Improving Australia's competitiveness in the Mauritius export seed market

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Southern Packers

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Contents

Mauritius is expanding its potato production with the help of Australian seed. This project aimed to improve the competitiveness of Australian seed potatoes in this international market. Potato crops grown from Australian seed potatoes in 2011 flourished in the fields of Mauritius.

1 Media Summary

Mauritius has been an important market for Australian potato seed with Western Australia being the major supplier in recent years. Mauritius is diversifying its agricultural sector to reduce its dependence on sugar and an important component of this is increased local potato production to reduce imports. Mauritius increased its potato production by 69% from 2005 to 2010 and reduced its imports by almost half. WA seed has been an important part of that expansion. For example, seed exports from WA steadily increased from less than 1000 tonnes to more than 2000 tonnes per annum over the same period.

The continued successful expansion of Mauritian potato production depends heavily on the supply of high quality affordable seed. The export seed market is highly competitive and exporters need to make cost savings in the supply chain to retain markets.

Although round (whole) seed is traditionally preferred in tropical countries like Mauritius, cut seed can be used successfully in the cooler planting period of June to July. Cut seed represents increased profits for both the Australian seed exporter and Mauritian potato grower. WA exporters will be able to sell a larger fraction of their crop for seed thus reducing costs which will in turn provide benefits for the Mauritian growers.

Trials showed crops grown from cut seed performed almost as well as from round seed. Experimental crop yields from WA seed were at least 30% higher than the average yield of potatoes in Mauritius. This finding was supported by commercial experience in the second year of the project when small growers tested cut seed. It is anticipated that at least 10% of crops on the estates and 20% of the smaller farmers' crops could use cut seed which could result in an extra 200 tonnes of export seed. WA exporters could reduce seed costs if they could sell at least 10% more of their crop as seed rather than as ware or for processing.

A previous project showed cost savings could be made by packing and shipping seed in larger sizes compared with smaller bags. For example crops grown from lower-cost seed packed in bulk pine bins (0.75 t) yielded as well as from seed packed in more expensive mesh (25 kg) bags. As a follow up, this project showed yield of crops grown from seed packed in large ventilated 1.25 t Bulka™ bags was the same as from seed packed in the usual 25 kg woven bags. WA exporters can save $15-20/t due to reduced labour costs in filling the larger bags which will increase their competitiveness and in turn profits for Mauritian growers. Further savings can be made in seed handling in Mauritius using the larger bags. It is anticipated all WA seed used by the sugar estates (two-thirds of production or about 1000 t) could eventually be packed in the Bulka™ bags leading to savings of $15,000 to $20,000 per annum for WA growers/exporters - a good return for a project costing $75,239.

More work with cut seed is needed to expand its use in plantings at all times. There is scope for more improved and efficient use of fungicides as seed treatments for control of *Rhizoctonia* and new fungicides need to be tested in Mauritius.

2 Technical Summary

Mauritius needs to expand potato production and reduce dependence on sugar. WA seed is part of that expansion but WA needs to reduce seed costs to remain competitive in the international market.

This project tested methods for improving the competitiveness of Australian seed potatoes in the Mauritian market. Findings from trials in the first year which had potential to improve the competitiveness of Australian seed were then tested in a series of activities in the second year.

Increased use of cut seed by the Mauritian growers, using a larger fraction of the crop than is exported for round seed tubers, can decrease costs because WA exporters can sell more of their crop. This could also increase the competitiveness and market share for WA seed exporters and increase profits for the Mauritian growers.

Crops grown from cut or round (whole) seed were compared in the field. Yield from cut seed were almost the same as from round seed. This needs to be verified in more detailed experiments but the use of cut seed by small growers in Mauritius in the second year of the project showed growers can be confident about its commercial use. It is anticipated that up to 200 tonnes could be used initially for cut seed by both the sugar estates and small farmers. The market for larger tubers will be for planting in cooler months (June-July) and should be developed by exporters. This increased use of cut seed from larger tubers will enable WA exporters to sell at least 10% more of their crop initially as seed rather than ware or for processing. This will improve market competitiveness and reduce seed costs to growers.

Other work compared a new fresh market variety 'Harmony' with the standard Delaware on three sites at Omnicane, Riche en Eau and Union Estates. It was found that Harmony was not suited to Mauritian requirements. This has led to project proponents seeking alternatives. Fungal and viral diseases limit potato yield in Mauritius and new varieties with tolerance to these diseases, and high market acceptance, need to be evaluated there if the country is to reach its goal of self-sufficiency in potatoes. It is anticipated these will be tested in Mauritius in 2013 and may lead to ongoing variety development work between Australian exporters and the Mauritian industry.

Yield and gross margin of crops grown from different seed sizes were examined. It was confirmed that sowing smaller seed is of no benefit. Both exporters and growers should avoid buying and planting smaller seed to save money if it leads to lower economic returns.

Export of seed in bulk such as 1.25 tonne Bulka™ bags compared with 25 kg woven bags could reduce packing and shipping costs. The quality of WA seed shipped in these bags was compared in the field on two sugar estates in 2010. Crops from seed packed in the Bulka™ bags yielded as well as that packed in the smaller woven bags. This means packing costs for the exporter can be reduced by $15-20/t which should assist the Mauritian grower. As the Bulka™ bags can be used satisfactorily, this mode should be developed for the larger farmers with bulk handling facilities. In 2011 100 tonnes of seed was sent in Bulka™ bags for commercial evaluation and increased to 200 tonnes in 2012. This indicates that this technology is well on the way to being commercially adopted. It is anticipated all seed exported from WA to the sugar estates (up to 1000 tonnes) could be in bulk as handling facilities are available. Further savings are therefore possible in handling bulk rather than smaller bags upon arrival in Mauritius.

Beneficial future work identified included:

- Examination of the effectiveness of fungicide seed treatments for control of *Rhizoctonia*
- Improving the economic efficiency of potatoes in Mauritius and reducing risk of resistance to fungicides through improved fungicide applications by interspersing systemic and locally systemic fungicides with contact fungicides.

3. Introduction

3.1 Historical background

Potato production in Mauritius has increased recently due to a reduction in the European Union quota for Mauritian sugar. This growth in potato production has followed government initiatives to increase diversification of the agricultural sector away from primary dependence on sugar. Production increased 70 per cent in just five years from 12,777 tonnes in 2005 to a high of 21,709 tonnes in 2010 (Mauritian Chamber of Agriculture 2012). This is still about 4000 to 5000 tonnes short of local consumption of 25,000 tonnes per annum but has reduced the country's dependence on imported potatoes from a high of more than 12,000 tonnes per annum in 2005 (see Table 1 and Figure 1).

Table 1. **Production (t), area (ha) and yield (t/ha) of potatoes in Mauritius from 2005 to 2011 (Mauritian Chamber of Agriculture 2011).**

Measure	Year						
	2005	2006	2007	2008	2009	2010	2011
Tonnes	12,777	14,522	15,367	14,868	19,828	21,709	19,650
Area (ha)	599	675	610	648	858	1066	960
Yield (t/ha)	21.33	21.5	25.19	22.94	23.11	20.4	20.47

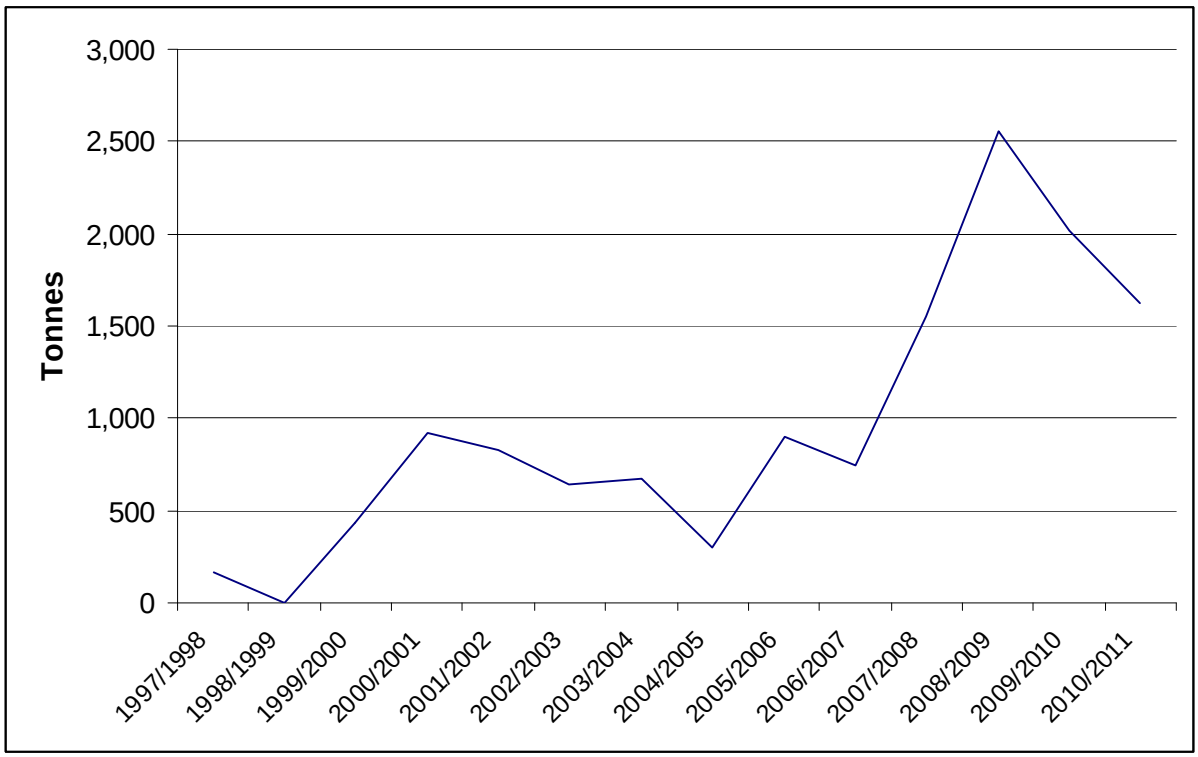

Figure 1. **Exports of seed potatoes from Western Australia to Mauritius from 1997/98 to 2010/11 (Agrifood Infonet Department of Agriculture and Food, Western Australia).**

Australian (mainly Western Australian) potato seed has been an important part of the Mauritian expansion. For example, from 2006 to 2010 the value of seed exports from Australia ranged from $0.98 million to $2.7 million (average = $1.6 million) for 982 to 2386 tonnes (average = 1593 tonnes, ABS). Most (88%) of these seed exports originated from WA which supplied all from 2008 to 2010. Recent growth is due to interest from the large estates.

The main sugar estates such as Omnicane and Riche en Eau are increasing potato production focusing on import substitution. Mauritius sources its seed primarily from Australia and South Africa. The policy of increasing production from 12,777 tonnes in 2005 to a target of 25,000 tonnes to cover current imports has provided a major opportunity for Australia. Figure 1 shows how WA seed potato growers and exporters have benefited from this policy with increased sales.

Project PT06046 *Supporting bulk bin exports of Western Australian seed potatoes to Mauritius* aimed to reduce supply costs by testing bulk bin exports (Thomas 2009). Bulk bins from WA were trialled in Mauritius during 2008 and proved to reduce costs and improve quality through reduced disease levels in the seed crop. However, with bulk exports direct from back-of-the-harvester grading in Australia, larger tubers suitable for cutting will inevitably be sent to Mauritius. It was found that these are not being used for seed as the farmers are wary of cutting seed in tropical conditions where pests and diseases are prevalent.

Research work conducted by DAFWA in Indonesia under HAL project PT02018 *A partnership to build Indonesian crisping potato capacity and Australian seed potato sales* (Dawson *et al*. 2004) and in Vietnam under the AusAID-funded CARD Program (McPharlin *et al.* 2003) has demonstrated that seed can be cut and used in tropical conditions without affecting crop yield and quality if the seed tuber has been stored correctly to maintain vigorous physiological age and the cut surface is effectively sealed by providing conditions suitable for suberisation with chemical prophylaxis against rotting organisms.

3.2 Significance to industry

If it is possible for Mauritian farmers to use cut seed from Australia, this means that Australian seed exporters will be able to sell a larger fraction of their crop for seed, thus reducing their costs and in so doing increasing their competitiveness and expanding the market for Australian seed.

3.3 Aims

The aim of the project was to increase the competitiveness of exports of seed potatoes from Australia to Mauritius. This would enable Australian exporters to increase sales in this growing market. Increased competitiveness will be achieved through reduced seed costs and better adapted varieties. This will be done by conducting trials of:

- cut seed technology which will reduce the cost of seed from Australia
- the performance of Australian-sourced varieties including tropically-adapted varieties.

An additional aim was opportunistically added after the project commenced and this was to:

- evaluate the use of cheaper bulk bags to replace more expensive wooden bulk crates and small woven bags tested in project PT06046.

4 Comparing cut and round seed

4.1 Introduction

Whole potato seed, often called small round seed (SRS), of 25 to 90 g weight (28–55 mm diameter) is the preferred planting material in the warm humid tropical conditions. Cut seed is not normally used as high rates of breakdown from disease infection of seed pieces are considered an unacceptable risk. Similarly in Europe, SRS is widely used as cut seed is seen as too risky (Struik & Wiersema 1999). However, there are many exceptions. For example a survey of growing practices in the Red River Delta of Vietnam showed 30% of seed was cut (McPharlin *et al.* 2003). These were larger tubers cut in order for the farmer to save money. There the seed was only cut once, exposing one surface/piece to ambient conditions. Cut seed is also commonly used in temperate areas of North America and Australia. However, at hotter times of year in these regions SRS is often used. For example in WA SRS is preferred to cut seed in summer plantings on the sands of the west coast.

Even though cut seed is widely used in the cooler seasons of North America and Australia it still needs to be managed properly to prevent breakdown. Cut seed of healthy tubers properly cured and treated with appropriate fungicides yielded as well as untreated SRS of Russet Burbank in experiments in Idaho over five years (Nolte *et al.* 2003). Crops grown from cut seed may yield as well as from SRS in the tropics if the seed is of high quality (vigorous with low disease status) and hygienic cutting practices are used. For example in Vietnam the yield of crops grown from cut, cool-stored G4 certified seed from WA which was cured for three days after cutting, was as high as crops grown from SRS (McPharlin *et al.* 2003).

WA seed potato growers would benefit if export markets could use cut seed. The benefit would accrue from their ability to sell a larger fraction of their crops as seed. For this reason an experiment compared the performance of cut versus SRS WA Delaware seed on sites on two sugar estates in Mauritius in 2010.

4.2 Materials and methods

4.2.1 Seed

Certified G4 seed of Delaware variety grown by Southern Packers Ltd in Manjimup WA was used. The seed was harvested mid-January 2010, then packed and shipped in 25 kg net bags in ‘reefer’ (refrigerated) containers at 4°C which arrived in Mauritius on 18 March.

4.2.2 Storage and treatment of seeds prior to planting

After arrival, the seed was transferred to the Agricultural Marketing Board (AMB) cool store at Moka. Seed for the SRS treatment was 35 to 45 mm in diameter, and larger seed (>55 mm) was cut in two transversely for the cut seed treatment. Seed was removed from the cool store two weeks before planting and stored in a well ventilated location in diffuse light to encourage sprouting. The seed was dusted with Forzeb 80WP (mancozeb 800 g/kg) @ 3 kg/t for disease control. Only sprouted seeds were planted.

4.2.3 Land preparation

The potatoes were grown in full stands, not in sugarcane inter-rows. Soil bed preparation was completed by one pass of a light disc harrow followed by a clod separator to separate the

stones from the clods. Furrows 20 cm wide and 20 cm deep, with a spacing of 80 cm were then prepared.

4.2.4 Experimental design

All plots were four rows wide and 10 m long with three replications and repeated on two sites - Omnicane Sugar Estate near Britannia in the south (57.56.18 E, 20.45.04 S) and at Riche en Eau in the south-east (57.39.20 E, 20.23.50 S).

4.2.5 Planting

Planting was delayed until late May 2010 due to the hot and humid conditions prevailing at the beginning of May, to avoid rotting of cut seed pieces. Treated cut and small round seed (SRS) were planted manually at the same density of 38,000/ha at 2.5 t/ha (65 g/seed piece) or 2.0 t/ha (53 g/seed) for the cut and SRS treatments respectively.

4.2.6 Fertilisation

A compound fertiliser (NPK 15:23:15) was applied at 1.3 t/ha to provide 195, 299 and 195 kg of N, P and K respectively to the bottom of the furrows and covered with soil to avoid direct contact with the potato tubers. Cement was also applied (1300 kg/ha) to minimise soil acidity. Magnesium was applied as $MgSO_4.7H_2O$ at 3 kg/ha and 4 kg/ha 10 and 17 days after planting at 5 kg/ha each week following for six weeks to a total of 37 kg/ha or 3.7 kg Mg/ha.

4.2.7 Irrigation

One day before planting, if needed, irrigation was applied to restore soil moisture to field capacity (10 to 20 mm depending on initial soil wetness). From one week after planting to 50 per cent leaf senescence, water was applied every week s to provide the crop with about 4 mm per day.

4.2.8 Hilling-up

Hilling-up was done about five weeks after planting when the plants were around 25 cm tall. This was to ensure stem bases were covered with soil to avoid exposure to light and attacks by tuber moth.

4.2.9 Weed control

Sencor® was applied at 1 L/ha for weed control. Weeds such as *Solanum nigrum* (brède martin) and *Bidens pilosa* (villebague) are the preferred hosts of leaf miners. Fields were kept free of these weeds at all times to reduce pest pressure.

4.2.10 Pest and disease control

Insecticides were applied to control the main insect pests which were leaf miners (*Liriomyza trololii* and *Liriomyza huidobrensis*), leaf-eating caterpillars (*Spodoptera littoralis* and *Helicoverpa armigera*), aphids and thrips (*Thrips palmi).* Fungicides were applied in rotation such that there was a maximum of four successive applications of the same systemic fungicide, to minimise resistance for control of early and late blight infection (*Alternaria solani* and *Phytophthora infestans* respectively, summarised in Table 2). The active

ingredient of fungicides and insecticides used are listed in Table 3. Crops were harvested after natural senescence and no chemicals were used to spray-off crops.

Table 2. **Fungicide and insecticide program (date, name and rate/ha) for potato crops grown at Omnicane Sugar Estate, Mauritius, 2010 (fungicide mentioned first and insecticide second).**

Application	Date	Chemical (Rate/ha)
1	15/6/10	Dithane M45 (3 kg) + Karate Zeon (600 mL)
2	23/6/10	Infinito 687.5 (1.4L) + Agrimec (260 mL)
3	2/7/10	Infinito 687.5 (1.4L) + Stewart 30WP (130 g)
4	9/7/10	Infinito 687.5 (1.4L) + Patron WP (150 g)
5	15/7/10	Curzate PRO (3 kg) + Agrimec (260 mL)
6	22/7/10	Ridomil Gold MZ68 (1.875 kg) + Patron WP (150 g)
7	29/7/10	Ridomil Gold MZ68 (1.875 kg) + Confidor 200SL (400 mL)
8	5/8/10	Ridomil Gold MZ68 (1.875 kg) + Dicarzol 500SP (400 g)
9	12/8/10	Electis 750WG (1.8 kg) + Stewart 30WP (130 g)

Table 3. **Trade name and active ingredient of fungicides and insecticides applied to potato crops grown at Omnicane Sugar Estate, Mauritius 2010.**

Trade name	Active ingredient
Fungicides	
Curzate PRO	cymoxanil (60 g/kg)+ mancozeb (700 g/kg)
Dithane M45	mancozeb (800 g/kg)
Electis 750 WG	zoxamide 83 g/kg + mancozeb (667 g/kg)
Infinito 687.5SC	fluopicolide (62.5 g/L) + propamacarb-HCl (625 g/L)
Ridomil Gold MZ 68 WG	mefenoxam (40g/kg)+ mancozeb (640 g/kg)
Agrimec 200 SL	abamectin (18 g/L)
Insecticides	
Confidor	imidacloprid
Dicarzol 500 SP	formetanate (500 g/kg)
Karate Zeon 5CS	lamda-cyhalothrine
Patron WP	cyromazine (750 g/kg)
Stewart 30 WP	indoxacarb (300 g/kg)

4.3 Results

There appeared to be no visual differences between the crops of cut and SRS seed throughout the entire growing season.

It was reported that the diseases were light and it is difficult to determine whether this was a direct result of the spray program or weather conditions or both. No weather data were presented from the sugar estates during crop growth. However, the spray program followed a general seven day interval that is indicative of the Mauritius Sugar Industry Research Institute (MSIRI) recommendations for a crop grown in a humid area.

The crop was harvested by hand in October 2010. The two sites were used as replicates in the statistical analysis as data from the individual replicates at each site were bulked into one due to inexperience of the harvesting team.

There was a significantly higher total yield from crops grown with SRS compared with cut seed with respective yields of 28.0 and 26.3 t/ha (Figure 2). The lower yield was 30% higher than the average yield for 2010 in Mauritius (Table 1). The increase in yield of the SRS over cut seed was 6%. However, there was no significant difference in < 50 mm or > 50 mm yield categories (Figure 2). Even though the cut seed pieces were heavier than the SRS, seed this didn't appear to increase yield.

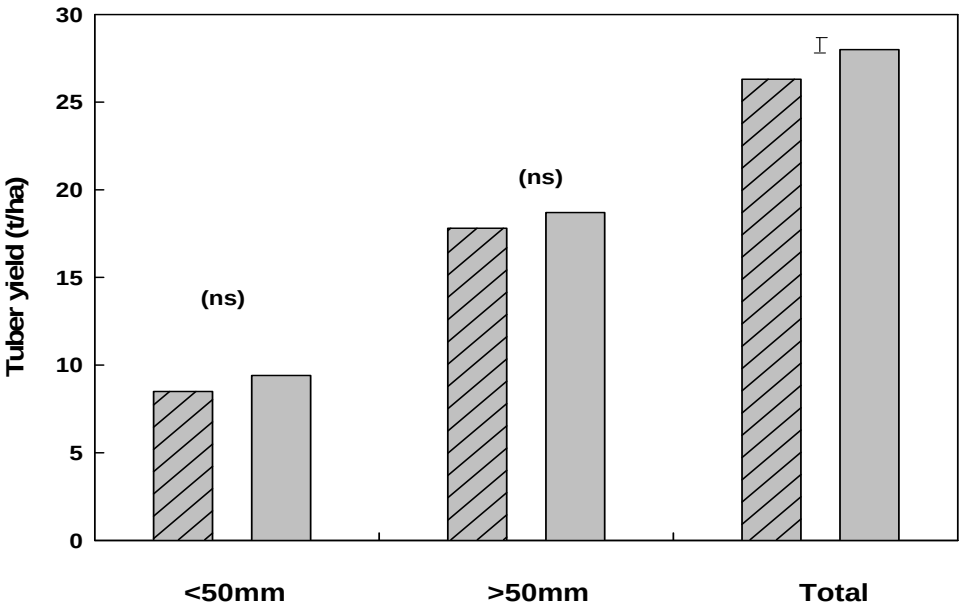

Figure 2. **Total small (<50 mm) or large tuber (>50 mm) yield (t/ha) of Delaware potatoes in Mauritius grown from cut (lined bars) or small round (unlined) WA seed in 2010. Vertical bar shows the significant difference (P < 0.05) in total yield between treatments whereas ns indicates non-significant yield differences in the <50 mm and >50 mm grade yields.**

4.4 Discussion

The yields obtained for both SRS and cut seed at 28.0 and 26.3 t/ha respectively were at least 30% higher than the average 2010 Mauritian potato yield of 20.4 t/ha (Table 1). This shows that despite the lower total yield, cut seed has a role in Mauritian potato production especially as the weather cools and is less humid in late May onwards when seed would cure properly.

The comparison between SRS and cut seed was not conducted properly with appropriate replication on each site as the estate staff found it impractical to follow some of the experimental procedures. Consequently at harvest, yields from individual replicates at each site were bulked together. This meant there was no chance to obtain treatment means and variance and carry out proper statistical analysis. In this experiment cut seed pieces were heavier than the SRS (65 v 53 g on average) and were sown at a higher rate but this did not appear to result in higher yield. It was decided to export ungraded seed where the larger seed (> 55 mm diameter) is selected in Mauritius and used for cutting. In 2010 due to organisational and labour supply only 10-15% of the seeds could be cut.

These results show that cut seed can be used as an alternative to small round seed in Mauritius and this should be retested in more statistically valid experiments or in demonstration plots with a greater number and type of seed treatments. WA exporters should develop this market as it will enable them to sell a larger fraction of their crop and reduce costs to growers. This lower cost should increase their competitiveness in this market as well as increase grower profits. Anecdotally, Mauritian farmers were happy with cut seed but were concerned that the growing season was atypically dryer than normal.

5 Variety evaluation

5.1 Introduction

Potato yields in Mauritius are from 21 to 23 t/ha which is better than some tropical countries such as Indonesia (17 t/ha) but lower than Australia (40 t/ha). Diseases such as late blight, bacterial wilt and viruses (potato leaf roll virus and potato virus Y) limit yield, and new varieties with tolerance to these diseases as well as high market acceptance are needed to improve yield and quality. Growing food crops in association with sugar cane has occurred to maximise production for self-sufficiency, with potatoes being a priority (Julien 1996). The priorities outlined for potato development include breeding for better adaptation and disease development and n improvement of seed quality, with particular emphasis on extending the planting season of potatoes and therefore reducing the time in storage (Julien 1996).

Varieties grown in Mauritius have been developed for temperate climates (Govinden 1996) and therefore varietal evaluations are required. Currently, the main potato variety grown in Mauritius is Delaware, an older variety from California with medium to early maturity. Harmony is a UK variety with white skin and flesh, that matures early and is resistant to numerous skin blemishes and diseases (Potato Council 2012) and was therefore considered for trial in Mauritius. An experiment was conducted to compare the performance of Harmony and Delaware.

5.2 Materials and methods

Harmony G4 seed was harvested in WA on 20 February 2010, packed in woven mesh bags (25 kg) and shipped in refrigerated containers at 4°C which arrived in Mauritius on 18 March. The Delaware seed was as described in the previous experiment.

Round (35-45 mm) seed of both varieties was planted manually at a density of 35,000 seeds/ha (1.5 t/ha) in plots three rows wide with three replications on three sites: Riche en Eau (17 June), Union Sugar Estate (3 June) and Omnicane (25 May). The seed was taken out of the cold room three weeks before planting at Riche en Eau. The crop was grown according to the general agronomy program as outlined in Section 4 ‘Comparing cut and round seed’.

5.3 Results

Plant growth was reported to be slow on all three sites although there are no emergence data to verify this. This may have been due to dormancy issues but the time between harvest and planting and the cool storage of the seed suggests this is unlikely. Anecdotally it was claimed that Harmony appeared to have poorer germination and emergence than Delaware and average tubers per plant were approximately eight for Harmony and 10-12 for Delaware. The sites were harvested by hand from 7 to 29 September 2010.

As with the cut and round seed experiment individual replicates were not measured (see Section 4.3). Therefore sites were used as replicates to determine average yield for Harmony and as there was a single average yield for Delaware for the three sites no statistical analysis was carried out. On average, yield of Harmony was 61% of Delaware (Table 4).

Table 4. **Average yield (t/ha) of Delaware and Harmony potatoes in Mauritius grown from WA seed in 2010.**

Variety	Yield (t/ha)*
Delaware	22.5
Harmony	13.7

*Yield is average of three sites and unreplicated.

5.4 Discussion

In the opinion of CopeSud Sugar Estate staff the quality of the Harmony tubers was not compatible with the Mauritian market (tubers had grooves and round shape) and there will be no further testing of the variety.

Information about more suitable varieties has led to the introduction of three new varieties into Australia. The varieties are Barcelona, Montreal and Monte Carlo. These varieties are from The Potato Company (2012) at Emmeloord in the Netherlands. The first two have yellow skins while Monte Carlo's skin is red. Flesh varies from yellow to cream. All varieties are early maturing and are tolerant of hot and humid climates (Gaby Stet, personal communication). Further characteristics are shown in Table 5. Plantlets are expected to arrive at Australian quarantine facilities in mid-2012 with tissue cultures expected to be released to project proponents in early 2013.

Table 5. **Characteristics of varieties selected for test marketing in Mauritius (from The Potato Company 2012).**

Characteristic	Barcelona	Montreal	Monte Carlo
Pedigree	Mondial x Felsina	Amalia x Amore	Mul 91-13 x Bru 93-136
General description			
Suitable for replacing:	Mondial & Spunta	Premiere	Desiree
Maturity	Middle early	Very early	Medium early
Skin color	Light yellow	Light yellow	Light red
Flesh color	Light yellow	Cream	White
Tuber shape	Long oval	Round-oval	Oval
Eye depth	Shallow	Reasonably shallow	Shallow
Tuber size	Large to very large	Large	Medium to large
Yield	High	Very high to high	High
Dry matter contents	19.5%	20.0%	21.5%
Cooking type	A-B	A-B	A-B
Market type	Fresh market	French fry & fresh market	Fresh market
Resistance* to			
leaf-roll virus	8	8	7
A-virus	7	7	8
X-virus	7	8	8
Y-virus	6	7	6
Phytophthora (leaf)	6	7	6
Phytophthora (tuber)	5	8	7
internal bruising	Normal	Normal	Sensitive
Common Scab	6.5	7	8

* 1 = susceptible, 9 = resistant

6 Comparing different-sized Delaware seeds

6.1 Introduction

Seed size (weight/diameter) is an important factor in producing high yielding potato crops. Normally seeds weighing between 35 and 80 g are considered large enough to maximise yield (Struik and Wiersema 1999). However, optimal seed size will vary with variety and environment. To lower cost growers may reduce seed size but care must be taken with smaller seed as it may reduce yield which may offset the lower seed costs. Seed that is too large may, in addition to extra cost, reduce tuber size and marketable yield at excessively high plant and stem densities. Potato crops in Mauritius are sown at 2.4 to 3.6 t/ha with seeds from 55 g to over 100 g and planting densities from 35,000 to 41,600 (MSIRI 2003). A trial compared the performance of crops grown using different seed sizes to see if the recommended size produces maximum crop yield and profit.

6.2 Materials and methods

The Delaware seed was from the same shipment as comparing cut versus round seed. Round seed of three different sizes (< 40, 40-50 and > 50 mm diameter) was sown at three different densities (38,000, 35,000 and 30,000 setts/ha) on the 25 May 2010 in plots four rows wide with two replicates on one site (Omnicane). The crop was grown using the general agronomy program described in the previous experiments.

6.3 Results and discussion

The crop was harvested by hand on 22 September. Yield was higher when larger seed was used (Table 6). As this was an unreplicated evaluation the data was not statistically analysed. Results showed higher yield with larger seed diameter and lower sett density. Preliminary economic analysis predicts maximum profit using the largest (> 50 mm) compared with the smaller sizes of round seed for Delaware in Mauritius. These results show that reducing seed size and cost below recommended rates will lead to reduced returns and that using larger seed will maximise profits. The current MSIRI recommendations to use seed of at least 55 g and preferably larger, seem to be justified from this preliminary evaluation. Nevertheless, information on optimum seed size for maximum profit is important and needs to be confirmed in replicated experiments.

Table 6. **Yield (t/ha) of Delaware crops in Mauritius grown from WA seed of three different sizes in 2010 (not based on replicated data).**

Seed size		Sowing density	Seed rate	Yield	Income[A]	Costs[B]	GM[C]
(mm)	(g)	(setts/ha)	(t/ha)	(t/ha)	($/ha)	($/ha)	($/ha)
< 40	53	38,000	2.0	24	14,400	7,470	6,930
40–50	63	35,000	2.2	28	16,800	7,707	9,093
> 50	93	30,000	2.8	30	18,000	8,418	9,582

[A] yield*$600/t
[B] $5100 base costs + $1185/t of seed
[C] Gross Margin = Income-costs

7 Comparing seed shipped in large and regular-sized bags

7.1 Introduction

The export seed potato market is highly competitive with exports from Holland and Scotland dominating. This requires export seed growers and exporters to examine ways of reducing price to remain competitive. One way of reducing costs is by reducing packing costs. This should enable WA exporters to remain cost competitive and Mauritian potato producers to increase profits. One way to reduce costs is to ship in larger packs rather than smaller bags. HAL Project PT06046 *Supporting bulk-bin exports of Western Australian seed potatoes to Mauritius* (Thomas 2009) demonstrated that labour intensive bagged (25 kg woven mesh) seed potatoes (cv Delaware) resulted in a similar yield (around 25 t/ha) to seed potatoes shipped in bulk 750 kg pine bins when grown out in Mauritius. Both were shipped in the same reefer container at 4°C. The lower cost of the 'bulk' seed resulted in higher profits for the Mauritian grower compared with bagged seed (Thomas 2009).

After a review of the 2009 project it was recommended that large bags be used to pack seed instead of bins due to lower cost and suitability for larger producers, such as the sugar estates, with bulk seed handling facilities and this be compared with seed packed in 25 kg woven bags. Mauritius is interested in pursuing the bulk seed potatoes if the seed is graded and the price is lower than bagged seed. To achieve a lower price, it was decided to test 1.25 tonne Bulka™ bags. These cost $26 each compared with $58 for the wooden 750 kg bins (or $99.18 for equivalent quantity of the Bulka ™ bag) used by Thomas. This project provided an opportunity to confirm these findings as well as test the performance of the bulk bags. Therefore a follow-up experiment was conducted to compare performance of crops grown from WA Delaware seed shipped in large (1.25 t) Bulka™ bags or small (25 kg) woven bags.

7.2 Materials and methods

7.2.1 Seed potatoes

Certified G4 seed of Delaware variety was used in the experiment. The seed was grown by Southern Packers in Manjimup WA and was harvested mid-January 2010. Seed was packed in either Bulka™ bags (1.25 t) or woven mesh bags (25 kg) and shipped in refrigerated containers at 4°C which arrived in Mauritius on 18 March. The Bulka™ bags or 'ventilated bulk bags' were purchased from Colquhoun's Fremantle Bag Company in Bibra Lake, WA, (www.colquhouns.com.au). Cost of packing each treatment was recorded in Manjimup. Round seeds (35 to 45 mm diameter) were planted on 25 May in three rows of each of the two treatments (Bulka™ bag versus small bag seed) in three replicates on two sites, one at Omnicane Sugar Estate near Britannia in the south (57.56.18 E, 20.45.04 S) and at Riche en Eau Estate in the south-east (57.39.20 E, 20.23.50 S). The crop was grown using local agronomic practices as described in comparing cut versus round seed and harvested by hand on 22 September. The two sites were used as replicates in the statistical analysis as data from the three individual replicates were bulked into one at each site.

7.2.2 Statistical analysis

Data from replicated experiments was analysed using analysis of variance. Genstat® statistical software was used and residuals were graphed to determine the validity of the analysis. Where significant effects occur, treatment means were separated using the least significant difference method.

7.3 Results

Results of the harvest showed no significant yield differences in crops grown from the two packaging treatments with seed packed in 25 kg woven bags yielding 25.9 t/ha and seed from Bulka™ bags producing 25.3 t/ha (Table 7).

Packing costs showed that packing 30 tonnes of seed packed in Bulka™ bags required 16 hours less labour than packing into 25 kg bags. With a casual labour rate of $27/hour this is a saving of $432 or $14.40/tonne. Material costs of Bulka™ bags were also cheaper at $26 for 1.25 tonnes compared to $22 for 40 25 kg bags ($27.50 for 1.25 tonnes). Total savings per tonne were $15.90 and are shown in Table 7.

In Mauritius the Bulka™ bags are mechanically handled and emptied into 750 kg wooden bins before placing into cool store. The cost of this operation is believed to be cheaper than manually unloading the regular 25 kg bags. This saving has not yet been accurately measured and has not been included in the packing costs in Table 7.

Table 7. **Packing cost savings for Bulka ™ bags and yield (t/ha) of Delaware potatoes in Mauritius grown from WA seed shipped in either regular or Bulka™ bags in 2010.**

Bag treatment	Comparative packing cost			Yield (t/ha)
	Labour ($/t)	Materials ($/t)	Total ($/t)	
Regular (25 kg) bags	14.40	1.50	15.90	25.9
Bulka™ (1.25 t) bags	0.00	0.00	0.00	25.3
Significance				ns
LSD (P = 0.05)				1.1

7.4 Discussion

Seed delivered in Bulka™ bags was cheaper to pack in Australia by $15.90/t compared with the regular 25 kg bags, due to reduced labour and material costs. There are also unloading savings in Mauritius which have not been quantified. Yield of the Bulka™ bags was the same as the regular 25 kg bags therefore Bulka™ bags are a suitable method of exporting WA seed to Mauritian growers with bulk seed handling facilities. This finding supports results of a previous project that showed shipping in bulk bins was cheaper than in small bags without any decline in seed quality as shown in the yields of the crops grown from the seed (Thomas 2009). This is good news for both WA seed exporters and users of WA seed in Mauritius such as the sugar estates. It is thought that costs of packing seed in Bulka™ bags for WA exporters could be reduced to $20/t, compared with woven bags, when fully mechanised. This cost saving when passed onto the buyer will result in Australian seed becoming more competitive in the Mauritian market. In 2011 100 tonnes of seed was sent in Bulka™ bags and increased in 2012 to 200 tonnes showing commercial adoption of the technology is being achieved (see Section 8.4 Bulk seed containers).

8 Technology transfer

The second year of the project provided an opportunity for the findings from the first year to be tested directly by farmers in a series of technology transfer activities.

8.1 Cut seed

In 2011 seed tubers up to 175 g were included in the shipment to the AMB. The AMB holds a monopoly for certain products for which there are marketing schemes and guaranteed prices, such as potatoes (Austrade 2012). The AMB stores the seed in its cool stores after arrival in Mauritius and before distribution to growers. The AMB provides the seed to small growers on credit with the full payment of seed not required until harvest, when it is deducted from the income the grower receives for his crop. This is done to fulfil one of the AMB's objectives "to encourage local production of as much of the country's food requirements as is economically feasible" (AMB 2012).

The aim in sending larger seed was to enable small growers to assess its performance for themselves following the successful experiment carried out in 2010 (Section 4). During the 2011 growing season six small growers in Mauritius were visited by the seed supplier, Mr Kon Peos and his representative in Mauritius Ingrid Fraser, to observe their evaluation of cut seed against SRS. The growers grade off the larger tubers in their seed delivery and split these with one longitudinal cut from rose end to stem end, to give two pieces with similar eye numbers. Emergence was the same for cut and SRS as reported by growers and observation.

The canopy of crops grown from cut and SRS appeared similar. The small growers reported that they preferred larger, cutting seed because it performs as well as the SRS and as it is the same price per kilogram results in cheaper seed costs as one seed piece can be cut in two. Reports after harvest from growers were that yield of both cut and SRS were similar.

It is expected that the AMB will continue to import larger seed for cutting. This is beneficial to both Australian seed exporters, who can sell a larger fraction of his crop as seed grade, and to the small farmers in Mauritius who have reduced seed costs.

8.2 Bulk seed containers

In 2011, 100 tonnes of seed was sent in Bulka™ bags. This was used successfully by the sugar estates (see Figures 3 and 4). In 2012, 200 tonnes of seed was sent in these bags showing commercial adoption of the technology by the large growers is being achieved.

Figure 3. **WA seed in Bulka™ bags being off-loaded from containers and transferred into wooden crates used for cool storage in Mauritius 2011.**

Figure 4. **Kon Peos from Southern Packers Ltd (centre left) inspecting crops grown from WA seed shipped in Bulka™ bags with CopeSud staff in Mauritius 2011.**

9 Recommendations – scientific and industry

9.1 Future work

To obtain accurate and useful information from testing of agronomic practices such as comparing seed size, seed treatments etc it is important that this is done in a proper scientific way. This means that experiments need to be properly designed with replication and randomisation so results can be analysed statistically. In this project it was impractical for the staff of the estates to follow the experimental protocols provided as they did not have time or the relevant experience. Consequently, individual replicate data was not saved but bulked into one and it was not possible to properly statistically analyse results from the experiments. For future work it is recommended that personnel with proven experience in field experimentation be involved. It is recommended that the Mauritius Sugar Industry Research Institute be approached to join future project to ensure the successful completion of scientific work.

In this project only mancozeb was used as a cut seed treatment for control of seed rots such as *Fusarium*. In future it may be useful to examine the effectiveness of other fungicide seed treatments. For example tolclofos-methyl and iprodione for control of *Rhizoctonia*. Iprodione was initially proposed for testing on the cut seed and is available in Mauritius but was not tested due to supply issues (Marcel Le Josne, pers. comm.). Iprodione has been shown to provide effective control of *Rhizoctonia* when applied to seed pieces (Bains *et al.* 2002) Bacterial breakdown of seed pieces is often caused by *Pectobacterium (*syn. *Erwinia*) in hot and humid conditions and is not prevented by chemicals and therefore the use of liquid seed treatments and their impact in Mauritius remain to be assessed. Healthy seed properly cut and cured is the best prevention against bacterial seed piece break down.

There appears to be good prospects for improving the economic efficiency of potatoes in Mauritius through improved fungicide applications. For control of late blight MSIRI recommends systemic fungicides should be sprayed in block spray programs that do not exceed four applications of the same fungicide per crop. MSIRI also recommend that contact fungicides are interspersed within the use of systemic and locally systemic fungicides. Contact fungicides are generally cheaper than systemic or locally systemic fungicides. The cut seed experiment showed that there is a possibility that the Omnicane Sugar Estate is spending more on chemical inputs than required given that during its spray program used eight systemic and locally systemic fungicides in a row (Table 2). Had contact fungicides been used as indicated by the MSIRI then this would have saved money on inputs, increased profitability of the crop and further reduced the potential for resistance to develop.

Based on the one spray program received during this study it is possible the effectiveness of the metalaxyl or mefenoxam used in the trial is not as effective as some of the alternatives available in Mauritius and that there need to be further investigations into the spray regimes for this disease. The Global Initiative Late Blight (GILB) indicates that although no A2 strains are present in Mauritius there have been studies on the resistance levels towards metalaxyl and it is possible that resistance strains occur (GILB 2012).

Concerns over the effect of bacterial wilt remain for Mauritian growers but there did not appear to be significant problems with this disease during 2010. This is likely a result of the unseasonably dry weather during the experiments. It has been noted that a variety that is truly resistant to bacterial wilt will need to be selected for the Mauritian potato industry to reach its full potential (Govinden 1996).

9.2 Outcomes compared with objectives

The aim of the project was to increase the competitiveness of exports of seed potatoes from Australia to Mauritius through reduced seed costs and better adapted varieties. Results of the cut versus round seed and bulk versus small bag trials were very encouraging.

It is clear cut seed can be used successfully as an alternative to whole round seed in Mauritius. This will enable WA exporters to sell larger tubers and therefore a larger proportion of their crops. The benefits of this are that exporters can reduce costs to increase competitiveness in the market and the seed delivered at a lower cost that should increase grower profits. The degree to which cut seed can be used in Mauritius is not clear yet as CopeSud staff suggests only 10% of plantings will be sown in the future, whereas it appears the degree of acceptance by small farmers may be higher.

As with the cut seed work the bulk seed work showed encouraging results with respect to cost savings in the supply chain. The Bulka™ bags appear to be a satisfactory means of packing and shipping seed to Mauritius compared to smaller bags without any decrease in seed quality as measured by subsequent crop yield. This result links very well with a previous project that showed seed shipped in bulk pine bines performed as well as seed shipped in small bags. The Bulka™ bags provide lower packing cost than the small bags with cost savings estimated at $15 to $20/t. As with cut seed the benefits will accrue to both the exporter and grower. It will be easier for the estates to adopt this technology than smaller growers as they have bulk handling facilities. It is possible AMB can assist smaller growers with handling the Bulka™ bags upon arrival in Mauritius.

The result of the seed size work has a bearing on the size specifications of the seed shipped and therefore the use of cut or SRS. The preliminary results here warn growers against opting for small sized seed to save money as this may lead to lower profits due to proportionally lower yields. A more detailed scientific investigation of the optimum seed size is required before any changes from MSIRI recommendations could be considered.

The search of better varieties to replace the commonly grown varieties Delaware and Spunta is in its early stages. Harmony doesn't appear to be a suitable replacement for Delaware as it appears to have lower yield and unsuitable cosmetic qualities. Information about more suitable varieties has led to the introduction of varieties Barcelona, Montreal and Monte Carlo from 'The Potato Company' (2012) in the Netherlands into Australia with tissue culture material to be available in 2013.

9.3 Recommendations

WA exporters are encouraged to develop the market for larger tubers for cut seed as an alternative to whole round seed for plantings after late May with similar benefits of cost savings in the supply chain. More properly conducted experimental work is needed with cut seed where a range of seed treatments is tested to insure against possible seed piece breakdown in the tropical climate.

This work confirms the MSIRI findings that sowing smaller seed is of no benefit to the grower. Both exporters and growers should note this information to avoid buying and planting smaller seed to save money, if it leads to lower economic returns. However, this is a preliminary investigation and a more scientific investigation of the optimum seed size with MSIRI staff is needed.

Variety development in conduction with Mauritian growers will enable further collaboration between WA growers and their Mauritian counterparts.

WA exporters are encouraged to further expand the shipping of seed in bulk such as in Bulka™ bags with their Mauritian clients as a way to lower packing and shipping costs for mutual benefit. As the benefits of bulk versus small bags have now been demonstrated in two projects there is no need to further examine this concept experimentally.

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