenhouse and field

List of vegetables grown at Polmennor Farm

Crop	Site
Mooli	Field
Pumpkin	Field
Winter squash	Field
Sweet potato	Field
Karella	Polytunnel
Melon	Polytunnel
Aubergine	Polytunnel
Sweet peppers	Polytunnel

Site details and treatments at Rosewarne

Polytunnel

A recently recovered polytunnel of dimensions 16m x 8m received an initial treatment of Growmore 7.7.7. fertiliser applied at 50g/m². Crops were irrigated using a lay flat seephose irrigation system. All crops except the mooli were planted into black plastic.

Greenhouse

A greenhouse of dimensions 13.2 x 8.6m was used. The greenhouse crops received a pre-planting treatment of farmyard manure applied in a trench and covered with 15 cm of soil and a base fertiliser of fish blood and bone applied at 50g/m². Crops were irrigated using a lay flat seephose and all crops were planted into plastic except for the sweet potatoes.

Field crops

Crops were grown in an area of 12m x 25m located within an established south facing organically certified sloping field following a green manure crop and farm yard manure applied at approximately 10 tonnes/acre the previous year. Apart from the sweet potatoes and beans, all crops were planted into black plastic.

Treatments at Polmennor Farm

The trial field at Polmennor Farm was south facing and received a pre-trial fertility building treatment of horse manure ploughed in November 2010, plus 6cwt/ac of 14:14:21 pre planting. The polytunnel had horse manure rotovated in followed by a 14:14:21 potato fertiliser, spread lightly on the surface. Irrigation was by hand lance into sunken pots.

Amaranth 'Garnet Red'

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Amaranth	Greenhouse	7 April	No harvest	35cm	Thrips
Amaranth	Polytunnel	25 July	No harvest	30cm	none
Amaranth	Field	27 July	No harvest	1m	none

Propagation

Crops were initially sown into a standard seed tray using organic propagation compost in a frost free glasshouse. Germination of seed took place within 10 days of sowing. Plants were pricked out into modules with organic propagation compost on 29 March, 2011. Dates of transplanting are indicated in the table above.

Crop management

In the greenhouse and poytunnel plants were watered 2-3 times per week. Five plants were regularly 'topped' and leaves were harvested from topped and untopped plants on the 7 and 15 June.

There were no field treatments

Plant health

The greenhouse became infested with thrips which affected the more mature leaves of amaranth. Otherwise the crop was trouble free.

In the field one plant died and two did not flourish. This may have been due to the later planting date, more challenging conditions, less water and more wind. The remaining plants were healthy.

Crop production

The crops grown under cover grew very high and eventually needed staking to prevent them from falling over (Photo 1). Regular height measurements were made. On 15 June, the average height of greenhouse plants which had not been topped was 2.3m. The field amaranth grew more slowly and developed a more bushy plant, as opposed to the upright growth under protection (Photo 2).

There was no yield estimates made for this crop, as there were no clear protocols available as to when harvesting should take place in order to meet market requirements. Leaves were harvested and weights taken from five greenhouse plants on 15 June. The weight of marketable young leaves (approximately 7 to 20cm long) from five plants was 0.55kg. The comparable weight of similar sized leaves from plants which had previously been topped was 0.63kg.



Photo 1. 31 May. Amaranth plants cut for leaves and uncut.



Photo 2. Field Amaranth 18 October 2011

General observations

- This plant grows easily under cover and outside.
- Amaranth was susceptible to thrips in the greenhouse but otherwise the crop was problem free. Thrips did not damage new leaves and they were still able to be harvested.

- The cut leaves, although palatable, wilted very quickly and would require cold storage if transported.
- Cutting the tops in the greenhouse plants produced a better more bushy growth.
- Leaves can be harvested continuously with off shoots producing a continual supply of young leaves.
- Amaranth produced copious seed heads which were in demand by the Duchy College floristry department for flower arranging. Local florists may be a secondary market.

Recommendations

- Garnet Red did not appear to be a suitable variety for eating and trials are needed to test other cultivars suited for dual purpose production (for both leaves and seed), such as *Amaranthus cruentas*.
- An alternative cultivar for grain is *A. dubious* and for edible leaves *A. tricolour*. (www.seedsofindia.co.uk and www.realseeds.co.uk)
- The leaves of Garnet Red are bitter. This is not the case with edible varieties. All grain varieties produce edible leaves but seed varieties have a tendency to go to seed faster and the leaves then become bitter (pers.com. Sally Cunningham)
- Amaranth is wind pollinated and hybridises easily. It is not easy to find seed which is true to species and this should be borne in mind if growing different species next to each other.
- A future trial should investigate topping regimes and transport methods.
- At least 2m height should be allowed for if growing under cover.
- Crops should be topped regularly if growing for edible leaves.

Aubergine ‘Calliope F1’

Crop	Site	Date planted	Harvest date	Spacing	Pests and disease
Aubergine ‘Calliope’	Rosewarne Greenhouse	24 May	27 Sept	40-50cms	Thrips Some rot
Aubergine Calliope	Polmennor Farm field	27 May		90cms	
Aubergine ‘Calliope’	Polmennor Farm Polytunnel	26 May		60cms	

Propagation

At Rosewarne, seeds were sown direct into 7.5cm pots in organic potting compost on 21 March 2011 and were ready to transplant 6 weeks later. Twenty plants were transplanted into the greenhouse during the 2nd week of May, 2011.

At Polmennor 15 modules were planted outside and 150 were planted in the polytunnel. They were watered into sunken pots twice weekly but they were not fed during season.

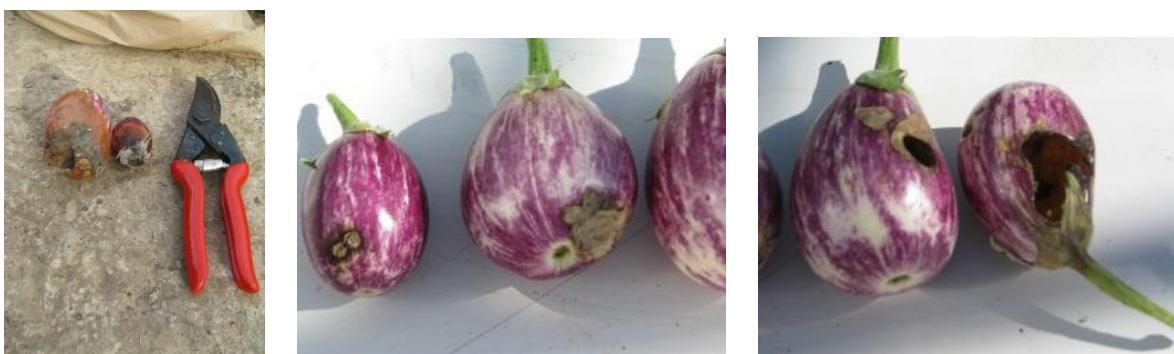
Crop management

The Rosewarne crop was regularly irrigated 2-3 times per week and liquid fed using maxicrop at a dilution rate of 1:200 every 2 weeks from mid-June onwards via the seep hose irrigation system.

Plant health

At Rosewarne:

- The main problem was a Thrip infestation in the greenhouse.
- They were slow to mature into larger sized fruit.
- Their growth pattern was mainly at the bottom of the plant so there were fruit resting on the ground where there was some rot.
- Two were eaten by mice and two had callouses. (see Photos 3-5)



Photos 3-5, L to R aubergine rot, calloused aubergine, mice damage 27 September

Crop production

- At Rosewarne small fruit (<7.5cms) were appearing by 2 August, 2011.
- On the 24 August fruit from ten plants were harvested with the average weight of fruit over 10cm being 223g/fruit.
- A final harvest was completed on 27 September, 2011. 386 fruit were harvested. Of these, 33 (8.5%) were more than 10cm in length. There were an average 19 fruits per plant.
- At Polmennor by mid-August the plants were flowering but not setting fruit.

General observations

- In terms of edibility, a simple taste test found that the fruit were watery and more bitter than the varieties commonly sold.
- As they matured, the fruits turned a creamy yellow losing their bright crimson stripe. Although the literature described them as being creamy colour it was not ascertained at what stage they should be harvested as there was considerable variation in the colour of fruits as they matured (Photos 6-9).
- When the fruits are yellow they are over ripe and tend to go bitter.
- There is conflicting information regarding the size of mature fruit. The identified market requirement seems to be for fruit larger than 12cm but the literature describes them as being mature at 10cms or possibly even less.



Photos 6-9. L – R showing large fruit >12cm on 15 September, colour variation on 28 September, harvest of small fruit on 28 September and 7 October, 2011

Recommendations:

- The crop would benefit from earlier planting to take full advantage of the growing season.
- The plants should be staked to avoid plants trailing on the ground, fruit rotting and for ease when harvesting.
- They fruits should be harvested as soon as they are coloured and shiny - there needs to be further investigation with regard to size of fruit in relation to harvesting.
- It is important to maintain a high temperature under cover to help the flowers set and fruit develop.
- Market requirement is for them to be pink and white striped.
- Ideal weight for the market is between 340 -450gs. They also need to be as uniform in weight as possible rather than a range of weights in the same box.
- There are other varieties sold in retail markets which should be investigated.

Borlotti Beans 'Adone'

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Borlotti beans	Rosewarne Greenhouse	7 April	18 July	30cm	Thrips Some mould on pods.
Borlotti Beans	Rosewarne Field	11 July	17 August	40cm	Failed to thrive

Propagation

Initially seed was sown direct into 7.5cm pots into organic potting compost on 23 March, 2011, with a further sowing some weeks later. They were planted out into the greenhouse on the 7 April.

Crop management

In the greenhouse, the crop was sprayed for Thrips. The crop received no other management inputs after planting.

Outdoors, the cropping area was treated with slug pellets pre-planting and transplants were planted into bare ground. During the growing season they were hand-weeded on three occasions.

Plant health

- The plants were badly affected by Thrips in the greenhouse (Photos 11 and 12).
- Some pods had become too wet and developed mould (Botrytis)

Crop production

Under greenhouse conditions:

- The yield was considered to be good and commercially viable;
- There was an average of 4.8 beans in a pod;
- The average pod weight was 3.6g; and
- Approximately 17% of the crop had botrytis.

Outdoors, the yield of the crop was poor and yield and quality were below that expected for commercial production. This result does not suggest that the crop is not viable outdoors as there were extenuating circumstances.



Photos 10 and 11. Green Borlotti beans and Thrip, 31 May 2011

Conclusions

- The crop grown indoors was successful and the produce was of good quality.
- The identified market is for green beans still in the pod. The greenhouse beans were harvested too late for this but it would not be difficult to achieve a green crop.
- A judgement on the suitability of the crop for outdoor production could not be made on the basis of the results from this trial.

Recommendations

- Conduct a further trial for growing outside with successional planting from late April/early May (use of fleece for early plantings may be beneficial).

- Beans growing under cover need lifting up from the floor to prevent them going mouldy.
- Careful ventilation if growing under cover should reduce Botrytis. Achieving a balance between good ventilation and heat retention is important.

Chilli ‘Caribbean Antillias’

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Chillis	Rosewarne Polytunnel	6 July	No harvest	20-30cms	Some leaf curl
Chillis	Rosewarne Field	14 July	Crop failed	20cms	Failed

Propagation

The crop was sown on 21 March 2011 into modules in a frost free glasshouse and planted out in a polytunnel on 6 July and outdoors on 14 July, 2011.

Crop management

There were no management inputs to the crop grown in the polytunnel or outdoors.

Crop health

There was a small amount of leaf curl and possible aphid infestation detected in the propagating glasshouse but it was not considered a problem.

Crop production

Crops planted in the polytunnel produced a reasonably heavy crop of fruit although these were not ready for harvesting at the time of writing. Chillis started to appear in September (see photo 12) just turning orange by 1 November, 2011.

The outdoor crop was a failure, with plants struggling to survive and no fruit being produced. Outdoors, the crop had died by 17 August. They were not suited to the more challenging conditions and with a lack of water they failed to thrive.



Photo 12 Polytunnel chillis 28 September

Recommendations

- The evidence from the trial would suggest that this variety would be a viable crop if planted earlier in the season under cover with a targeted planting date early May when risk of frost is past.
- Outside they need be in a position which is sheltered, in full sun and watered if necessary.
- An alternative variety to trial for outdoor cultivation could be Bird Pepper chilli.

Dudhi (variety unknown)

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Dudhi	Rosewarne polytunnel	6 July	27 October	2m	Mildew
Dudhi	Polmennor polytunnel	NA	NA	NA	

Propagation

At Rosewarne seeds were sown into pots on 9 May 2001 in a frost free glass house. Germination was very slow. Of the 13 seeds sown, 10 (77%) germinated. Plants were planted out into a polytunnel on 6 July, 2011.

At Polmennor 15 Dudhi were planted outside but were very slow to grow and by 16 August four had survived.

Crop management

The Dudhi in the Rosewarne polytunnel were watered regularly (2-3 times per week). Apart from this there was no management.

Crop health

At Rosewarne, powdery mildew initially seen on winter squash also appeared to a lesser extent on the Dudhi. There were no pests observed.

Crop production

At Rosewarne the crops were grown in the same environment as winter squash plants grown as part of the same trial. Images of the crop at various stages of development are shown in Photos 13,14 and 15. The growth habit of the squash was such that they partly smothered the Dudhi plants. However, four plants were not affected and these produced six large gourds. Five of these are shown in Photo 16, with the sixth being sent to a London market for identification and quality testing.

- The gourds were harvested on 27 October, 2011.
- The weight of gourds ranged from 1.02 - 2.07kgs.
- The length of gourds ranged from 14.4 – 18.5cm.



Photos 13-15 indicating stage of development of Dudji plants on 9 August 2011, 15 September 2011 and 18 October 2011

The variety grown at Rosewarne was sent to a London market for quality assessment with the response being that this was not the variety required by that particular market. Further, the variety was unfamiliar to that particular market and was thought to be *Benecasia hispida* (syn *B. cerifera*), also called winter melon, tungqwa, wax gourd or ash gourd.



Photo 16 (right) Five Dudhi gourds harvested on 27 October 2011

Recommendations

- Trials should be conducted on the “true” Dudhi, *Lagenaria siceria*, also known as calabash or bottle gourd. It is understood that these taste differently, bleed a reddish juice when the fruits are cut and store well. These are apparently prolific with an established market within certain domestic Asian communities. An alternative variety ‘*Sepente di Sicilia*’ has been recommended (Sally Cunningham, personal communication). Source from www.seedsofindia.com and www.seedsofitaly.com.
- Achieving a balance between good ventilation and heat retention is important under protected cropping conditions;
- Future trials should include growing the plant up a trellis with earlier planting.

Karella (variety unknown)

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Karella	Rosewarne polytunnel	12 July	27 October	1m	Caterpillar
Karella	Polmennor field	6 June		1m	

Propagation

At Rosewarne thirteen (13) seeds were sown into separate pots on 9 May, 2011 in a frost free glasshouse. All seeds germinated approximately one month later. Transplants were planted into a polytunnel on 12 July, 2011.

At Polmennor fourteen (14) Karella were planted outside but they did not thrive. 11 were bought into the polytunnel where eight survived and produced some small fruit by 16 August.

Crop management

At Rosewarne, the crop was allowed to trail along the ground without any support (Photo 17). It was irrigated 2-3 times per week. The crop was grown alongside melon plants which smothered the karella plants (Photo 18).

Plant health

At Rosewarne, there was insect damage of leaves but not to the extent where growth and yield were affected (Photo 19).

Crop production

At Rosewarne:

- Flowering began by August 10, 2011.
- Small fruits were developing by the 23 August.
- The Karella plants started to flourish towards the end of September, following the removal of melon plants growing close by.
- Fruit left on the vine in the heat had a tendency to go soft
- Fifteen (15) Karella fruit were harvested on 27 October, 2011
- Of the 15 harvested, one was rotten and two were curled and not very big.
- Total weight of harvest was 2.42kg
- Length range of fruit was 16.7 to 24.5cm (see photo 20 and 21).
- At harvest, 49 small fruit >1.5cm were still growing on the vines.
- An additional Karella weighing 0.29 kg, length 22cm, was sent for market approval on the 20 October, 2011. This sample was deemed as being “perfect”.



Photo 17 Karella plants trailing on plastic covering on 9th August 2011



Photo 18 Karella and melon plants on 9th August 2011



Photo 19 Evidence of unidentified insects feeding on Karella plants on 22 September 2011



Photos 20 and 21 Harvested Karella fruit (18 Oct 2011)

Recommendations

- Karella appear to be well suited to growing indoors.
- An early planting is required to take full advantage of the growing season.
- Growing the Karella up a trellis would have improved management and harvesting.
- Although mildew was present in the polytunnel, Karella was not affected badly until late 2011 after the harvest.
- Care needs to be taken that it is not grown in close proximity with more competitive plants like melon and winter squash.
- Achieving a balance between good ventilation and heat retention is important .
- Harvesting regularly promotes fruit development and would help prevent rotting/splitting.

Melon Charentais MEL10

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Melon	Roswarne greenhouse	7 April	18 July	1m	Thrips, Mildew
Melon	Rosewarne field	7 June	Crop failed	1m	Slugs, wind damage
Melon	Rosewarne polytunnel	12 July	26 Sept	1m	Mildew
Melon	Polmennor polytunnel	27 May	NA	60cms	
Melon	Polmennor polytunnel	27 May	NA	90cms	

Propagation

At Rosewarne, an initial crop was sown in modules on 21 March in a frost free glasshouse and germinated seven (7) days later. Plants were transplanted out to the greenhouse and a second sowing one month later was sown under field conditions and in the polytunnel (Photo 22).

At Polmennor, 15 were planted in the polytunnel.

Plant health

- In the Rosewarne greenhouse crops were affected by thrips (photo 23).
- In the Rosewarne polytunnel crops were also affected by powdery mildew
- Also at Rosewarne, outdoor crops did not flourish and wind.



Photo 22 Chanterais melons growing in plastic in a polytunnel

Crop production

By 15 June there were small fruit being produced in the polytunnel at Polmennor.

Experiences at Rosewarne showed that this crop produced a large quantity of green vegetation trailing over a large area and, in the polytunnel, smothered plants growing alongside to an extent (Photos 24 & 25). In the greenhouse, a total of 12 fruits were harvested between 18 July and 3 August 2011, with an average weight of 0.54kg per plant.

In the Rosewarne polytunnel, a total of 36 fruits were harvested on 26 September. These had not ripened sufficiently and were small in size (average weight 0.4kg, diameter 8.4cm) (see Photo 26 showing harvested melons and Photos 27-31 showing the planting area).



Photo 23 Mildew on Chanterais melon leaves (September 15, 2011)



Photo 24 growth of melons in a polytunnel (August 9, 2011)



Photo 25 Melon smothering Karella (17 August)



Photo 26 Harvested Chanterais melons grown in a polytunnel (28 September 2011)



Photos 27-30 (L-R) Melon plants growing under greenhouse conditions on 6 June, 15 June, 7 July & 18 July 2011

Yield from the Polmennor polytunnel were approximately 2-3 fruit per plant.

Regarding crop quality, the flavour of melons grown in the greenhouse was considered to be passable/good. However, the flavour of the smaller melons grown later in the Rosewarne polytunnel was considered to be poor even when left to ripen off the plant in the greenhouse. The melons grown at Polmennor Farm had a good sweet flavour.

Recommendations

- The flavour was variable and this is a problem with Charentais melons generally. Further trials are required to test for reliably good flavour.
- Melons can be grown outside but they need a rich soil, the right spot to grow in and a good summer.
- Melons should be sown and planted early to allow them to reach their full potential.
- When grown in polytunnels, ensure good ventilation whilst maintaining heat.
- Charentais melons are considered to be of potential commercial value as a protected crop. They grew well outside at Polmennor and also in the greenhouse at Rosewarne. The soil and aspect at Rosewarne were not so suitable and consequently they did not do so well. Care needs to be taken when deciding where to site them.
- Other varieties which could be trialled for flavour are Troubadour (fusarium resistant), Halls Best Jumbo (good under cover) and Petit Gris de Rennes (might be better suited for weather in the SW. Has been grown in Yorkshire – pers.comm, Sally Cunningham).

Pumpkin ‘Rouge detamps VIF’

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Pumpkin	Rosewarne field	7 June	28 Sept-18 Oct	1m	Slugs, wind damage
Pumpkin	Polmennor field	19 May		1m	Powdery mildew, Fruit rot

Propagation

At Rosewarne, thirty seeds were sown into pots in a frost free glasshouse on the 9 May, 2011, of which 21 were transplanted into plastic mulch in a field.

Plant health

- The plants in the Rosewarne field were badly affected by wind and slug damage, only 3 plants survived.
- These produced small fruit which had a tendency to rot and did not reach maturity (Photos 31-33).
- At Polmennor the pumpkins grew well and developed a solid canopy. However an inspection on 16 August found powdery mildew and fruit rot.



Photos 31-33 Showing pumpkins producing small fruit which tended to rot and were affected by slug damage

Crop production

The plants that survived the field conditions at Rosewarne were flowering in August and went on to produce fruit. Between 28 September and 18 October, 2011, three fruits were harvested at a weight ranging from 1.9 to 3.9kg (Photo 35) and of a diameter 21.5 to 26.5cm. At this time, other smaller fruits were left on the plants still developing (Photo 34).



Photo 34 Outdoor pumpkin plants (15 September)



Photo 35 Outdoor pumpkin ready for harvest (18 October)

Recommendations

- Slug control may be necessary under high risk, particularly during the initial stages of growth.
- The addition of extra manure may be beneficial.
- The crop should be planted sufficiently early, during early/mid May, once risk of frost has passed, to ensure fruits have an opportunity to ripen.
- It is recommended that other varieties are tested, such as Crown Prince and Queensland Blue, and Marina di Chioggia (pers.comm Sally Cunningham).

Winter squash ‘Musquade de Provence’

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Winter squash	Rosewarne field	5 June 14 July	11-18 Oct	60cms	some slug damage fruit rot
Winter squash	Rosewarne polytunnel	6 July	27 Oct	1m	Powdery mildew Fruit rot
Winter squash	Polmennor Field	19 May	NA	1m	Powdery mildew, fruit rot

Propagation

At Roswarne thirty five (35) seeds were sown into pots in a frost free glasshouse on the 9 May, 2011. Twenty three plants were transplanted out under field conditions on 5 June, 2011. A further 17 seeds were sown on the 16 July and planted out under field conditions (9 plants) and in a polytunnel (7 plants).

Crop management

The outdoor crop at Rosewarne was irrigated during establishment and was then rain-fed (Photo 36). The crop grown in the polytunnel was watered two to three times a week using a seep hose lay flat irrigation system. The polytunnel crop wilted very quickly when it did not have enough water. Growing tendrils were cut off periodically to encourage existing fruit growth. This did not seem appear to check growth overall.



Photo 36 Winter squash outdoors in plastic mulch

At Polmennor, the squash were not watered or mulched relying on the initial fertility building treatments pre planting. They grew well, developing a thick canopy.

Plant health

The first field planting at Rosewarne was severely affected by slugs and wind and only six plants survived. The second field planting was more successful as slug pellets (organically approved) were applied. A number of fruits in the field suffered fruit rotting and subsequent slug attack (see Photo 37).



Photo 37 Slug damage on winter squash

In the Rosewarne polytunnel all plants developed powdery mildew but this did not stop their growth. A number of maturing fruits rotted.

At Polmennor they grew well producing many fruit, some of which developed powdery mildew and some of the fruit rotted.

Crop production

By 22 August, 2011, the crop at Rosewarne was flowering and fruiting and there was significant growth of foliage. Production in the polytunnel was much better and more vigorous than that achieved outdoors at Rosewarne.

The fruit rot both in the polytunnel and at Polmennor field was aided by a combination of a humid shady microclimate, produced by the thick canopy of leaves, and dull July weather. Botrytis may have been an underlying problem with a build-up of spores in the soil after three years of dull summers (pers comm. Sally Cunningham). The problem can be mitigated by clearing leaves away from developing fruit so they get full sun.

In the field at Rosewarne

- Between 11 October and 18 October, 2011, seven (7) squash were harvested, of which 6 were considered marketable.
- The weight range was 2.9kg to 11.4kg, with the average weight being 5.7kg.
- On the 16th November a further 13 squash were harvested with a weight range of 0.2kg to 4.1kg
- The harvested squash ranged in diameter from 8.2cm to 24.4cm (Photos 38 and 39).



Photos 38 and 39 Winter squash grown outdoors on 15 September and 28 October, respectively

In the polytunnel at Rosewarne

- By August 2011, the winter squash in the Rosewarne polytunnel had spread over the neighbouring Dudhi crop to a width of 3m. It was cut back but by October had re-grown to 3m width again (see photos 40-43 showing growth pattern).
- On 27 October, 2011, 13 fruit were harvested of which 6 were considered marketable.
- The weight range of marketable fruit ranged from 5.63 to 9.99kg, with a diameter range of 28.4 to 34.5cm (Photo 44).
- A further twelve small fruit (less than 5cm) were still growing on the plants at the end of the monitoring period.
- Information from the seed company suggested that this variety matures as orange. The trial fruits were green, with a prominent yellow area where they fruits rested on the ground (Photo 45). This may be a consequence of not having enough sun to enable ripening.



Photos 40-43 Images showing rapid growth pattern of winter squash under protected cropping conditions (from L-R: on 9 August 25 August, 6 September, 15 September)



Photos 44 & 45 Maturing winter squash (polytunnel, September 28th and ready for harvest, October 27th, 2011)

Recommendations

- The crop is suitable for outdoor and indoor production.
- The crop should ideally be sown in late April for a late May planting in order to take full advantage of the sun during the summer months to enable ripening.
- Apparently, this squash should ripen off the vine if kept at room temperature and be ready to eat around March, April (pers. comm. Sally Cunningham). Further trials need to be conducted to explore storage options.
- The crop trails over a large area and this needs to be considered when planning planting density and cropping area.
- The heavy fruit does not make this plant suitable for trellising.
- Some fruit grew to a large size and in some cases became too large whilst remaining unripe, thus potentially limiting their market value. Careful harvesting by weight, size and ripeness is required, according to market requirements.
- Powdery mildew is a challenge but did not appear to affect its ability to grow, spread and produce fruit.
- Source and trial other varieties more suitable for less sunny climates.

Mooli radish

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Mooli	Polytunnel at Rosewarne	12 July	27 October	Hand sown & thinned	Slugs, Rot, Cabbage white caterpillars
Mooli	Field at Polmennor	August under fleece	Successional harvesting in September	5cms	Cabbage root fly, Slight skin damage by slugs.

Propagation

At Rosewarne the Mooli radish seeds were hand sown to a depth of 1.0 cm in a single strip into bare ground in a polytunnel on 12 July, 2011 and germinated 10 days later on 22 July (Photo 46).

At Polmennor they were drilled directly into the ground, once on 6 June and again on 15 August.

Crop management

At Rosewarne, the ground was cultivated to a depth of 25 cm. It was irrigated using a lay flat seepage irrigation hose, apart from an area 2m long which received no irrigation (top of Photo 47). The crop was thinned once and was watered 2-3 times per week.

The crop at Polmennor was planted in August under fleece and did well. When the fleece was taken up in September the mooli subsequently put on a lot of growth. However, they were still susceptible to cabbage root fly at the end of the summer in places where the fleece had blown up. The carrot sized roots were of sufficient size and quality to be sold within a vegetable box.

Plant health

- At Polmennor an early crop planted on the 6 June failed due to flea beetle attack.
- During the growing season, the mooli in the Rosewarne polytunnel suffered an infestation of cabbage white caterpillars, although production did not appear to be unduly affected.
- A proportion of the radishes suffered splitting, which suggest issues associated with irregular irrigation;
- Some of the specimens grown at Rosewarne rotted in the ground, and this may have been due to the crop being over watered and a later harvest. Rotting was minimal at the first harvest on 22 September, 2011.

Crop Production

The growth stages of the mooli crop at Roswarne are shown in Photos 46-48.



Photo 46, 47 and 48 Mooli crop at post-germination and on 25 August and 22 September, 2011

The crop was harvested twice, on 22 September and 27 October, 2011. On 22 September, 3 lengths of 1m each (3x1m) were harvested producing 73 radishes with a total weight of 21kg (Photos 49-51). Of these, 33 (45%) were considered to be of marketable quality, weighing 16kg, equivalent to 71% of total harvest. These ranged in length from 25 to 40cm. Five (5) of these weighed more than 1kg each.



Photos 49, 50 and 51 Harvested Mooli radish (L-R non-irrigated to well-watered)

In between first and second harvest the crop was watered well to try and boost production, but leaves started to die back and rot set in amongst the large roots (Photo 52).

On 27 October, 2011, a final harvest produced 52 mooli, weighing 9.3kg. Of these, only 11 (21%) were considered marketable, ranging in length from 11 to 23cm (Photos 53-55). Of the unmarketable, 37% had rot, 32% had slug damage, 20% were split, 18% were very small and 16% were misshapen. Some were split, rotten and/or had slug damage. The mooli produced on both sites were crooked in shape.



Photo 52 Mooli showing leaf die back



Photos 53-55 Final mooli harvest showing 'marketable' roots produced under dry to very wet conditions (L to R) on 27 October, 2011

At Polmennor a trial sample of 9 roots were lifted on the 19 October. Length ranged from 28 to 51.5 cm, weight ranged from 0.42g-1.5kg. Two were split. A 2m strip produced approximately 25kg including 2-3 large specimens weighing 4-5kg each. There was slight skin grazing by slugs which did not seem to affect marketability.

From the experience at Rosewarne, it appeared that as the crop grew, competition between roots resulted in samples being pushed out of the soil making them susceptible to rot

Recommendations

- Mooli is best suited to deep soils allowing deep rooting as the market requirement is for long, straight roots.

- The mooli produced on both sites were crooked in shape, which is a product quality issue, although out-grades should be suitable for less exacting local markets.
- The long roots were easily damaged due to their length and need special boxes with solid floors to support them during transport.
- The issue of snapping is also an issue when harvesting.
- Trial the mooli in ridges to improve depth of soil and length of root. This may also ease harvesting.
- Successional sowing would improve supply and quality.
- The proximity of planting was a problem and prevented straight growth limiting the number of marketable roots. A suggested spacing regime for a future trial would be sowing one bed of 4 rows every two weeks, approximately 23cms apart and 10 cms apart in the row. For field scale production this could be done with a drill.
- The crop would require protection from cabbage white butterfly and flea beetle if grown outdoors e.g fleecing
- Hand-sown crops should be thinned rigorously to 10 cms apart to avoid distortion of roots through competition.
- Watering under cover has to be frequent but with care to prevent rot and splitting.

Sweet Potatoes (Beau Regard, Georgia Jet and T65)

Crop	Site	Date planted	Date harvested	Spacing	Pests and disease
Sweet potato Beau Regard	Rosewarne Greenhouse	24 May	29 Sept 17 Oct	25 x 60cm	None
Sweet potato Beau Regard	Rosewarne Field	13 June	No harvest	45 x 60cm	None
Sweet Potato Georgia Jet	Rosewarne Greenhouse	24 May	29 Sept 17 Oct	25 x 60cm	None
Sweet Potato Georgia Jet	Rosewarne Field	13 June	No harvest	45 x 60cm	None
Sweet potato T65	Rosewarne Greenhouse	24 May	29 Sept 17 Oct	25 x 60cm	None
Sweet potato T65	Rosewarne Field	13 June	No harvest	45 x 60cm	None
Sweet potato Georgia Jet	Polmennor field	3 May	Trial harvest	40 x 100cm	None
Sweet potato Beau Regard	Polmennor field	3 May	Trial harvest	40 x 100cm	None

Propagation

At Rosewarne three varieties (Georgia Jet, Beau Regard and T65) were planted out directly as 'slips' into two rows in the greenhouse on 24 May, 2011 at a depth of 15cm. The soil had received 10:10:10 base fertiliser applied at 75g/m². An outdoor crop was planted on 13 June, 2011.

At Polmennor, two varieties (Georgia Jet and Beau Regard) were planted outside on the 3 May, 2011.

The information on sweet potatoes was supplemented by information from a crop grown at third site located at Millpool, near Goldsithney, in the bottom of a valley where the soil conditions were good. These were grown outside and planted through black plastic.

Crop management

At Rosewarne, in the greenhouse the crop was irrigated 2-3 times per week during most of the growing period. There were no other management inputs.

There were no crop inputs at Polmennor.

Plant health

There were no pests, weed or disease problems observed or reported at Rosewarne. At Polmennor there was evidence of slug damage to tubers in Beau Regard but none in Georgia Jet.

Crop production

The greenhouse crop at Rosewarne and the field crop at Polmennor were successful with a good yield of tubers. The outdoor crop at Rosewarne failed with only small root-like tubers being produced. At Millpool they grew a couple of inches and were ultimately grubbed out.

The most noticeable feature of the growing crop at Rosewarne was the large distance covered by the foliage in the greenhouse, with the crop spreading horizontally for approximately 3m out from the planting row in the greenhouse and covering an area much larger than anticipated (Photos 56 and 57). In the field at Polmennor the crop cover did not spread so extensively. The yield produced at Rosewarne was perhaps lower than its potential as it was lifted earlier than recommended in the literature. At Polmennor the leaves on the Georgia Jet variety were just beginning to go brown by 4th November but the leaves on Beau Regard were still green. All the leaves were green in the Rosewarne greenhouse throughout the growing period.

Preliminary yield assessments were carried out at Rosewarne. A 2m strip was harvested on September 29, 2011 for each variety. At this stage it was obvious that the crop was still producing. There were many small roots left which would potentially have developed into tubers.

On the 19 October Polmennor harvested a trial of two varieties, Beau regard and Georgia Jet. A second Rosewarne harvest on October 27, 2011 was completed on a 1m strip for each variety. The results of the harvest monitoring showed that on both occasions the

variety Beau Regard was the heaviest cropper and produced more tubers. The results are shown below



Photo 56 (left) Sweet potatoes in two rows on 23 June 2011

Photo 57 (above) Sweet potatoes showing dense growth habit on 25 August 2011

	Georgia Jet	Beau Regard	T65
Rosewarne 28/09/11			
16 plants produced:			
No of marketable tubers	19	35	14
Combined weight of marketable tubers	3.0kg	4.8kg	4.1kg
No. of small tubers	56	12	12
Rosewarne 17/10/11			
8 plants produced:			
Total no. marketable tubers	19	na	24
Combined weight of marketable tubers	1.4kg	4.9kg	3.1kg
Max length marketable tubers	19cm	30cm	28cm
No. potentially marketable but small & developing tubers	32	na	14
Rosewarne 27/10/11			
8 plants produced:			
Total number of marketable tubers	11	17	11
Total weight marketable tubers	3.0kg	5.4kg	3.4kg
Length range marketable tubers	10-20cm	9-32cm	10-28cm
Number of small tubers and roots	48	27	25
Weight of small tubers and roots	1.4kg	1.4kg	0.9kg

These estimates indicate that the variety Beau Regard had the greatest yield potential, producing in a 1m strip at Rosewarne 2kg more than the other varieties. These results are preliminary and would require verification via further testing with follow up trials.

The tubers yielded from each variety at Rosewarne are shown in Photos 58-60. These indicate that tubers produced from the lower yielding varieties tended to be rounder, with Beau Regard producing longer, thinner tubers. At Polmennot and Rosewarne tuber shape was affected by soil depth.



Photos 58-60 (L-R) Sweet potato varieties Georgia Jet, Beau Regard and T65 harvested from a 1m strip.

Recommendations

- Whilst the crop grown under glass at Rosewarne and at outdoors at Polmennot produced viable and comparable yields suggesting that under Cornish conditions the crop has some commercial potential, experiences under field conditions over the last three years in the UK suggest that the very few crops planted are successful (pers comm Sally Cunningham).
- Sweet potatoes require good fertility and if grown outside they need a sheltered location.
- West Cornwall is characterised by micro-climates. Further trials are needed to test the crop under a range of these micro-climate conditions, soils and harvesting dates as well as the use of fleece in early summer for outside growing.
- Trials are required to test whether growing in ridges can influence tuber shape, and in particular straightness.
- Whilst the T65 cultivar has apparently been developed to suit UK conditions, preliminary quality tests indicate that it is of inferior quality, producing an unattractive grey/white flesh colour when cooked and having an uninteresting flavour. On the basis of this preliminary trial, the T65 variety cannot be recommended.
- Apparently, the ideal marketable weight is 340-400 grams and this should form the yield basis upon which further trial results are measured.
- Other varieties, such as the apparently sweeter 'Oh Henry' should be trialled outdoors under Cornish conditions.

Summary

This project has been a preliminary trial and the results and recommendations require further validation. However, the observations made provide good indicative results that should inform further work. All of the crops tested produced fruit, although this varied between species and varieties with regard to quantity and quality. Some of the varieties chosen for the trial proved to be unsuitable with regard to their marketable quality. Further trials are required to test other varieties.

One of the main issues that emerged was the differences in results achieved between crops grown outdoors and those grown in a polytunnel or greenhouse, with the latter producing growing conditions akin to the tropical humid climates to which many of the tested crops are well suited. In order to further test crops showing good commercial potential, further trials need to consider the very specific micro-climates that exist in Cornwall. Sweet potatoes grown outdoors at Polmennor were successful whereas those grown outdoors in the more exposed fields at Rosewarne were not. Local and field micro-climate is likely to have been a significant influential factor.

With regard to protected cropping, there is a particular requirement to ensure that ventilation is optimal so as to maintain high temperatures without creating conditions conducive to the build up of diseases such as mildews. The aubergines at Polmennor did not set due to the polytunnel being too cold whereas they produced a good crop under the hotter conditions in the greenhouse at Rosewarne, which also had good roof ventilation. The challenge is to provide good ventilation without losing heat.

Date of planting proved to be of significant importance and a consistent recommendation was for early planting of crops as soon as frost risk has passed and late harvesting to ensure a prolonged season and to enable crops to reach maturity. Protected cropping in a polytunnel or greenhouse offers much greater flexibility in this respect, but for some crops such as sweet potatoes and pumpkin and squashes that produce large amounts of vegetation, space is likely to be an important economic constraint.