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Variety development for the fresh potato market in Western Australia

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Department of Agriculture
Western Australia

Project Number: PT03070

PT03070

This report is published by Horticulture Australia Ltd to pass on information concerning horticultural research and development undertaken for the potato industry.

The research contained in this report was funded by Horticulture Australia Ltd with the financial support of Agriculture Produce Commission Potato Producers Committee.

ISBN 0 7341 0985 7

Published and distributed by:
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FINAL REPORT

HORTICULTURE AUSTRALIA LIMITED

PROJECT PT03070

POTATO DEVELOPMENT FOR THE FRESH POTATO MARKET IN WESTERN AUSTRALIA

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Purpose of this Report: To present methods and experimental data used to identify new varieties recommended for commercial testing.

Funding Sources: Department of Agriculture, Western Australia, The Potato Producers Committee of the Agricultural Produce Commission, Horticulture Australia Ltd, potato growers and processors who assisted with these projects.

Date 14 September 2004

White Star (97-38-2), a new potato variety for winter production in Western Australia, at *Boatshed Fresh Food* with Ruby Lou and Mondial. This display was organised to help assess consumer reaction to White Star. Note that Ruby Lou and Mondial, established commercial varieties in WA, were selected through previous variety evaluation work carried out in WA. Photo: Western Potatoes.

Contents PT03070

Media Summary

Key components of project

Potato breeding-lines, selected under Western Australia conditions, were screened for potato virus y to ensure a clean supply of seed for future project work. This screening procedure interrupted evaluation work. However one advanced selection which offers benefits for fresh market winter production was tested successfully on a commercial scale for the second consecutive year.

Industry significance

The industry priority we are tackling is the improvement of the performance of winter grown crops. The yield of these crops is just 60% of the overall average yield for fresh market potatoes in WA. The reduced yield of the winter crop is due to many factors which include storm and wind damage, heavy rain, frost, low temperatures, short days and lack of sunshine.

Key outcomes

The new fresh market variety, White Star, offers improved culinary quality and is a good example of the benefits improved varieties can provide. White Star has much higher starch level than Nadine and produces a higher yield of large tubers which will help overcome the excess winter production of small potatoes. These improvements benefit farmers and consumers alike.

The variety Dawmor, released in WA in 1999, was approved by the Indonesian Department of Agriculture for crisp production in Indonesia.

Virus free seed was produced to allow variety evaluation work to continue in WA.

Conclusions

Improved potato varieties adapted to local conditions can be produced through this local selection program.

Recommendations for future R&D

- The current system of selecting breeding-lines from a summer planted crop at Toolangi, Victoria, does not suit the selection of winter varieties. In future crosses should be planned that will provide breeding-lines with the characteristics required by the WA potato industry.
- White Star should be tested for potato cyst nematode resistance.
- A workable quarantine procedure to allow potato breeding material into WA needs to be developed.

Recommendations for practical application to industry

- White Star requires a further year's successful commercial testing in order to be accepted by Western Potatoes as a new commercial variety for Western Australia.
- Future priorities for WA variety evaluation need to be identified and suitable crosses should be planned to allow the timely production of suitable breeding-lines for testing in WA.

Technical Summary

Nature of problem

The standard potato varieties grown in WA have faults that limit production and marketing. Gains can be made if improved varieties are developed and adopted. Our aim was to select improved varieties for winter fresh market production.

Research undertaken

Breeding-lines were obtained from the National Potato Improvement Centre, Toolangi (NPIC). These will be screened in WA in winter. Breeding-lines already in WA were screened for virus to produce virus-free seed. An advanced selection was tested successfully on a commercial scale for the second year.

Major findings & industry outcomes

97-38-2 (White Star) was tested in commercial tests for the second year. Western Potatoes require three years of successful commercial testing before they will place a variety on their preferred variety list. These second year commercial tests of White Star confirmed our previous findings that White Star produces yields similar to other commercial varieties but has a superior pack-out. Importantly White Star produces fewer small potatoes than Nadine does.

The Indonesian Department of Agriculture officially approved the crisp variety Dawmor for production in their country. This approval was based on commercial evaluation carried out by a WA seed exporter.

Viral infection of the breeding-lines in WA was eliminated and this has allowed potato variety evaluation work to resume in WA.

Recommendations

- The current system of selecting breeding-lines from a summer planted crop at Toolangi, Victoria, does not suit the selection of superior winter varieties. In future crosses should be planned that will provide breeding-lines with the characteristics required by the WA potato industry.
- White Star should be tested on a commercial scale for a third year.
- White Star should be tested for potato cyst nematode resistance.
- A workable quarantine procedure to allow potato breeding material into WA needs to be developed.

Future work

Future priorities for WA variety evaluation need to be identified and suitable crosses should be planned to allow the timely production of suitable breeding-lines for testing in WA.

3. Introduction

3.1 Historical Background

This project (PT03070) continues work commenced with HRDC Project PT017 *Potato Variety Evaluation for local, export and processing markets* which commenced in 1989 (Dawson *et al*. 1997). It continued with Projects PT214, PT515 and PT96017 all entitled *Potato Breeding & cultivar trials in Australia - Western Australia component* (Dawson *et al*. 1998, Dawson & Mortimore 2000). Projects PT214 and PT515 formed part of the National Potato Improvement & Evaluation Scheme (NaPIES) that commenced in 1993. This scheme is based on the potato-breeding program of Agriculture Victoria with evaluation of breeding-lines being carried out in all states. The last project finalised was PT00010 Potato variety evaluation for Western Australia's fresh and export markets (Dawson & Mortimore 2004).

During the last project two significant events occurred. First, the potato industry revised the way variety evaluation would take place. The new procedures are contained in the *Business Model for the Evaluation and Commercialisation Phase of the National Breeding Program for Fresh Potato Varieties* by the National Evaluation & Commercialisation Committee for the Fresh Potato Breeding Program (FNECC). This plan provided for variety evaluation to continue with voluntary contribution funding. It also meant new varieties could be commercialised through private individuals or companies to allow revenue from royalties to be raised for future research into variety breeding and development. We took this opportunity to revise the evaluation program to concentrate on a single industry priority rather than look simultaneously for improved varieties for a number of locations and end-uses. Second, the finding of potato viruses in the potato breeding material meant that new procedures would have to be introduced to ensure that these were not introduced to WA with the seed. This is especially important for potato virus y had been eradicated from WA.

3.2 Significance to Industry

Current varieties do not always meet potato purchasers' specifications and so the industry does not operate to its full potential. An example showing how current varieties do not meet consumer and grower expectations for the fresh market is given below.

The industry priority we are tackling is the requirement to improve variety performance in winter grown crops. These are the crops in Pool 2 under the Western Potatoes system. Pool 2 is for deliveries in September to mid October and the 6,500 tonnes are produced with an average yield of just 26.9 t/ha. The potatoes are freshly harvested from crops planted in April and May. The yield for Pool 2 is just 60% of the overall average yield for fresh market potatoes in WA of 44.9 t/ha. It is just 36% of the average yield of Pool 5 production (See Table 3.2). The reduced yield in this Pool is due to many factors which include storm and wind damage, heavy rain, frost, low temperatures, short days and lack of sunshine. This results in small tuber size with many tubers being rendered unmarketable by powdery scab disease. The result is reduced profitability.

Table 3.2. Yields by pool for fresh potatoes grown in WA (Anon 2002).

Pool	Delivery	Tonnes	Area	Yield
1	1 Jul - 1 Sep	10,521	266	39.6
2	2 Sep - 13 Oct	6,403	238	26.9
3	14 Oct - 17 Nov	6,875	115	59.8
4	18 Nov - 29 Dec	6,156	120	51.3
5	30 Dec - 16 Mar	11,504	153	75.2
6	17 Mar - 11 May	11,324	231	49.0
7	12 May - 30 Jun	7,212	213	33.9
Total		59,995	1,336	44.9

If marketable yield can be increased to by 5% then, assuming an average return to growers of $500 per tonne the benefit to growers will be 26.6 t/ha x 5% x $500/tonne x 238 ha = $160,000 per year. The benefits could be expected to accrue over many years during which the variety evaluation project would have moved on to tackle other problems.

Some of these could include varieties more tolerant to the fungal blemish of diseases of silver scurf (*Helmithosporium solani*) and black dot (*Colletotrichum coccodes*) that affect the major production areas.

Aim

The project was undertaken to provide superior potato varieties better suited to the requirements of the WA potato industries. In particular we are looking for improvement in winter grown varieties. This report shows that a new variety we have selected, which is undergoing advanced commercial testing, may offer the industry benefits that will help to overcome some of the problems of winter production.

4. Materials & Methods

4.1 Sources of material

Breeding

New varieties were bred by Department of Primary Industries, Victoria, Agriculture division's Potato Breeding Program based at the National Potato Improvement Centre (NPIC) in Victoria. 25,000 seedlings are produced annually but only 20,000 produce tubers. All 20,000 are field tested and around 1,500 are selected for further evaluation in the second year. These 1,500 lines are grown in short rows and selected on the basis of tuber characteristics and cooking tests.

A tripartite number identifies the breeding-lines. For example the advanced breeding-line now known as "White Star" was tested as 97-38-2. The "97" indicates the year the first field generation was planted, the middle number "38" indicates the cross (Gladiator x 91-158-6) while the last number "2" indicates that White Star was the second selection from the first field generation of that cross.

Importation

About twenty new varieties are imported into Australia annually. The imported varieties are also screened at the NPIC.

4.2 Quarantine requirements for Western Australia

Potato cyst nematode

Western Australia has quarantine regulations that prohibit the importation of potatoes from Victoria. This is due to the finding of potato cyst nematode in Victoria. Currently the breeding material is brought into WA under an exemption to this regulation. Conditions placed on the import of the material are that it is accompanied with a declaration that the paddock in which it was grown was tested for PCN and none was detected. The material has then to be dipped in bleach (2% available chlorine for 45 minutes) upon arrival in WA as an additional precaution against PCN. This treatment can burn sprouts of tubers so it is important the tubers are received soon after harvest before sprouting occurs.

Potato virus y

Introduction of new material.

To ensure that potato virus y is not introduced with the breeding-lines the following procedure is proposed. The tubers will be stored in a cool sore at 3°C after treatment with bleach. It is expected the tubers will be put into cool storage in June.

In September the tubers will be removed from cool store and allowed to sprout. Sprouts from individual tubers will be grouped in lots of 10 and tested for potato virus y, potato virus x, potato virus s and tomato spotted wilt virus using ELISA.

Only those tubers with negative virus results will be planted.

If a positive test is found the tubers that provided the sprouts will be tested individually to identify the infected breeding-line(s).

PLRV is not tested using ELISA as the stem-print method is used. It is proposed that testing for PLRV be done in the field using leaf tissue soon after the breeding-lines have emerged.

The material that is grown under this system will enter the WA Certified Seed Scheme as "G2"due to the intensive virus testing done. Once the material reaches generation 5 and is required for further evaluation and there is no pathogen tested material available, it will be re-tested for viruses with the sample size being 500 plants, and only released to industry if it meets the standards of the Certified Seed Scheme.

This proposed procedure is yet to be approved by the plant heath officials in WA.

Material already on-hand in WA

Breeding-lines on-hand in WA in 2003 and which had been selected for further testing were removed from cool store in September 2003. Four lots of 10 tubers from each breeding-line were allowed to sprout. When all tubers in each lot of 10 had sprouts at least 5 mm long a sprout from each tuber was removed and grouped with the other sprouts from that breeding-line's sample. 10 sprouts from two lots of 10 tubers per breeding-line were sent to AGWEST Plant Laboratories for ELISA testing for PVY. If no virus found, the 20 tubers from two lots of 10 were cut to give 40 setts required to plant the seed-bulking plot.

For advanced lines for which we had larger quantities of seed, a sample of 500 tubers was selected and sprouted. The sprouts were tested for PVY using ELISA. If no virus found the seed line was clear for planting.

4.3 Proposed testing sites and planting times

The potato variety evaluation procedure in WA is in a transitional phase. This is due to two factors. First, changing the focus of the work to a single industry priority and district rather than testing breeding-lines in the four major production areas as previously occurred. Second, the finding of potato virus y in the breeding material and the consequent requirement to ensure that this virus is not introduced in the potato breeding material. Therefore the following description may include activities that have not yet been initiated but which are planned as the transition progresses.

The first test in WA is a summer grown seed bulking to produce seed to plant a winter grown unreplicated screening. This screening is the first activity to select breeding-lines that will address the industry priority to improve performance of winter grown crops. Seed from the first seed bulking is also used to plant another summer seed bulking plot in year 2 to supply seed for the next testing phase.

The next phase of testing is a replicated district trial. This is planted in the major winter cropping area of Perth. Selections from these trials then proceed to a demonstration phase via a further seed bulking.

Grown concurrently with the winter grown district trial is a disease screening. This is used to assess field tolerance to powdery scab and a disorder known as crocodile skin. To ensure disease-screening findings are accurate, the disease screening is repeated in the following year for entries selected for demonstrations.

The demonstrations phase has larger plots but these are unreplicated. Farmers and other industry representatives are invited participate in the selection of varieties at the harvest of the demonstration.

Type, design & size of experiments

Selection of breeding-lines at the breeding station (Toolangi)

Selection of material for testing in WA begins with the second year material grown at the NPIC. A member of the Department of Agriculture potato evaluation team attends harvest at the NPIC to apply a selection bias suitable for the WA industry. This bias includes selection of oblong varieties for the fresh market, varieties that may be susceptible to late blight which show other promising characteristics (this disease is not important in WA), less smooth skin texture for the fresh market and yellow fleshed varieties for the export market.

Three tubers of each of 200-300 selections were supplied by the NPIC. Tubers of standard varieties were also obtained from the NPIC to ensure seed of the standard varieties was of the same generation and physiological age as the breeding-lines.

First seed bulking

The first seed bulking is planted in October in the high yielding seed production area of Margaret River. Two tubers were used to plant two-row plots, each with eight plants at 25 cm spacing between setts. A buffer area between plots is planted with a contrasting coloured variety to prevent "end-plant" effects.

Unreplicated winter screening

Two tubers from the first seed bulking are used for the unreplicated winter screening planted in May in the Perth metropolitan area. This screening allows selection of varieties which performed well in winter. This winter screening is dug in early October to allow selection of material before the next seed bulking is planted at the end of October.

Second seed bulking

Selections from the unreplicated screening are grown in a second seed bulking planted at Margaret River late in the following October. Plots are two rows by 3.6 m having 36 plants on average. 60 cm of row between plots was planted with a buffer variety having tubers of contrasting colour to separate the plots. The use of two row plots is effective and economical as it eliminates "half" the edge effects. A twin row digger was used at harvest. Sufficient seed is now available to plant the district trial and have spare seed for further bulking. For the district trial the seed is shed-stored. For the October seed bulking at Margaret River seed is cool-stored.

District Trial

The trial is planted in a commercial crop. Two row plots, as described in replicated screening above, are used with three replicates being planted. About 30 entries will usually be tested each year.

Third seed bulking

Selections from the district trial are grown in a third seed bulking planted at Margaret River late in the following October. Methods used are as described for the second bulking above.

Demonstration

Varieties selected from the district trial are next tested in a demonstration which allows district trial results to be confirmed. It also allows growers and industry representatives to participate in the evaluation of the varieties.

The demonstration will be planted in commercial crop. Unreplicated double row plots 15 metres long will be planted. Mostly six to 12 varieties were grown at each site. We name most of the breeding-lines before they are tested in demonstrations to allow easily identification. We have found that the breeding-line serial numbers were confusing and difficult to memorise.

A field day is held when the demonstration is harvested. Farmers and industry representatives are asked, at the start of the field day, to inspect the unlabelled, harvested plots which are laid out on the ground. They are asked to vote for their top three varieties using a simple 1, 2, 3 vote. All votes are used to determine the industry's favourites. First, or "1" votes are multiplied by 3 then tallied. Second, or "2" votes are multiplied by 2 then tallied. Third votes are simply added to give a final ranking of votes. Subsequent discussions can then concentrate on the most popular varieties. On-farm testing is the best way to get adoption of new varieties. Varieties selected from the demonstrations will then be tested in a commercial phase.

Commercial tests

The aim of the commercial tests is to confirm the yield and quality results from the district trials and the demonstrations. These tests also allow the new variety to be challenged with the commercial handling practices of mechanical harvesting, bulk transport, washing, packing and retail sales.

Two commercial crop locations were chosen to indicate the consistency of the results. Each farming enterprise was supplied with 500kg to 3 tonnes of seed, depending on availability. This is enough seed to plant a quarter to one hectare at each site. The planting is done in consultation with Western Potatoes who arranged to have the production from these sites assessed for yield and pack-out.

Consumer tests

Western Potatoes also conducted consumer reaction to new varieties undergoing commercial testing. Test potatoes were displayed in a specialty fruit and vegetable store as well as in major supermarket store.

Consumers were told that a new potato variety was being tested. A survey questionnaire asking consumer's opinion of the appearance, what is important when judging appearance, asked to compare the taste of the new variety with a standard variety.

Customers were given cooked samples of the test potato and a standard for comparison and asked to assess the taste.

Consumers were also asked for comments about the taste of the potatoes.

4.3 Measurements

Growth characteristics

Dates when 50% of plants emerged, closed, matured and broke dormancy will be recorded. Dormancy will be assessed by noting when 2 out of 3 tubers, stored under sacks in a shed, had shoots 3 mm long.

Tuber characteristics

At harvest a tick sheet of tuber characters will be completed. Skin colour and texture, eye and heel depth, shape and size and uniformity of same, plus faults and disease reaction will be recorded. Tuber characteristics will be assessed as being suitable, questionable or unsuitable for the market requirements.

Wash pack quality

A sample of 25 tubers will be harvested from the demonstration by hand 2 weeks after maturity of that variety, hand washed and packed in plastic bags for two weeks in the dark at room temperature. The tubers will be assessed weekly for; skin bloom, percentage of marketable tubers, amount of rots and amount of shooting. This will allow selection of varieties that tolerate washing and storage and maintain their appearance in the market chain.

Disease resistance

A dedicated powdery scab trial was introduced during the seventh series of fresh market trials using the method of Genet and Braam (1995). Five replicates of four plant plots were used. From each plot tubers >30g were washed and the surface area affected on each tuber was assessed using the following scale:

a) nil,
b) slight (up to 5%),
c) medium (5-25%)
d) severe >25%.

The severity score was calculated from the equation:

$$\text{Severity} = \frac{(b \times 1)+(c \times 2)+(d \times 3)}{a+b+c+d}$$

Entries will be tested in two consecutive years in order to improve confidence in the results.

Grading for yield

The grades used will vary with market type and are shown in Table 4.3a. Most trials will be for the fresh market although a crisp demonstration has been planted in 2004.

Table 4.3a. Grades yield assessment by market type.

Grade	Market type	
	fresh market	crisp
chats	0- 70g	0-50g
small	70-120g	50-80g
medium	120-350g	80-300g
large	350-450g	300-430g
oversize	>450g	>430g
marketable*	70-450g	50-430g

*Marketable yield was classed as the small to large grade and this was called Grade No. 1 for the fresh market trials.

Internal disorders

For the unreplicated winter screening and the district trial 10 tubers from each plot will be assessed for internal disorders. Tubers will be cut in half and number affected by fleck, hollow heart, vascular stain or other disorders were recorded. For the demonstration 50 tubers will be assessed.

Specific gravity

A 5 kg sample will be used to determine specific gravity using the weight in water weight in air method.

Cooking

Fry colour

Crisp

This test showed which varieties produce acceptable frying colour for both the crisp, French-fry and fresh markets. Five tubers from each plot are tested. Three unpeeled tubers are cut in half longitudinally and two transversely. One half of each tuber was discarded. Slices about 2.2 mm thick were prepared. The first slice from the remaining halves was also discarded, and the next four slices were cooked to give 20 crisps per sample. The crisps are fried straight away (less than 2 minutes exposure to air) in cottonseed oil at 180°C until bubbling ceased. Crisps were placed in the oil individually to prevent then sticking together. The crisps were then drained and scored for colour using a scale of 1 - 10 shown in Table 4.3b. Oil was changed after 90 frying tests.

Domestic French-fries

Fresh French-fries for domestic use will be cooked for assessment by Western Potatoes at the demonstration stage. French-fries will be prepared from three tubers and fried at 170°C for 5 minutes, cooled then re-fried at 190°C for 3 minutes. Overall colour of each French-fry is scored on a scale of 1-7 with 1 being white and 7 being dark gold. A score of four or less is acceptable. {This scale equates to Simplot's 000,00,0,1,2,3,4 colour chart, 000 and 00 scores are acceptable in the plant after one minute frying while scores of 0 and 1 are acceptable after full frying in the plant and at home (i.e. about 3'45" frying time in all)}.

Table 4.3b. Fry colour score sheet used in cooking tests.

Crisp fry colour test			French-fry colour test		
Range	Score	Description	Range	Score *	Description
Too light	1	White	↑ Acceptable after	1 (000)	White
↑	2	Very light yellow	1 minute (') frying for frozen product	2 (00)	Very light yellow
Desired colour	3	Light yellow	↑ Acceptable after 3'45"	3 (0)	Light yellow
	4	Yellow	frying for frozen product ↓	4 (1)	Yellow
↓	5	Light gold	Acceptable after 5' + 3' frying for fresh product	5 (2)	Light gold
Borderline for crisps	6	Gold	↑ too	6 (3)	Gold
Borderline for French fries	7	Dark gold	dark ↓	7 (4)	Dark gold
↑	8	Brown	* Simplot score shown in brackets		
Too dark	9	Dark brown			
↓	10	Black			

Boiling tests

3 tubers from each plot will be boiled until soft when tested with a skewer. The tubers will be scored for colour, after cooking darkening (ACD), sloughing and mash quality. Mash quality will be assessed for one of the boiled tubers. This tuber will be mashed to a creamy texture and the riciness, or lumpiness, of this mash will be assessed by rubbing mash between thumb and forefinger. These tests will be done immediately after cooking except for ACD which will be assessed 24 hours after boiling. Details of scoring scales are shown in Table 4.3c.

Table 4.3c. Boiling tests, scores and descriptions.

Test	Score	Descriptive terms
Flesh colour	1	White
	2	Creamy white
	3	Cream
	4	Deep cream
	5	Yellow
Greying and after cooking darkening	1	Nil
	2	Slightly grey
	3	Moderate, greyish black
	4	Marked blackening around eyes and/or stem end
	5	General blackening
Disintegration and sloughing	1	Nil, surface smooth and translucent
	2	Slight, surface dull but mainly intact
	3	Moderate, major part of surface sloughed off but mainly intact
	4	Severe, floury mass
	5	Severe, soupy
Riciness after mashing	1	Nil
	2	Slight
	3	Moderate
	4	Marked

Demonstration tests

For the fresh market, Western Potatoes will assess samples which will be cooked at the Department of Agriculture, WA potato laboratory at Bunbury. Tests are as above but a microwave test has been added.

Microwave and taste test

Two tubers of about 200g will be tested individually. The tubers will be washed, dried and their skins will be pricked. One tuber will be placed in a Western Potatoes microwave capsule (*Potato Microwaver*). This is placed in a 750-Watt microwave oven set on high for 2

minutes. The capsule is then turned upside down and microwaved for another 2 minutes to give a total cooking time of 4 minutes. The second tuber is then cooked. After cooking the tuber is removed from the oven and left to stand for 1 minute. The tubers are assessed by cutting in half longitudinally. A knife is used to check for evenness of cooking and evenness of texture. One half of the tuber has its flesh roughed up with a knife to see how it flakes up. The evenness of texture and flakiness are used to give a score of 1 to 4. 1 is "not recommended", 2 is fair, 3 is good and 4 is excellent. The flaking of the flesh also releases aroma which can be assessed. The tuber will also be assessed for taste.

4.4 Selection criteria

We want to identify varieties that would provide benefits to growers and consumers.

For the fresh market we specifically wanted to identify higher yielding varieties for winter production that have tolerance to powdery scab. They should have tolerance to wind. Culinary quality must be versatile with good boiling quality but frying quality should also be acceptable.

When large scale French-fry processing ceasing in Manjimup in 1999 we decided to evaluate only those French-fry varieties that could also be used for the fresh market. This meant that any new varieties selected require cooking quality and appearance acceptable to both fresh market and French-fry processors.

For the crisp market we want improvements in yield and quality over Atlantic. Main quality factors are shape, eye depth, specific gravity, fry colour and internal disorders.

Selection criteria will be discussed with the results of each experiment.

4.5 Statistical analysis

Data from replicated experiments will be analysed using analysis of variance. Genstat® statistical software is used and residuals are graphed to determine the validity of the analysis. Where significant effects occur, means will be separated from those of the standard variety using least significant difference method.

An “arcsin” transformation of disease data will be used when distribution of raw disease-index is skew. Transformation formula = (asin (sqrt(disease index/100)))*180/pi.

5. Results

5.1 Production of virus free seed

5.1.1 Background

When potato virus y was found in the breeding-lines all material had to be tested for this virus. The first step was to assess which material should be tested.

Breeding-lines on hand comprised

- the 00 series, which had been tested in one unreplicated screening, and were due to proceed to the winter unreplicated screening.
- the 99 series which had been tested in a summer unreplicated screening, a winter unreplicated screening as well as a summer replicated screening. These were due to proceed to district trials.
- the 98 series which had been tested in the district trial phase and were destined for the demonstration phase, and
- The 97 series which had been tested in the demonstration phase and which were due for commercial testing.
- Earlier series breeding-lines which were already undergoing commercial testing.

Most investment had been put into the earlier breeding-lines and these were the priority to screen and retain if possible to allow the completion of testing. The breeding-lines which were selected for screening are discussed below.

5.1.2 Crisp selections

Crisp breeding-lines selected are shown in Table 5.1.2, grouped by the series in which they were tested.

00 series of crisp breeding-lines

Dawson & Mortimore (2004) selected five crisp breeding-lines of the 00 series in an unreplicated screening. These were 00-15-18, 00-15-30, 00-15-40, 00-15-67 and 00-16-17. They were selected as they all had suitable tuber characteristics, crisp colour less than 5 and specific gravity greater than 1.080. Sprouts from 10 tubers of each breeding-line were tested for PVY and found free. These breeding-lines were planted at Margaret River on October 24 2003. For the crisp varieties tested PVY was found in samples of Dawmor. This seed was replaced with material from a minituber source.

99 series of crisp breeding-lines

Five crisp selections were also made from the 99 series of breeding-lines after summer and winter unreplicated screenings plus a summer replicated screening (Dawson & Mortimore 2004). These were 97-101-7, 99-7-3, 99-37-8, 99-51-11 and 99-62-3. 99-7-3, 99-37-8, 99-51-11 and 99-62-3. The first was a summer selection and was retained. The remaining selections were all winter selections and their selection was re-assessed. All were rejected as they had very poor yield, most being well under 50% of the yield of Atlantic. Sprouts from 20 tubers of 97-101-7 were tested for PVY and found free. This breeding-line was planted at Margaret River on October 24 2003.

98 series of crisp breeding-lines

Dawson & Mortimore (2004) selected three crisp breeding-lines for testing in demonstrations. These were 98-10-11, 98-27-3 and 98-33-27. All of these were retained.

97 and earlier series of crisp breeding-lines

Dawson & Mortimore (2004) selected five breeding-lines from the 97 and earlier series of breeding-lines for testing in demonstrations. These were 90-2-6 (Bliss), 94-28-1, 97-74-3, 97-84-6 and 97-84-16. 90-2-6 (Bliss) was found to be heavily infected with PVY and was not replanted. This breeding-line was already undergoing commercial testing and these commercial seed lines were also found to be infected. Tubers, which were sprouted and tested and found free from PVY, were allowed to grow to produce tubers so a source of virus free seed would be available for tissue culture propagation. 97-84-16 was selected for its summer performance and was tested in a summer grown demonstration were it produced low yield with questionable tuber characteristics (Dawson & Mortimore 2004) and so it was not selected for further bulking. The remaining three breeding-lines were tested for virus, found free and bulked for further testing.

Table 5.1.2. Crisp selections for virus screening and seed bulking.

Entry	Experiment where selected	Comments
Standards		
Atlantic		Standard crisp
Dawmor		standard
00 series		
00-15-18	02AL34	To be tested in Perth
00-15-30	02AL34	To be tested in Perth
00-15-40	02AL34	To be tested in Perth
00-15-67	02AL34	To be tested in Perth
00-16-17	02AL34	To be tested in Perth
99 series		
97-101-7	02AL36	To be tested in Manjimup, also fresh market
98 series		
98-10-11	02AL37MA	crisp Manjimup & Perth
98-27-3	02AL37MA	crisp Manjimup & Perth
98-33-27	02AL37MA	crisp Manjimup & Perth
97 & earlier series		
94-28-1	01PE8	to be tested in coast demonstrations
97-74-3	01BU4A	to be tested in coast demonstrations
97-84-6	01BU4A	to be tested in coast demonstrations

5.1.3. Fresh market selections

Fresh market breeding-lines selected are shown in Table 5.1.3, grouped by the series in which they were tested.

00 series of fresh market breeding-lines

Dawson & Mortimore (2004) selected seven fresh market breeding-lines of the 00 series in an unreplicated screening. These were 98-31-3, 00-1-5, 00-6-24, 00-11-28, 00-48-1, 00-58-1 and 00-69-8. Sprouts from 20 tubers of each breeding-line were tested for PVY and found free. These breeding-lines were planted at Margaret River on October 24 2003.

99 series of fresh market breeding-lines

Dawson & Mortimore (2004) selected 11 fresh market breeding-lines of the 00 series in an unreplicated screening. These were Cherry Red, Victoria, *97-101-7, 99-5-10, 99-9-25*, 99-23-11, *99-37-16, 99-58-25*, 99-61-13 and *99-64-5*. The winter-only selections, shown in italics, were re-evaluated. Two had questionable tuber characteristics and were de-selected (99-5-10 and 99-9-25), three others (99-23-11, 99-37-16 and 99-64-5) had yield 20 t/ha less than Delaware and were also omitted. 9-58-25 had 20% of tubers with internal disorders and was also omitted.

Sprouts from 20 tubers of each breeding-line were tested for PVY and found free. These breeding-lines were planted at Margaret River on October 24 2003.

98 series of fresh market breeding-lines

Seven fresh market breeding-lines were selected for testing in demonstrations after district trial testing (Dawson & Mortimore 2004). These were 98-4-5, 98-31-22, 98-34-11, 98-77-6, 98-77-7, 98-107-13 and 98-109-1. All of these were retained. 98-107-13 was also selected for further testing for the French-fry market. Sprouts from 20 tubers of each breeding-line were tested for PVY and found free. These breeding-lines were planted at Margaret River on October 24 2003.

97 and earlier series of fresh market breeding-lines

Dawson & Mortimore (2004) selected four breeding-lines from the 97 and earlier series of breeding-lines for testing in demonstrations. These were Maris Piper, 95-11-20 (Auski), 95-37-12 (Billabong) and 97-38-2 (White Star). Maris Piper was found to be lightly infected with PVY and was not replanted. This breeding-line was already undergoing commercial testing and clean material sourced from minitubers was substituted. Tubers of the other selections were sprouted and tested and found free from PVY. 97-38-2 (White Star) was undergoing commercial evaluation and material given to farmers was tested by sampling 500 tubers which were sprouted and tested for PVY. When no virus was found in this sample the seed was cleared for planting. If PVY was found another lot of 10 tubers were tested until to find a group of tubers that where no virus was found. For the fresh market PVY was found in samples of 98-31-22 and 98-77-7. When these were planted in the field leaf samples of all plants were taken and testing for PVY using ELISA confirmed that the material contained no PVY.

Table 5.1.3. Fresh market selections for virus screening and seed bulking.

Entry	Experiment where selected*	Comments
Standards		
Coliban		Eastern states' standard
Delaware		Old WA standard fresh market
Desiree		Powdery scab standard
Mondial		Standard winter variety
Nadine		New WA standard
Ruby Lou		WA red skinned standard
00 series		
00-1-5	02AL34	To be tested in Perth
00-6-24	02AL34	To be tested in Perth
00-11-28	02AL34	To be tested in Perth
00-48-1	02AL34	To be tested in Perth
00-58-1	02AL34	To be tested in Perth
00-69-8	02AL34	To be tested in Perth
99 series		
Cherry Red	02AL36	
Victoria	02AL36	
97-101-7	02AL36	also crisp
99-23-11	02AL36	
99-61-13	02AL36	
98 series		
98-4-5	02AL37BUA	
98-31-22	02AL37MA	
98-34-11	02AL37BUA+MA	Red skin
98-77-6	02AL37BUA	
98-77-7	02AL37BUA	
98-107-13	02AL37BUA+MA	Also F-fry
98-109-1	02AL37BUA	
97 & earlier series		
Maris Piper	02AL39PE	Perth commercial testing
95-11-20 (Auski)	02AL39BU1,2,3	Re-test in Manjimup demonstration
95-37-12 (Billabong)	02AL39BU1+3	Manjimup demonstration
97-38-2 (White Star)	02AL39PE+BU1&3	Commercial testing

* From Dawson & Mortimore (2004).

5.1.4. French-fry selections

French-fry varieties are not a priority of this project because Western Australia only has a small French-fry processing industry. However we believe there is benefit in selecting breeding-lines that could be used for both the fresh and French-fry markets and so we will select material that has characteristics that might suit both markets. The French-fry breeding-lines selected are shown in Table 5.1.4, grouped by the series in which they were tested.

00 series of French-fry breeding-lines

Dawson & Mortimore (2004) selected two French-fry breeding-lines of the 00 series in an unreplicated screening. These were 00-15-25 and 00-26-1. They were selected as they all had suitable tuber characteristics for the fresh and French-fry market, specific gravity greater than 1.080crisp colour less than 6 and after cooking darkening and sloughing less than 3. Sprouts from 20 tubers of each breeding-line were tested for PVY and found free. These breeding-lines were planted at Margaret River on October 24 2003.

99 series of French-fry breeding-lines

No French-fry selections were made from the 99 series of breeding-lines (Dawson & Mortimore 2004).

98 series of French-fry breeding-lines

98-107-13 was the sole 98 series French-fry breeding-line selected for testing in demonstrations (Dawson & Mortimore 2004). It was also selected for further fresh market tests.

97 and earlier series of French-fry breeding-lines

Dawson & Mortimore (2004) selected six breeding-lines from the 97 and earlier series of breeding-lines for testing in demonstrations. These were 89-19-2 (Sleeping Beauty), 89-27-33 (MacRusset), 92-37-1 (Barman aka Fergie Fry), 94-42-10, 89-27-6 (My Fry) and 96-141-12 (Windsor). The first four plus 89-27-6 were available from tissue culture and so these were not replanted. 94-42-10 was found to be infected with PVY and was not replanted. This breeding-line was about to undergo commercial testing and has now been lost due to PVY infection. The breeding-line 96-141-12 requires further testing and tubers which were sprouted and tested, found free from PVY and was bulked for further testing.

Table 5.1.4. French-fry selections for virus screening and seed bulking.

Entry	Experiment where selected*	Comments
00 series		
00-15-25	02AL34	To be tested in Perth in fresh market trial
00-26-1	02AL34	To be tested in Perth in fresh market trial
99 series		
No selections made		
98 series		
98-107-13	02AL37BUA+MA	Also fresh
97 & earlier series		
96-141-12 (Windsor)	02AL39PE+BU1&3	Commercial testing

* From Dawson & Mortimore (2004).

5.1.5. Export market selections

The WA potato industry is developing its trade in export seed potatoes. This market requires varieties suited to our tropical markets. However varieties also suited to the domestic market will benefit our industry. To identify these varieties export seed varieties were tested with fresh market varieties.

98 series of export market breeding-lines

The variety PO3, developed in the Philippines was selected for further testing for the fresh market. Another export variety, Eben, may also have potential for the local market.

5.2 Initiate testing for new priority of winter fresh production

5.2.1. Background

The priority for variety improvement in the WA potato industry is improved winter performance. Varieties should perform well in short, cold days. Tolerance to powdery scab and resistance to potato cyst nematode are other desirable characteristics. Specific gravity should be greater than Nadine with an arbitrary target of greater than 1.065.

Crisp breeding-lines that might produce well in winter are also required for a potential export market in fresh crisp potatoes. High yield and light cooking from cold soils are required.

5.2.2. Selection of material from Toolangi 2004

5.2.2.1 Aim

To select potato breeding-lines most suitable for testing in WA.

5.2.2.2 Selection criteria

The selection plots were grown over summer and so under completely different conditions to make selection on field performance useful for winter production. The material will not be screened in winter in the eastern states by the DPI. Therefore to overcome this disadvantage crosses were used in an attempt to predict which breeding-lines may produce the most suitable material. This material should grow well in winter and be tolerant of powdery scab and potato cyst nematode. The progeny from potentially suitable crosses was selected in a more lenient manner. There was reduced emphasis on tuber characteristics, as these are likely to differ when grown under winter conditions, but more emphasis on maturity. Late maturing breeding-lines may not be suitable for the short season of winter production.

A future priority is likely to be blemish tolerant varieties for summer production to complement Nadine. Here varieties with resistance to blemish diseases (silver scurf and black dot) are required. The varieties must also have low (score of 2 or less) after cooking darkening. Versatile cooking quality is also required. At present it is not possible to predict which crosses may have the desired blemish tolerant and after cooking darkening free progeny.

5.2.2.3 Generation 2 selections

This material is in its second field generation and is grown in *Selection Plots*. About 1,500 breeding-lines were planted for the crisp, French-fry and fresh markets. Breeding-lines were being selected for inclusion into the following year's *Junior*, or generation 3, trials. Selection by the breeder is based on tuber characteristics, maturity and cooking quality.

Selection for WA should include fresh and crisp material with a high chance of PCN resistance and good winter performance.

PCN resistance

The following crosses have one parent with PCN resistance.

Table 5.2.2.3a. Crosses with one parent resistant to potato cyst nematode.

Cross #	Cross*		Likely market
	*PCN resistant parent in bold		type of progeny
02-1	Agria	**91-158-6**	F-fry
02-9	**Atlantic**	Trent	crisp
02-10	**Atlantic**	Wilstore	crisp
02-34	**Mondial**	Ranger Russet	F-fry/fresh
02-35	**Mondial**	85-30-12	F-fry/fresh
02-36	**Mondial**	88-102-24	F-fry/fresh
02-37	**Nadine**	Coliban	fresh
02-39	**Nemarus**	Centennial Russet	French-fry
02-52	**Saturna**	93-6-3	crisp
02-76	**89-12-1**	Exodus	?
02-77	**89-12-1**	Knox	?
02-78	**89-12-1**	80-102-7	?
02-79	**89-12-1**	80-174-8	?
02-80	**89-12-1**	89-30-8	?

From these crosses the following breeding-lines were selected for testing in WA in addition to those already selected by the breeder.

02-34

02-34-1
02-34-2
02-34-4
02-34-8
02-34-11
02-34-12
02-34-14
02-34-18 (added by breeder)

02-35

02-35-1
02-35-2
02-35-3
02-35-4
02-35-6
02-35-7
02-35-8
02-35-10
02-35-12
02-35-15
02-35-17
02-35-19 (added by breeder)
02-35-20

02-35-22
02-35-24
02-35-25
02-35-29
02-35-32
02-35-34 (added by breeder)

02-36
02-36-5
02-36-9 (not delivered)
02-36-17(not delivered)

02-37
02-37-1

02-63
02-63-9

The following crosses had not been harvested by the end of the selection trip. The breeder was asked to select material for WA from these that have tuber characteristics suitable for the fresh market. Maturity should be early to medium dormancy and tuber characteristics should be treated leniently.

02-76 from which
02-76-1
02-76-3
02-78-11
02-76-13
02-76-17 were selected.

02-77 from which
02-77-1
02-77-3
02-77-11
02-77-15 were selected.

02-78
02-78-1 was selected.

02-79 from which none was selected.

02-80 from which
02-80-1
02-80-4
02-80-5
02-80-6
02-80-8

02-80-11 were selected.

Light crisp colour from cold soils

The following crosses have one parent that may confer light cooking. These parents were identified from 3 degree cooking tests done at NPIC from 02-03 trials. Breeding-lines from these crosses that should be selected if they have tuber characteristics suitable for crisp processing. These breeding-lines will be required for screening in winter (April/May planting) and so their appearance in the selection plots (summer harvest) is not of prime importance and some leniency should be made in their selection. Short maturity is important for winter production and breeding-lines that suit the above but, which have long maturity should not be selected.

Table 5.2.2.3b. Crosses which may produce light crisp colour from cold soils.

Cross #	Cross*		Likely market
	*Light frying parent in bold		type of progeny
02-2	A84180-8	**88-102-24**	French-fry
02-3	A8495-1	**88-102-24**	French-fry
02-17	Centennial Russet	**88-102-24**	French-fry
02-27	Lady Rosetta	**ND 860-2**	crisp
02-29	**Lemhi Russet**	Knox	
02-30	**Lemhi Russet**	80-102-7	
02-31	**Lemhi Russet**	89-30-8	
02-32	**Lemhi Russet**	MacRusset	French-fry
02-33	**Lenape**	80-102-7	?
02-36	Mondial	**88-102-24**	F-fry/fresh
02-70	**80-102-24**	80-102-7	French-fry
02-74	**88-102-24**	Ranger Russet	French-fry
02-75	**88-102-24**	80-102-7	French-fry
02-84	**91-158-6**	**88-102-24**	
02-91	94-119-14	**Lemhi Russet**	

Selections were
02-29-5 (despite lateness)
02-70-1
02-70-9
02-84-8
02-84-11
02-84-17,

Crosses not harvested at time of visit

The following crosses were not harvested and are yet to be selected. The breeder is asked to select material for WA from these that have tuber characteristics suitable for the crisp market. Maturity should be early to medium dormancy and tuber characteristics should be treated leniently.

02-70 from which 02-70 -1 & 02-70-9 were selected,
02-74 from which none was selected,
02-75 from which none was selected,
02-84 from which 02-84-8, 02-84-11 & 02-84-17 were selected,
02-91 from which none was selected.

5.2.2.3. Generation 3 selections

A *Junior Crisp* and a *Junior Fresh* market trial were harvested during the selection trip. This material has not been tested in WA. Selections should be sent to WA with the selections from the G2 selection plots. The selections are shown in Tables 5.2.2.3a & b.

Fresh market trial

Table 5.2.2.3a. Selections for testing in WA from the Junior Fresh Market Trial.

Breeding-line	Cross	Features	Reason for selection
01-3-5	Campbell 14 x 89-42-6 (Warren Wonder)	PCN resistant?	PCN
01-20-9	Crystal x Wilwash	low acd†, space out	PCN
01-20-23	Crystal x Wilwash	low acd†, very late	late maturity may help avoidance of blemish diseases in summer production
01-34-18	Mondial x 88-102-24	PCN & light fry?	PCN & light fry?
01-46-32	Riverina Russet x Lemhi Russet	PCN & light fry?	PCN
01-46-58	Riverina Russet x Lemhi Russet	PCN & light fry?	Better than 01-46-32
01-66-1	77-16-5 x Crystal	dark fry	good tc*
01-75-6[£]	86-34-4 x Wilwash	low acd†	good tc*
01-77-3[£]	88-55-18 x Sebago	low acd	good tc*

* tc = tuber characteristics
† acd = after cooking darkening
[£] = not delivered

Crisp trial

Table 5.2.2.3b. Selections for testing in WA from the Junior Crisp Trial.

Breeding-line	Cross	Features	Reason for selection
01-1-1	Astra x 93-6-3	late	good crisp tc*
01-8-18	Centennial Russet x Crispa		possible fresh
01-55-10	Sonic x Crispa	late	good crisp tc*
01-56-11	Sonic x Aurora	space out	possible fresh
01-56-13	Sonic x Aurora	pink blush	good appearance for fresh
01-82-18	89-88-3 x Crispa	space out	good crisp tc*
01-87-11	93-6-3 x Crispa	late, no hollows	good crisp tc*
01-88-5	93-6-3 x Starlight		good crisp tc*
01-88-6	93-6-3 x Starlight		best appearance

* tc = tuber characteristics

Selections by the breeder

The potato breeder added the following breeding-lines.

01-4-5	02-86-4	02-87-7
01-37-2	02-86-8	02-87-10
01-41-7	02-86-10	02-87-11
01-77-3	02-86-16	02-87-13
01-79-5	02-86-20	02-88-5
02-12-6	02-86-21	02-88-6
02-18-3	02-86-22	02-88-11
02-72-2	02-87-1	02-88-13
02-73-8	02-87-2	02-89-1
02-83-4	02-87-4	02-89-2
02-83-17	02-87-5	02-90-1

5.2.3. District trial for fresh market winter production 2004

The breeding-lines to be tested in the district trial were selections already held in WA which had been tested to some degree by Dawson & Mortimore (2004). These are shown in Table 5.2.3.

Table 5.2.3. Entries for testing in a May 2004 planted variety trial in Perth.

#	Entry	Spacing	#	Entry	Spacing
1	Atlantic *	15	15	99-61-13	24
2	Cherry Red	24	16	00-1-5	24
3	Coliban	15	17	00-6-24	24
4	Delaware	24	18	00-11-28	30
5	Maris Piper	30	19	00-15-18*	24
6	Mondial	15	20	00-15-25	30
7	Nadine	24	21	00-15-30*	36
8	Ruby Lou	20	22	00-15-40*	24
9	Victoria	30	23	00-15-67*	24
10	97-38-2	30	24	00-16-17*	24
11	97-101-7*	24	25	00-26-1	20
12	98-31-3	24	26	00-48-1	20
13	98-109-1 (F-fry)	30	27	00-58-1	24
14	99-23-11	24	28	00-69-8	30

* Asterisks indicate entries suitable for crisp processing.

5.2.4. Disease screening trial winter 2004

Entries for the district trial were also planted in a disease screening to test for field tolerance to powdery scab and a disorder with an unknown cause known as crocodile skin.
The entries for this disease screening are shown in Table 5.2.4.

Table 5.2.4. Entries for testing in a May 2004 planted powdery scab screening trial in Perth.

#	Entry	#	Entry
1	Cherry Red	14	00-1-5
2	Desiree	15	00-6-24
3	PO3	16	00-11-28
4	Victoria	17	00-15-18
5	Nadine	18	00-15-25
6	97-101-7	19	00-15-30
7	98-4-5	20	00-15-40
8	98-10-11	21	00-15-67
9	98-31-3	22	00-16-17
10	98-34-11	23	00-26-1
11	98-109-1	24	00-48-1
12	99-23-11	25	00-58-1
13	99-61-13	26	00-69-8

5.3 Finalise work from previous project

5.3.1 Background

The previous project tested breeding-lines in three production areas in four seasons (Dawson & Mortimore 2004). Testing was incomplete and so we aimed to finish testing advanced breeding-lines and those showing particular promise. To do this a crisp demonstration was planted at Lancelin in July 2004. A fresh market demonstration is planned for spring planting at Manjimup or Pemberton. Associated with the fresh market demonstrations will be strip plantings of more advanced lines.

5.3.2 Winter & autumn crisp demonstrations for the Swam Coastal Plain

The crisp demonstration comprised the following breeding-lines: 94-28-1, 97-74-3, 97-84-6 and 98-10-11 which were selected by Dawson & Mortimore (2004). This is the first planting to test their suitability for double crop production on the Swan Coastal Plain. The standard variety was Atlantic.

5.3.3. Spring planted fresh market demonstration at Manjimup/Pemberton

The fresh market demonstration at Manjimup/Pemberton will comprise the following breeding-lines: 95-37-12, 95-11-20, 97-102-1, 98-4-5, 98-31-22, 98-34-11, 98-107-13, 00-6-24 and
00-15-40 11 which were selected by Dawson & Mortimore (2004). Standard varieties were Delaware, Nadine and Ruby Lou.

Strips of the advanced breeding-lines 95-11-20 (Auski) and 95-37-12 (Billabong) will be planted adjacent to these demonstration in order to commence commercial scale testing.

5.3.4 White Star commercial testing 2003

Commercial Production Results 2003

Commercial testing of White Star progressed to its second year. Two sites were again used. One site was grown by the farming enterprise that had participated in the demonstration while the other site was chosen as it was challenged by powdery scab disease.

Table 5.3.4a shows that White Star's yield was consistent with results from the previous commercial test done in 2002/03. White Star's yield was 36.8 tonnes per hectare in the latest test (2003/04)

Table 5.3.4a. Commercial production of White Star in limited commercial tests undertaken in 2002 and 2003. Data courtesy of Western Potatoes.

Variety	Season 02/03		Season 03/04	
	Production (tonnes)	Yield (t/ha)	Production (tonnes)	Yield (t/ha)
Delaware	1990	35.9	1880	36.2
Nadine	4230	32.2	3780	32.8
Maris Piper	9.7	36.0	-	-
Mondial	1230	30.3	2290	40.6
White Star	10.3	36.9	15.8	36.8

The pack-out obtained for White Star is shown in Table 5.3.4b. Over two years it shows a high percentage of Premium and Grade 1 tubers.

Retail Tests

Western Potatoes again undertook retail testing of White Star.

Potatoes were displayed in a specialty fruit and vegetable store as well as in major supermarket store (See Frontispiece). Consumers were told that a new potato variety was being tested. A survey questionnaire asking consumer's opinion of the appearance, what is important when judging appearance, asked to compare the taste of White Star with a standard variety. The survey also allowed Western Potatoes to gather other marketing information.

Table 5.3.4b. Pack-outs for White Star and Nadine for 2002/03 and 2003/04. Data supplied by Western Potatoes.

Variety	Premium (%)	Grade 1 (%)	Grade 2 (%)	Smalls (%)	Waste (%)
Season 02/03*					
Nadine	*	52	21	16	8
White Star (97-38-2)	7	75	9	3	3
Season 03/04					
Nadine	-	-	-	-	-
White Star (97-38-2)	17	59	8	10	4

* from Dawson & Mortimore (2004)

Appearance

The consumers rated the appearance of White Star as excellent (43%), good (49%) and average (8%). They reported that smooth surface and free of blemishes of the skin were the most important factors in assessing appearance.

Taste

Customers were given cooked samples of White Star and the test potato (Nadine) and asked to assess the taste. Choices allowed are shown in Table 5.3.4c. For the test potato 49% of consumers assessed it as good to excellent taste while 42% thought the taste was average. For White Star the assessment was 89% good to excellent taste and 11% average. The test potato was Nadine.

Table 5.3.4c. Consumer opinion of taste of White Star compared with a test potato. Data courtesy of Western Potatoes.

Variety	Rating (%)				
	Excellent	Good	Average	Below average	Poor
White Star	43	46	11	0	0
Test potato	14	35	42	7	2

Consumers were also asked for comments about the taste of the potatoes. The outcome of these comments was that White Star was much fluffier than the test potato and it had a creamy, smooth texture.

The standard cooking assessment of these two varieties from the same paddock is shown in Table 5.3.4d. A catering professional supplied by Western Potatoes made the assessment. The assessment shows that White Star boiled as well as Nadine and had improved flavour and frying quality.

Table 5.3.4d. Cooking assessment of White Star compared with a test potato. Data courtesy of Western Potatoes.

Cooking assessment	Variety	
	Nadine	White Star
Boiling tests	***	***
Colour	1.5	1
After cooking darkening	1	1
Sloughing	1	1
Mash smoothness	**	**
Taste	*	**
Aroma	good	very pleasant
Microwave texture	***	***
French-fry tests	n.r.	***
Colour	7	3
Texture	dark brown, greasy, soggy	crisp, dry, very good

*** = excellent, ** = good, * = fair, n.r. = not recommended

Retailer's Opinion
Both retailers said they were happy to stock the variety again on the strength of the consumer reaction to the potato.

5.3.5 Dawmor acceptance as Indonesian variety

5.3.5.1 Background

Dawmor was first identified as a high yielding crisp potato Dawson *et al*. (1998). They found that in October plantings at Manjimup and Pemberton Dawmor produced 84% higher yield than Atlantic with high dry matter, light fry colour with half the internal disorders of Atlantic. Dawmor was adopted by an exporter Agritrade International because Dawmor's higher yield meant that the export trade in fresh crisp potatoes would be more attractive to growers. Dawmor was named by Agritrade International at a ceremony in Manjimup in March 1999. Since then Dawmor had been grown for export crisp production in summer plantings (Dawson & Mortimore 2002).

5.3.5.2. Dawmor in Indonesia

Subsequently Dawmor was tested in East Java by a seed potato exporter Potato International. Yield proved to be much greater than Atlantic. The standard variety grown in Indonesia is Granola which is a fresh, or table, potato. Processing companies have been contracting growers to produce Atlantic but the yields are low compared with Granola and so farmers are reluctant to grow Atlantic. However trials by Potato International showed that Dawmor could out-yield Atlantic and even grow as well as Granola (Table 5.3.5.2).

Indonesia has an official potato variety list. On July 28 2004 the exporter presented evidence of Dawmor's performance to the Dinas Pertanian (Department of Agriculture) in Jakarta and Dawmor was officially accepted onto the Indonesian potato variety list.

Table 5.3.5.2. Yield comparison of Dawmor, Atlantic and Granola in East Java. Data courtesy of Potato International.

Variety	Yield (t/ha)	
	Site 1	Site 2
Atlantic	23	18
Dawmor	35	55
Granola	46	50

Discussion

6.1. Introduction

The project is in a transition phase between testing varieties for different districts and times of production to concentrating on one district at a time. Also the project had to suspend experimental activities while breeding material free from virus infection was produced. This report gives results for just one year's activities, which is a short time for achieving outcomes from variety evaluation work. Nevertheless we have been aided by previous variety evaluation work and can report on several achievements.

6.2. Quarantine

WA has quarantine regulations that prevent the free movement of seed potatoes from Victoria. This is to protect the WA potato industry from exotic threats like potato cyst nematode and bacterial wilt. The finding of virus in the breeding program material means that these quarantine regulations will be strengthened to reduce the risk of potato virus y being introduced to WA.

We have proposed a procedure that will test breeding-lines for PVY before they are planted in WA. This procedure, presented in Section 4.2, is yet to be approved by the Plant Health authorities in WA.

It is important for the success of this project that breeding-lines are allowed into WA to allow screening under our unique conditions. These conditions are discussed in the next section.

6.3. Selections for winter at NPIC

It is difficult to select breeding-lines for their suitability for winter production in WA from the selection plots at Toolangi. This is because these selection plots are grown under very different, summer conditions. To overcome this difficulty selection was not based solely on the breeding-lines performance at Toolangi. Instead we attempted to deduce the potential characteristics of the breeding-lines from their parents' attributes. This is difficult to do due to the lack of information about the parents' characteristics and the heritability of these characteristics. We attempted to select breeding-lines with a high chance of having potato cyst nematode resistance (see Table 5.2.2.3a) and light fry colour from cold soils (see Table 5.2.2.3b).

In future one way of making more useful selections of breeding-lines for WA is to have the breeder program plan crosses that will have a chance of providing the characteristics required by the WA potato industry.

Until this can happen the best chance of success is to screen large numbers of breeding-lines under WA conditions to allow selection to occur under the conditions for which improved varieties are required. To do this it is best to obtain breeding-lines at the generation 2 stage from the breeding program, rather than at the generation 3 stage as advocated in the FNECC (2004) business plan. This arrangement in turn relies on the WA Plant Heath officials approving a practical method for the import and testing of breeding material from Victoria (see Section 6.2 above).

Most material that was selected from Toolangi was provided as requested by DPI Victoria. However there is a need to speed delivery of the breeding-lines because this year some had sprouted by the time they had arrived in WA. This makes the tubers more susceptible to damage during the quarantine bleach dip, which can impair their performance when planted.

6.4 White Star (97-38-2)

White Star (97-38-2) was tested in commercial tests for the second year. Western Potatoes require three years of successful commercial testing before they will place a variety on their preferred variety list. When a variety is listed in this way it gives growers protection as crop failures will be borne from Pool payments. If non-preferred varieties fail then the cost is borne by the grower.

The second year commercial tests of White Star confirmed our previous findings and this result is encouraging. In 2002 White Star was grown in small-scale commercial trials where half a tonne of seed was planted at two sites (Dawson & Mortimore 2004). Yields were similar to other commercial varieties but pack-out was superior with White Star producing a pack-out of 82% Premium & Class 1 with just 9% Class 2. This was a substantially better pack-out than Nadine which had 52% Premium and Class 1 with 21% Class 2 (Table 5.3.4b). Importantly White Star produced less small potatoes than Nadine.

Table 5.3.4b shows that White Star had a similar pack-out again in 2004. Consumer reaction again was positive and packers where also happy with the way the potato came through the washing operation.

White Star was bred in Australia at the National Potato Improvement Centre in Victoria by Dr Roger Kirkham. Its parents were Gladiator and the breeding-line 91-158-6. When planted in May at 30 cm it produces oblong tubers with shallow eyes and heel. Skin texture is smooth and skin and flesh colour are cream. Our previous experimental results show that White Star had outstanding performance in May plantings (Dawson & Mortimore 2004) where its benefits over Delaware and Nadine were:

- better appearance than Delaware,
- better yield than Nadine,
- larger tubers than Delaware and Nadine,
- better fry quality than Delaware and Nadine,
- more tolerant to crocodile skin than Delaware,

White Star also had good tolerance to powdery scab.
Disadvantages compared with Nadine from May plantings were that its PCN resistance is not known however there is a high chance that White Star may have resistance to PCN. Parents of 97-38-2 (White Star) are Gladiator x 91-158-6. 91-158-6 parents were 86-12-17 and Atlantic. Gladiator and Atlantic are PCN resistant (either *Globodera pallida* and/or *G. rostochiensis*) so there is a better than 50% chance that White Star is also resistant to PCN. Therefore White Star should be tested for its resistance to PCN.

6.5 Dawmor

Dawmor was selected as a potential new crisp variety in 1998. The recent inclusion of this variety as an officially approved variety for Indonesia shows that benefits from variety evaluation can continue to accrue many years after the release of the variety. If Dawmor performs well in Indonesia, as commercial tests have shown (Table 5.3.5.2), then there will be a demand for seed form Indonesian growers. In this way the development of a new Australian variety will help with the development of the trade on Australian seed.

The long-term trade in export seed potatoes will depend on Australian seed growers having access to varieties demanded by the overseas markets. Should these markets demand proprietary varieties that we don't have access to then this could curtail our sales. Ways to prevent this are to either, work in partnership with overseas breeders, or to develop our own varieties for our export customers. The performance of Dawmor in Indonesia is proof that development of Australian varieties for export markets is a realistic opportunity for both Australian seed growers and the Australian potato-breeding program.

6.6 Outcomes achieved compared with objectives

This list shows the objectives of the project and the outcomes achieved.

1 Produce virus free seed to allow the continued evaluation of breeding-lines held in WA. This objective was achieved through a virus-screening program. Virus free seed of 48 breeding-lines was produced.

2 Complete the evaluation of breeding-lines first tested in previous projects. The establishment of a district trial, a disease screening and a crisp demonstration shows that this objective has been met. The successful commercial testing of White Star is another outcome that meets this objective.

3 Commence testing of new-breeding material for its suitability for the new industry priority of improved winter production. New breeding-lines suitable for screening in winter in WA was selected from the NPIC at Toolangi.

The list provides evidence that the outcomes compare favourably with the objectives of the project.

7. Technology Transfer

The major technology transfer activity was the second year commercial testing of White Star. Here the new variety was exposed to Western Potatoes, to growers, packers, retailers and consumers. The feed back from the growers and Western Potatoes had led to two seed growers producing this variety in a controlled manner so that the seed produced will be fed back into objective testing rather than spread thinly through the industry as a novelty.

8. Recommendations

- The current system of selecting breeding-lines from a summer planted crop at Toolangi, Victoria, does not suit the selection of superior winter varieties. In future crosses should be planned that will provide breeding-lines with the characteristics required by the WA potato industry.
- White Star should be tested on a commercial scale for a third year.
- White Star should be tested for potato cyst nematode resistance.

- A workable quarantine procedure to allow potato breeding material into WA needs to be developed.
- Future priorities for WA variety evaluation need to be identified and suitable crosses should be planned to allow the timely production of suitable breeding-lines for testing in WA.

9. Acknowledgements

Funding was supplied by the Horticulture Program of the Department of Agriculture, Western Australia, by the Potato Producers Committee of the Agricultural Produce Commission and by Horticulture Australia Ltd. The Department of Primary Industry, Victoria supplied breeding-lines and imported material. Western Potatoes are thanked for White Star commercial testing data and the photograph of retail testing of White Star. Potato International provided yield data for Dawmor in Indonesia. Most experiments were conducted in growers' crops and their assistance and expert crop husbandry is greatly appreciated.

10. Literature

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11. Abbreviations

ACD	after cooking darkening
aka	also known as
DPI	Department of Prmary Industry (Victoria)
ELISA	enzyme linked immunosorbent assay
F-fry	French-fry
FNECC	National Evaluation & Commercialisation Committee for the Fresh Potato Breeding Program
G	generation
ha	hectare
HRDC	Horticultural Research and Development Corporation
NPIC	National Potato Improvement Centre
n.r.	not recommended
NaPIES	National Potato Improvement Scheme
PCN	potato cyst nematode
PLRV	potato leafroll virus
PO3	not an abbreviation, this is the name of a potato variety
PVY	potato virus Y
SG	specific gravity
t	tonnes
tc	tuber characteristics
t/ha	tonnes per hectare
WA	Western Australia