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REGIONAL MACADAMIA VARIETY TRIALS – SERIES 2

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Department of Primary Industries, Queensland

Queensland Government
Department of Primary Industries

AUSTRALIAN MACADAMIAS

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PROJECT DETAILS

Project title:	Regional macadamia variety trials – Series 2.
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Purpose of the Report:	To compare the yield and quality performance of newer macadamia varieties in 4 growing regions to provide macadamia growers with information to assist them in the selection of most promising varieties for new plantings.
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Media summary

There is considerable potential for new macadamia varieties to produce higher yields of sound kernel, and higher sound kernel recoveries, than the industry standard variety,344. A range of new varieties were assessed in separate trials near Nambucca in central New South Wales with 14 varieties, at Forest Glen in south-east Queensland with 10 varieties, and in the Bundaberg region with 36 varieties at Winfield and 27 varieties at Hinkler Park.

Because of the susceptibility of 344 to a disorder called abnormal vertical growth (AVG) in the Bundaberg area, new varieties are needed there. Varieties that produced higher yields of kernel than 344 at Bundaberg were A268, A16, 814, 842, 741 and 816, and to a lesser extent A203, 788 and Daddow. Promising early varieties for Bundaberg were 816, 741, 344, and possibly A203 and 788. The most promising mid-season variety in the Bundaberg area was A268, and possibly 842 (mid-late season) although the latter is unpopular in some areas due to susceptibility to basal discolouration. The most promising late variety was A16 although Daddow produced reasonably high yields.

At Forest Glen, A29, A38, A268, A16 and A4 all produced higher yields of sound kernel than 344. Of these, A26 was earliest, followed by 344 which tended to be more mid-season at this site. High yielding mid-season varieties were A268 and A4 and late varieties were A16 and A38. All the A varieties, particularly A16, had excellent quality and very little discolouration at Forest Glen although kernel discolouration has occurred sporadically at other sites. Good management and frequent harvesting contributed to this high quality.

At Nambucca, A29, A38, A4 A268 and A203 produced high yields. Of these, A29, and to a lesser extent A203 were early, 246 and A268 were mid-season and A4 and A38 were mid-late season and late varieties respectively.

Generally, A268, A16, A29, A38 produced the most consistently high yields, although concerns about kernel discolouration, particularly for A29, A38 and, possibly A16, limit the appeal of these varieties. Summaries of new promising varieties are presented.

Technical Summary

Successful commercial macadamia production depends on selecting the best varieties for particular environments. Since yields are often variable, it is difficult to predict how a variety will perform in a new orchard. Local knowledge is invaluable as environment, soils and management profoundly affect yield and quality. Nevertheless, regional variety trials provide valuable information on which variety selection decisions can be based. Separate trials were established at four sites: near Nambucca in central New South Wales with 14 varieties, at Forest Glen in south-east Queensland with 10 varieties, and in the Bundaberg region with 36 varieties at Winfield and 27 varieties at Hinkler Park.

In trials at Bundaberg A268, A16, 814, 842, 741 and 816 all produced significantly more cumulative sound kernel over the life of the crop than 344. Other promising varieties at Bundaberg sites were A203, 788 and Daddow. High yields were largely related to large tree size. The highest production per unit projected canopy area was from A16 at 2.8t/ha of projected canopy, compared with 1.7-2.3t/ha for 344. The susceptibility of 344 to AVG in the Bundaberg area makes it risky in AVG-susceptible soils. Promising early varieties for Bundaberg are 816, 741, 344, and possibly A203 and 788. The most promising mid-season variety in the Bundaberg area was A268, and possibly 842 (mid-late season) although the latter is unpopular in some areas due to susceptibility to basal discolouration. The most promising late variety was A16 although Daddow appears to have some potential.

At Forest Glen, A29, A38, A268, A16 and A4 all produced significantly higher sound kernel yields than 344. The only early variety at Forest Glen was A26, followed by 344 which tended to be more mid-season at this site. High yielding mid-season varieties were A268 and A4 and late varieties were A16 and A38. All the A varieties, particularly A16, had excellent quality and very little discolouration at Forest Glen although kernel discolouration has occurred sporadically at other sites. Good management and frequent harvesting contributed to this good result.

At Nambucca, A29, A38, A4 A268 and A203 produced high yields. Of these, A29, and to a lesser extent A203 were early, 246 and A268 were mid-season and A4 and A38 were mid-late season and late varieties respectively at Nambucca.

Across all four trial sitesA268, A16, A29, A38 appeared to produce the most consistently high yields, although concerns about kernel discolouration, particularly for A29 and A38, limit the appeal of these varieties. Summaries of new promising varieties are presented.

Introduction

Macadamias are a relatively undomesticated crop, commercial production being limited to the past 100 years. Yield and quality has improved over this period of commercial development, partly due to better cultural management practices and better varieties. There is considerable potential, however, to further improve yield and quality through breeding and selection of even better varieties. This approach is the most efficient and cost –effective way of increasing macadamia productivity as it does not involve expensive cultural inputs. It has the greatest potential to boost orchard profitability and to give the Australian industry a competitive advantage over competitors on the world market.

The original DPI&F Regional Variety Trials (RVT – Series 1) identified better macadamia varieties that have been widely adopted by the industry. There are additional improvements to macadamia productivity demonstrated in the current RVTs. Improvements are achieved by selecting promising macadamia germplasm and, over a number of years, comparing yield and quality at randomised, replicated trial sites representative of the industry. Extremes of seasonal conditions over a period of time are useful in assessing variety performance under a wider range of conditions, including their capacity to recover after a poor season.

In addition to selecting macadamia varieties for yield and quality, they must also satisfy consumer and processor preferences, and have characteristics that reduce costs, increase profits and make management easier. To make sound decisions on the best varieties to select, tree characteristics must suit the orchard management system and kernel characteristics must suit customers.

Desirable variety characteristics include robust, compact tree with open growth habit resistant to wind damage, tolerance to sub-optimal nutrition, soils and environments, but responsive to good management, tolerance to major pests and diseases, precocious, beginning to bear by the 3rd or 4th year from planting out with steady increase in yield by increments of at least 1kg kernel/tree/year leading to consistently high yields of 3-4 t/ha of sound kernel from 10 years onwards (This is achievable but will dependent on good management) and short- harvest nut-drop season, largely complete (85-90%) by late August, before flowering. The variety should not have sticktight nuts or nuts that pre-germination on the tree or ground.

Desirable nut and kernel characteristics include sensory quality acceptable to processors, marketers and consumers, uniform colour, free from discolouration, even colour after roasting, regular, round kernels, weighing 2-3g, regular, round nut-in-shell (NIS) >18mm, NIS remaining in husk after it falls from the tree, husk separated readily from NIS in dehusker without any husk adhering to the shell, sound kernel recovery in excess of 36% and high % whole kernel (>50%).

Materials and Methods

Details of trial sites are shown in Table 1.Varieties represented by 3 digits are accessions from the Hawaii Agricultural Experiment Station. Numbers preceded by "A" are Hidden Valley A series (bred by Mr Henry Bell), numbers followed by "B" are selections made by Backer and numbers followed by "Mc" are selections made by Ian McConachie, all in Queensland), H2 (Hinde, selected by Ross and Wills in 1948), Daddow and Heilscher (selected by R.Misfield, Tinana), NG8 and Own Venture (both selected by Norm Greber), Beaumont (a natural hybrid selected by R.Kebby in NSW) and Fernleigh Special (selected near Teven in N NSW) are all Australian selections.

At all trial sites, each variety was replicated 4 times. Exceptions were:

Winfield

849 missing from blocks 2,3 and 4
2/48B missing from block 1
A4 missing from block 2
2/18 Mc missing from block 3
A203 missing from block 4
246 missing from block 4

Hinkler Park
814 missing from blocks 1 and 3
A4 missing from block4
804 missing from blocks 3 and 4
837 missing from blocks 1, 3 and 4
Heilscher missing from block 3
A426 missing from block 1

Forest Glen
A38 missing from block 2
A29 missing from block 3
A203 missing from block 2
741 missing from block 2

Nambucca
Beaumont and Fernleigh Special missing from all blocks (cooperator did not collect yields)
A38 missing from block 1

Table 1. Details of regional varietal trial sites.

Location	Grower	Varieties (no)	Planting Time/ Tree Spacing	Soil Type
Winfield	G.Sheppard	246, 344, 741, 705, 781, 783, 788, 814, 816, 835, 842, 849, 853, 856, Daddow, NG8, Own Venture, A4, A16, A38, A104, A199, A203, A268, A387, A417, A422, A423, A437, 2/5Mc, 2/12Mc, 2/18Mc, 4/7Mc, 4/44Mc, 1/40B, 2/48B, (36)	13 August 1997 7m x 4m	Sandy red/grey soil
Hinkler Park	Phil Zadrow	246, 344, 741, 772, 781, 783, 788, 804, 814, 816, 837, 842, 849, Daddow, NG8, Own Venture, Heilscher, A4, A16, A38, A104, A199, A203, A268, A422, A423, A426, (27)	15 July 1996 8m x 4m	Heavy black clay loam soil
Forest Glen	B. Winks, G, Sunner	344, 741, 772, H2, A4, A16, A29, A38, A203, A268 (10)	1 January 1992 8m x 4m	Grey loam
Nambucca	A. Seccombe	246, 344, 508, Beaumont, Fernleigh Special, A4, A16, A29, A38, A192, A199, A203, A268, A323 (14)	18 April 1992 7m x 4m	Kraznozem

Procedures developed and refined over the past 17 years were used. Generally, 6-weekly harvests were be carried out to determine yield and nut drop pattern. Tree size data was collected annually, together with NIS and kernel yield. Quality (sound kernel recovery %, whole kernel %, kernel size (g), NIS size

(nuts/kg) and % unsound kernel recovery % in each of the categories) were assessed from 2001 onwards on composite samples of nuts from each variety at each site at early (March/April), mid-season (June/July), and late season (August), except for years 10 to 12. Statistical analysis was carried out on mid season quality.

Procedures in the AMS Quality Manual were used, and assessors regularly undertook AMS quality assessment training to ensure consistency with commercial practice. In mid-September to mid-October, a final strip harvest was carried out to assess late drop, indicating sticktights.

Field sampling protocol

Individual Samples
All nuts (nut-in-husk) from the tree were weighed. A representative sub-sample of ca 10L was collected and a 2kg sample (Wet-in–husk weight, WIH) was weighed and placed in an open mesh bag with the appropriate sample identification label.

Composite Samples
A composite sample of ca 1kg each from a number of trees (reps), was collected in a clearly marked container with appropriate identification (eg treatment, replicate, etc). If there was a tree or a replicate missing, a larger sample was taken from the remaining reps to get a similar composite sample size. The composite sample was thoroughly mixed and a 2kg sample (Wet-in–husk weight, WIH) was weighed and placed in an open mesh bag with the appropriate identification label.

Sample preparation
Individual samples were dehusked and the weigh of wet nut-in-shell (NIS) was recorded. The wet NIS was then dried.

Drying procedure
Samples were oven –dried for 2 days at 38C, 2 days at 45C and 2 days at 60C and weighed (oven-dried NIS at ca 1.5% moisture). The bulk WIH yield was converted to NIS @ 10% moisture, the industry standard:

NIS @10% moisture = bulk WIH / ss WIH x od NIS x 1.09

Where ss = sub-sample, od = oven-dry (od nis has 1.5% moisture, thus nis with 0% moisture = od nis x 0.985. Thus nis@10% moisture = od nis x 0.985 / 0.9 = od nis x 1.09)

Sorting sound/unsound NIS
NIS defects (unsound kernel) was sorted from the sound NIS and each category of defect was noted (twins, rat damage, insect (spotting bug, nutborer), germination, cracked shell, etc), weighed and the % defect calculated.

Sound Kernel Recovery protocol
Quality was assessed on random samples of 100 nuts that had previously been dried to 1.5% moisture, and cooled. The 100-NIS sample was weighed and cracked using a commercial "Armanasco" cracking machine. The kernel sample was sieved over a 5mm mesh screen to remove fines (fine pieces of kernel and shell) before being sorted and weighed. Sound kernel recovery was expressed on the basis of this NIS sample, as follows: weight of sound kernel / weight of the NIS sample x 100% = Sound Kernel recovery.

Whole kernels
Whole kernel (% by number) was determined. Whole kernels are those which are "substantially (>80%) whole".

Unsound kernels
Unsound (immature, insect damaged, mouldy, discoloured, germinated, open micropile, pink staining, shrivelled kernel) kernels were sorted from the sample, weighed and expressed as a percentage of the total NIS sample. Not all damaged kernel can be seen from the outside. Unsound kernel recovery % = wt unsound kernel (the sum of all categories of unsoundness) @ 1.5% moisture / wt NIS @ 1.5% moisture x 100.

Sound first grade kernels
Sound kernels (fully mature kernel free from any insect damage, mould, decay, immaturity, discolouration, germination, deformity or rancidity and which is suitable for roasting and/or sale as raw kernel) were tested for flotation on water to confirm that all the sound kernels contain >72% oil (SG >1.0, float on water). Kernels that sink (SG<1) have <72% oil and may caramelise on roasting. Floaters and sinkers are then dried in an oven at 50 °C for 1 day, and weighed.

The Percentage of first Grade kernels = weight of floaters divided by the total weight of floaters + sinkers x 100.

Nut drop

Harvests were carried out at 6 weekly intervals and, at the end of the season, trees were stripped of remaining nuts (August or later). In this study, the date by which 90% of the crop has dropped naturally is used as a measure of earliness. Early varieties all dropped 90% of their crop or more by the end of June, mid-season varieties by the end of July and late varieties by, or after, the end of August.

Tree measurements

Height

Fibre-glass measuring poles were pushed up through the centre of the canopy to measure tree height.

Girth circumference

Galvanised clouts were driven into the trunk approximately 30 cm above the graft line or in a nearby area where the trunk was uniform. The circumference was measured with a fine tape measure at this point.

Canopy diameter (along and across the row)

Canopy diameter was measured between the extremities of foliage parallel to, and also at right angles to the row.

Effective canopy area

The projected canopy area was calculated assuming an elliptical canopy (area = πab where a=N-S radius (half-diameter) and b=E-W radius).

Statistical analysis
Data was subjected to statistical analysis and correlations between the various soil health parameters were carried out.

Results

Winfield

Fig. 1 shows that yields are still increasing steeply at Winfield. The yield of NIS continued to increase in 2003 despite the drought conditions and shortage of irrigation water at this site. In the following dry year (2004), however, NIS yield declined but recovered strongly in the more favourable 2005 season. The increase in NIS yield in 2003 was not, however, reflected in yield of sound kernel which increased only marginally and declined slightly during 2004 before increasing steeply in 2005. Data collection must continue for several more years to get a good indication of the mature tree performance of varieties at Winfield.

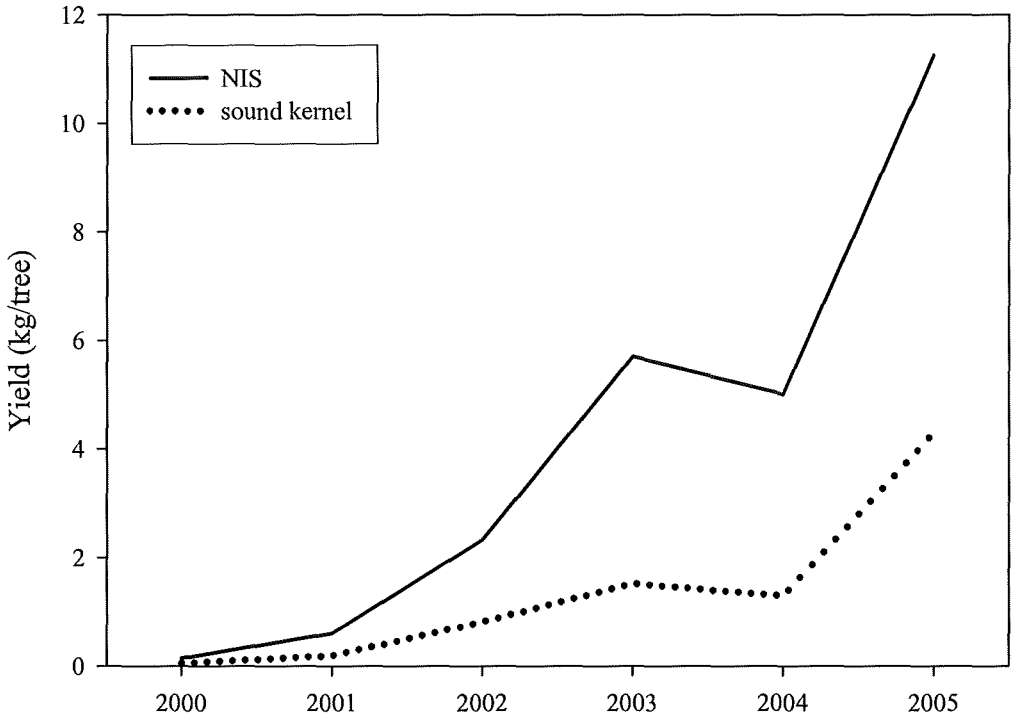

Figure 1. Mean nut-in-shell (NIS) and sound kernel yields of 36 varieties at Winfield from 2000 to 2005.

Sound kernel yield

Table 2 shows that the cumulative (years 2000-2005) yield of sound kernel (SK) varied with variety over a large range from 2.89kg/tree for 835 up to 12.03kg/tree for A268 at Winfield (an equivalent range of 1.03-4.3 t/ha over the four years). The cumulative yield of the industry standard variety, 344 was 8.07 kg/tree and six varieties produced significantly more sound kernel than 344: A268, A16, 814, 842, 741, and 816. These top six varieties all produced within 1.41 kg sound kernel/tree of each other over the 6 year period. Another two varieties, A422 and A104 produced sound kernel yields that were not significantly different to that of A268. Despite the wide range of cumulative sound kernel produced, only two varieties produced significantly lower cumulative yields of sound kernel than 344. They were 2/48B and 835.

The top varieties differed in the pattern of sound kernel yield over these six early years (Fig 2). In the first three years, A268 and 814 had significantly higher yields of sound kernel than 344. In 2000, A104, in 2001, A16, A104, A387 and 1/40B, and in 2002, A16, A104, 816, and 4/7Mc also had higher yields of sound kernel than 344. In the drought year of 2003, A16, 842, 816, 856 and 2/18Mc also produced higher yields of sound kernel and in 2004, A16, 741 and A422 produced significantly higher yields than 344. In 2005, only 842 and 741 produced significantly higher yields than 344. Although 788 , which earlier looked promising, produced 1.5kg less than 344 over the 4 years, this difference was not significant (Appendix 1). After the two unfavourable years, 2003 and 2004, yields increased steeply in 2005. A few more years of data are needed to confirm yield trends and identify the highest yielding varieties. Yields should plateau over the next 3 years or so.

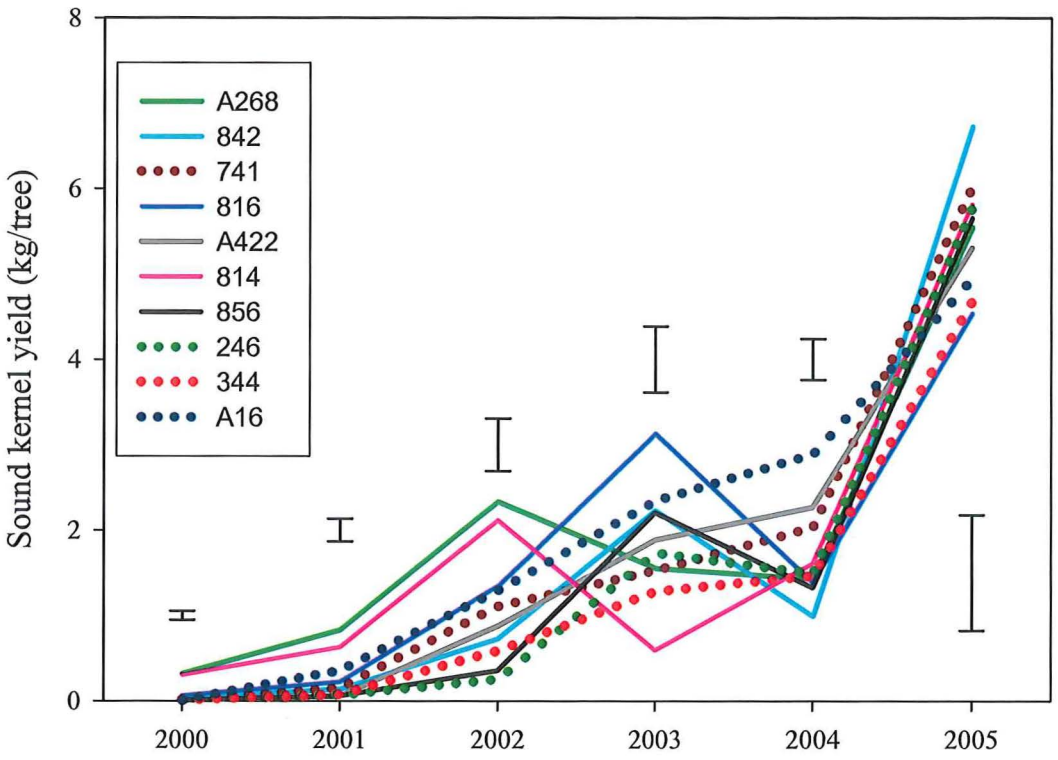

Figure 2. Sound kernel yield of the top nine varieties (based on cumulative sound kernel yield) and the industry standard variety, 344 at Winfield from 2002 to 2005. Bars indicate average LSD (P = 0.05) for each season.

Table 2. Sound kernel yield of 36 macadamia varieties at Winfield from 2002 to 2005 (with LSDs) and cumulative sound kernel yield from 2002-2005, ranked.

	Sound kernel yield (kg/tree)							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2000-5**	
A268	0.32	0.83	2.33	1.55	1.43	5.55	12.03	a*
A16	0.01	0.35	1.29	2.34	2.89	4.94	11.74	ab
814	0.30	0.62	2.11	0.59	1.61	5.81	11.08	abc
842	0.03	0.14	0.73	2.23	0.99	6.73	10.85	abcd
741	0.01	0.15	1.10	1.52	2.03	6.01	10.81	abcd
816	0.06	0.23	1.35	3.13	1.39	4.54	10.62	abcde
A422	0.01	0.06	0.88	1.88	2.27	5.31	10.35	abcdef
A104	0.35	0.66	1.48	1.73	0.98	4.74	9.96	abcdefg
856	0.01	0.06	0.36	2.21	1.33	5.66	9.59	bcdefg
246	0.01	0.07	0.25	1.73	1.49	5.78	9.32	bcdefgh
2/18Mc	0.01	0.08	0.69	4.34	0.92	2.85	8.76	cdefghi
2/5Mc	0.01	0.06	0.68	1.52	1.18	5.18	8.62	defghi
783	0.01	0.10	0.57	1.78	1.10	5.05	8.61	defghi
1/40B	0.04	0.49	1.11	1.40	1.46	3.96	8.46	efghij
4/7Mc	0.01	0.08	1.48	0.42	1.18	4.99	8.19	fghijk
344	0.01	0.07	0.58	1.28	1.46	4.67	8.07	fghijkl
A437	0.01	0.19	1.06	1.05	0.80	4.92	8.06	fghijkl
A203	0.07	0.30	1.09	1.44	1.36	3.70	7.94	fghijklm
849	0.02	0.14	0.83	1.63	1.07	4.24	7.91	cdefghijklm
A38	0.01	0.08	0.50	1.00	1.28	4.96	7.86	ghijklm
A387	0.09	0.43	1.16	1.24	1.47	3.44	7.82	ghijklm
NG8	0.04	0.31	0.94	1.29	0.87	4.30	7.77	ghijklm
A423	0.01	0.05	0.36	1.67	1.37	4.32	7.76	ghijklm
Own Venture	0.01	0.14	0.43	1.30	1.71	4.09	7.68	ghijklm
Daddow	0.01	0.09	0.25	1.46	1.63	3.77	7.19	hijklm
4/44Mc	0.02	0.14	0.99	1.61	1.22	3.08	7.04	hijklm
781	0.01	0.05	0.33	2.11	1.18	3.25	6.91	hijklm
2/12 Mc	0.03	0.15	0.96	1.08	0.78	3.87	6.90	hijklm
788	0.08	0.12	0.36	1.63	1.16	3.33	6.67	ijklm
A199	0.01	0.12	0.61	1.16	1.31	3.27	6.49	ijklm
A4	0.05	0.22	0.66	1.21	0.98	2.96	6.09	jklm
853	0.01	0.25	0.69	0.96	0.97	3.10	6.00	klm
A417	0.01	0.05	0.27	0.82	1.29	3.50	5.96	klm
705	0.02	0.04	0.45	1.19	0.74	3.31	5.78	lm
2/48B	0.01	0.03	0.16	1.03	1.09	3.23	5.58	m
835	0.01	0.03	0.12	0.23	0.42	2.02	2.89	n
LSD (P=0.05)								
Minimum	0.098	0.257	0.590	0.740	0.458	1.305	2.304	
Maximum	0.142	0.360	0.843	1.088	0.669	1.860	3.298	
Average	0.102	0.266	0.613	0.772	0.477	1.356	2.395	

*numbers of cumulative sound kernel yield followed by the same letter are not significantly different.

Nut-in-shell yield

There was insufficient yield of nut-in-shell during the first two years of production, 2000 and 2001, to carry out reliable kernel recovery tests. Fig 3 presents nut-in-shell data covering the years 2000 to 2005 to indicate t he likely impact of the early yields on the relative performance of these top varieties. Only A268 and 814 would have improved their cumulative sound kernel ranking based on the early NIS yields on 2000 and 2001. A268 produced 4.14kg NIS over these years, equivalent to 1.5kg kernel, based on average sound kernel recovery, which would have it ranked the highest (above A16). The additional NIS yield of 3.19kg from 814, equivalent to ca 1.23kg kernel, would also have improved its ranking slightly to third, just below A16.

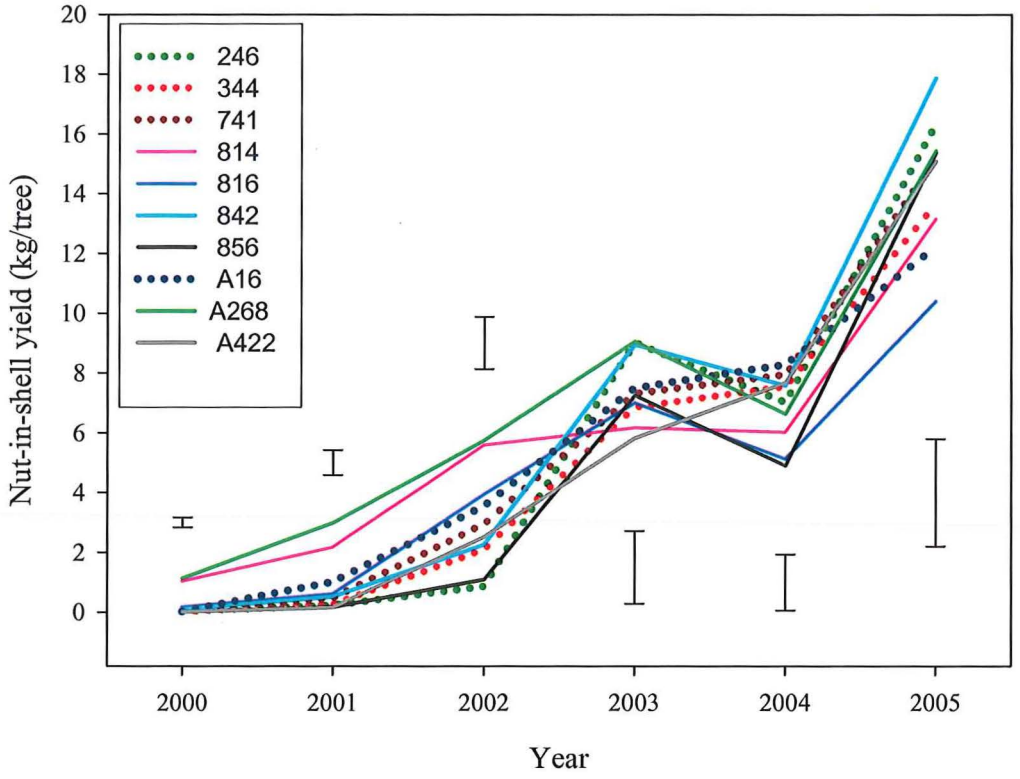

Figure 3. Nut-in-shell yield of the top nine varieties (based on cumulative sound kernel yield) and the industry standard variety, 344 at Winfield from 2000 to 2005. Bars indicate average LSD (P = 0.05) for each season.

Sound kernel yield per unit tree size

Since the macadamia industry is tending towards high density plantings, it may be helpful to present yield data on the basis of tree size. High yield from smaller trees is desirable for high density plantings. Yield of sound kernel per unit trunk cross sectional area of all varieties is shown in Table 3 and yield per unit projected canopy area in Table 4. Of the original top varieties, most remain in the top group based on tree size measurements (trunk cross sectional area and canopy area) with a couple of exceptions: 816 dropped from the top group based on trunk cross sectional area but not canopy area and A268 dropped out on the basis of canopy area but not trunk cross section. A number of varieties with large trees (842, 856 and 246) did not make the top group for either yield per unit trunk cross section or canopy area. The industry standard variety, 344, and 246 were well down the list based on sound kernel yield per unit tree size. Although tree size measurements are highly correlated, canopy area is more widely accepted as the appropriate way of assessing yield per unit tree size. Top varieties based on yield per unit canopy area are A16, 814, 816 and 741, A422 dropped to eighth and A268 dropped to fourteenth.

Table 3. Sound kernel yield per unit trunk cross sectional area of 36 macadamia varieties at Winfield from 2002 to 2005 (with LSDs) and cumulative sound kernel yield from 2002-2005, ranked.

	Sound kernel yield (g/cm^2 trunk cross sectional area)				
Variety	**2002**	**2003**	**2004**	**2005**	**2002-05**
A16	22.5	35.1	36.9	53.3	124.1
814	27.4	7.1	16.4	51.0	90.9
A268	30.6	16.9	12.8	42.9	84.4
A422	13.9	22.1	21.1	42.1	83.5
A437	20.4	16.0	9.8	51.3	83.5
741	15.0	16.8	17.7	46.4	82.9
NG8	18.6	21.1	11.0	45.5	78.7
A38	10.8	15.5	16.2	48.8	77.6
2/18Mc	12.4	63.2	9.8	25.9	77.4
4/7Mc	29.4	5.7	13.5	46.4	76.6
A423	6.9	23.6	15.6	41.3	74.0
A199	12.9	20.3	18.7	37.6	73.8
816	15.8	29.6	10.9	31.6	71.1
A387	19.4	16.3	16.7	33.1	70.2
A4	14.2	24.3	16.5	35.8	70.0
A104	21.6	20.7	9.2	36.8	69.8
849	13.9	22.0	11.5	37.4	69.5
783	9.0	20.6	10.4	40.9	68.8
2/5Mc	10.8	18.3	11.3	41.1	68.2
A203	17.4	18.7	15.0	33.7	67.5
Daddow	5.3	21.1	19.4	36.0	67.5
246	4.8	17.9	12.5	41.8	67.4
856	5.6	23.2	10.8	39.8	66.9
842	9.3	20.7	7.4	41.5	66.2
344	9.4	15.0	13.5	38.6	66.0
Own Venture	7.4	15.9	15.3	31.4	57.8
2/12 Mc	15.4	13.4	7.4	31.8	55.2
853	12.1	14.0	11.5	29.5	54.4
705	8.7	16.8	9.2	31.6	54.1
781	6.1	22.4	10.4	25.9	53.3
1/40B	14.3	14.3	11.5	27.2	53.2
2/48B	3.9	15.5	13.7	31.2	52.1
A417	5.1	9.5	12.4	29.7	49.4
4/44Mc	15.2	18.9	10.9	22.7	49.2
788	5.5	16.3	9.6	25.0	47.5
835	2.9	4.3	7.3	29.1	38.6
LSD (P=0.05)					
Maximum	10.78	9.261	4.912	10.62	18.12
Minimum	14.61	13.65	7.321	14.78	25.84
Average	11.15	9.657	5.128	11.01	18.83

Table 4. Sound kernel yield per unit projected canopy area of 36 macadamia varieties at Winfield from 2002 to 2005 (with LSDs) and cumulative sound kernel yield per unit projected canopy area from 2002-2005, ranked.

	Sound kernel yield (g/m^2 projected canopy area)				
Variety	**2002**	**2003**	**2004**	**2005**	**2002-05**
A16	213.3	228.7	246.0	365.0	823.9
814	251.7	48.5	126.1	431.8	772.8
816	194.0	299.7	117.1	320.9	730.0
741	211.2	154.4	161.4	400.0	719.0
A203	192.8	169.1	158.7	335.3	687.2
A104	279.4	168.5	93.2	355.6	675.1
2/5Mc	107.5	153.2	101.7	392.3	656.9
A422	122.9	155.4	168.2	336.4	656.5
NG8	199.2	164.9	82.2	353.7	613.6
A423	61.0	164.7	121.1	340.6	611.5
A437	187.7	112.4	68.4	366.3	598.9
A199	105.3	124.4	132.1	303.8	586.4
4/7Mc	259.1	39.4	93.7	356.4	585.8
A268	263.9	113.2	91.2	300.6	585.1
849	112.1	144.4	84.5	313.8	584.8
2/12 Mc	161.2	124.0	73.4	324.2	566.3
2/18Mc	107.1	440.7	67.6	194.3	563.1
783	83.6	152.5	87.6	329.9	557.4
A387	178.7	121.1	130.8	263.3	555.1
246	44.1	153.7	103.5	339.8	552.7
842	84.8	166.3	58.9	343.7	552.1
4/44Mc	179.4	197.4	115.7	241.7	536.6
Own Venture	80.6	136.7	146.0	291.8	536.6
1/40B	157.9	113.8	106.7	265.6	526.7
856	52.2	152.7	77.1	308.5	517.5
A38	85.9	98.8	93.4	323.7	515.2
344	102.0	112.2	105.9	290.5	492.9
A4	118.7	153.4	103.3	247.4	480.0
Daddow	49.4	134.9	124.7	246.1	462.6
705	103.5	143.9	66.8	264.8	456.8
853	166.3	125.9	95.6	244.7	452.1
781	55.0	173.3	83.0	211.8	434.0
A417	51.1	78.7	102.8	251.6	414.0
788	55.2	131.5	76.0	212.0	405.1
2/48B	44.5	106.3	96.4	239.3	401.1
835	31.4	25.3	38.3	166.7	232.2
LSD (P=0.05)					
Maximum	113.90	63.55	34.67	88.11	152.70
Minimum	153.10	94.60	51.72	120.40	212.60
Average	117.60	66.33	36.19	91.14	158.30

Nut drop pattern

The pattern of nut drop has a large impact on orchard management. Many growers want early varieties to condense the harvest period and to break the pest/disease cycle. In some areas, the drop pattern can be useful to minimise harvesting during unfavourable weather (rain) conditions so mid-late season varieties might be preferred. Larger growers may prefer to have varieties with a range of drop patterns to spread the harvest workload. In this study, the date by which 90% of the crop has dropped naturally is used as a measure of earliness. Early varieties all dropped 90% of their crop or more by the end of June, mid-season varieties by the end of July and late varieties by, or after, the end of August.

The cumulative drop patterns of early varieties 246, 344, 741, 788, 816, 835 and A387 over the years 2003 to 2005 are shown in Fig. 4. Some of these were very early varieties, often dropping >90% of their crop by the end of May in 2 of 3 years: 246, 816, 835 and A387. Nut drop varies with season. It seems that drop may have been slightly earlier in the harsh drought years of 2003 and 2004.

Cumulative drop of a selection of mid season varieties (814, 842, 856, A268, A4 and Daddow) plus 344 for comparison, is shown in Fig 5. A268 was much earlier in the drought year, 2004 but not in the normal season, 2005. Also tending to be early in 2004 was 842. These figures are biased by the stressful drought years and more analysis of the drop pattern at Winfield is needed. In 2005, 814 was particularly late and 842 and Daddow also tended to be late.

At Winfield, trees were stripped of nuts in August and were not separated from nuts that had dropped naturally during that month. Thus, data on late dropping varieties is not as detailed as it could be. Nevertheless, Fig 6 shows the contrast between late varieties and the industry standard, 344. It does not, however, show the extent of very late nut drop. In the dry year of 2003, the drop of late varieties was spread out: 783 was the earliest, followed by A38, 781, 849 and A422. Much later was A16 and the latest of all, 705. Separating the natural drop in August from the strip harvest over 2006/2007 will provide more information on very late dropping varieties.

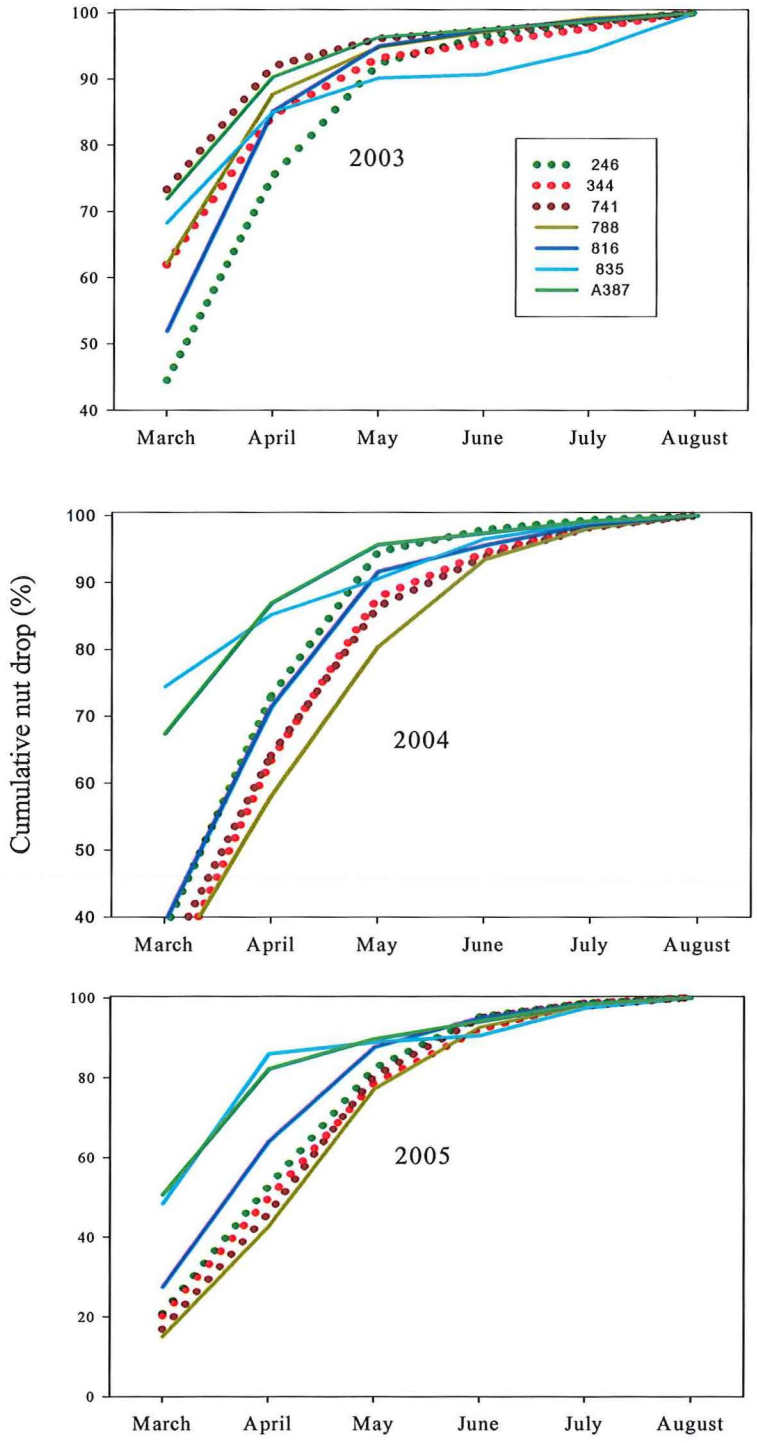

Figure 4. Cumulative nut drop of early varieties at Winfield from 2003 to 2005.

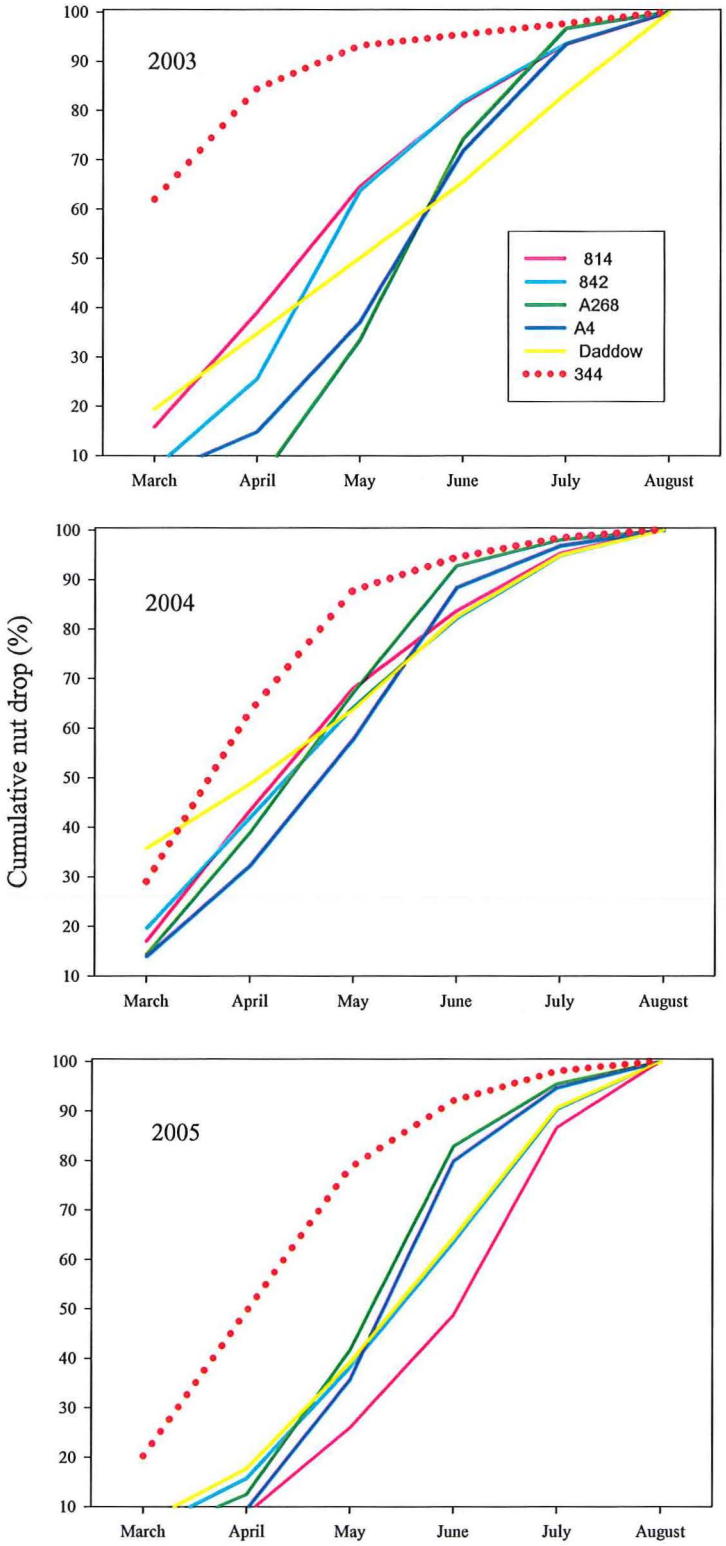

Figure 5. Cumulative nut drop of selected mid-season varieties (814, 842, A268, A4, Daddow), plus 344 for comparison, at Winfield during 2003-2005.

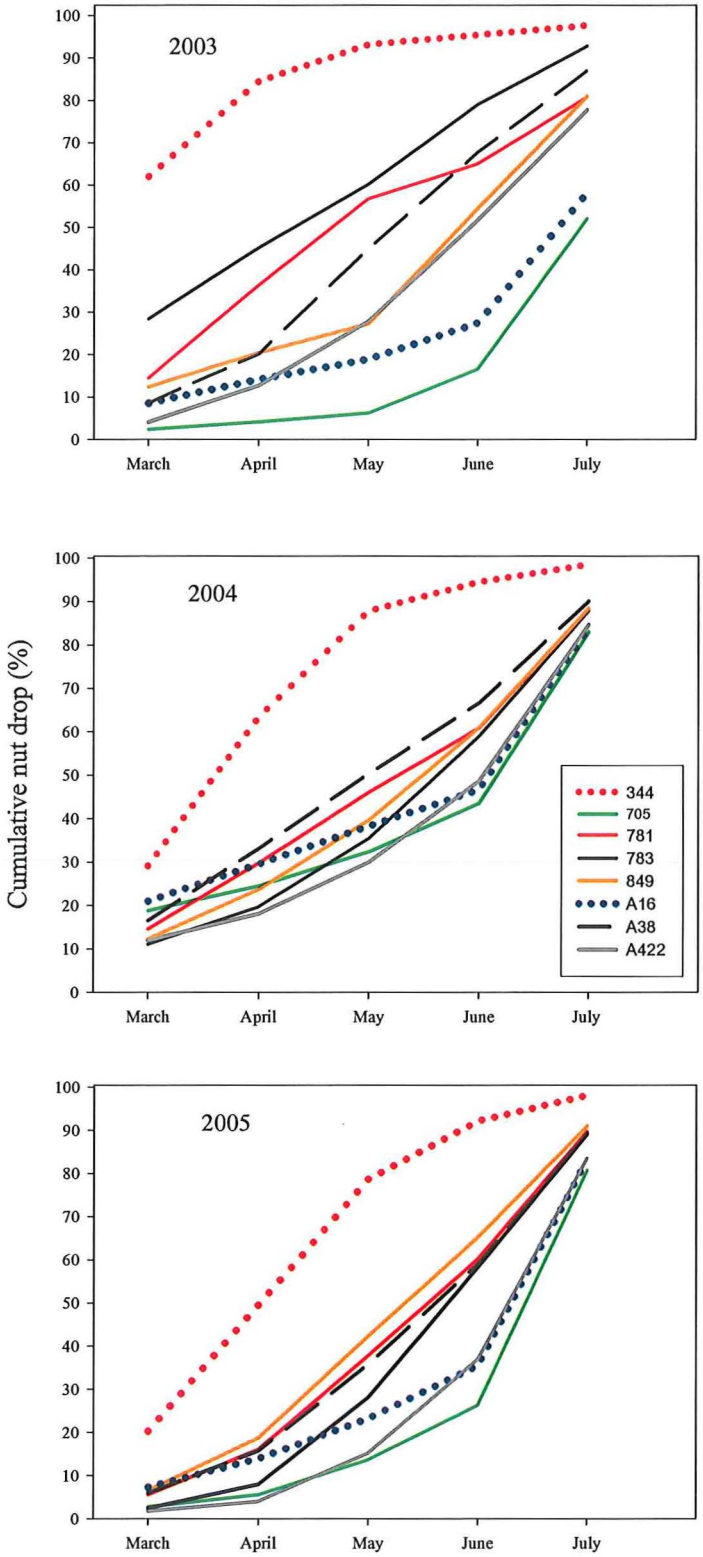

Figure 6. Cumulative nut drop of selected late varieties (705, 781, 783, 849, A16, A38 and A422), plus 344 for comparison, at Winfield during 2003-2005.

Sound kernel recovery

Sound kernel recoveries of 36 varieties at Winfield from 2002 to 2005 are shown in Appendix 1, Table 37). Ideally, it is desirable to select varieties that have high and stable sound kernel recoveries (SKR) from year to year. At Winfield, A4 and to a lesser extent 788, A16, A422 and 856 were relatively stable from 2002 to 2005 (Figs 4,5 and 6) whereas many varieties were unstable, probably adversely influenced by the drought years (2003 and 2004). One variety, 816, broke the trend and had very high SKR in 2003 and 2005 but low values in 2002 and 2004. Most of the remaining varieties had low SKR during the dry 2003 and 2004 years but the pattern was not consistent. The SKR of industry standard varieties 344, 741 and 246 and A268 were low in both these years. The SKR of 814 was disastrous in 2003 whereas in 842, 246, 856, A268, and A422, it was very low in 2004. Whereas total kernel recovery was relatively stable from year to year, SKR is more likely to be adversely influenced by stressful conditions and management. Of these 10 varieties, only four had average SKR (2002-2005) greater than 30%: 816 (37.1%), A16 (34.4%), A422 (32.7%) and 741 (30.4%). Although climatic conditions may have been extreme over this period, they are probably beneficial in helping to identify weaknesses in varieties.

There was quite a bit of variation in the composite SKR data at different harvests over the season but, since individual replicates were not analysed, this can not be interpreted. Previously, when more objective quality measures were used, differences between harvests over the season were relatively minor. Currently, replicate samples are being analysed so that differences in quality between harvests can be assessed more meaningfully in the follow-on RVT Series 3 project.

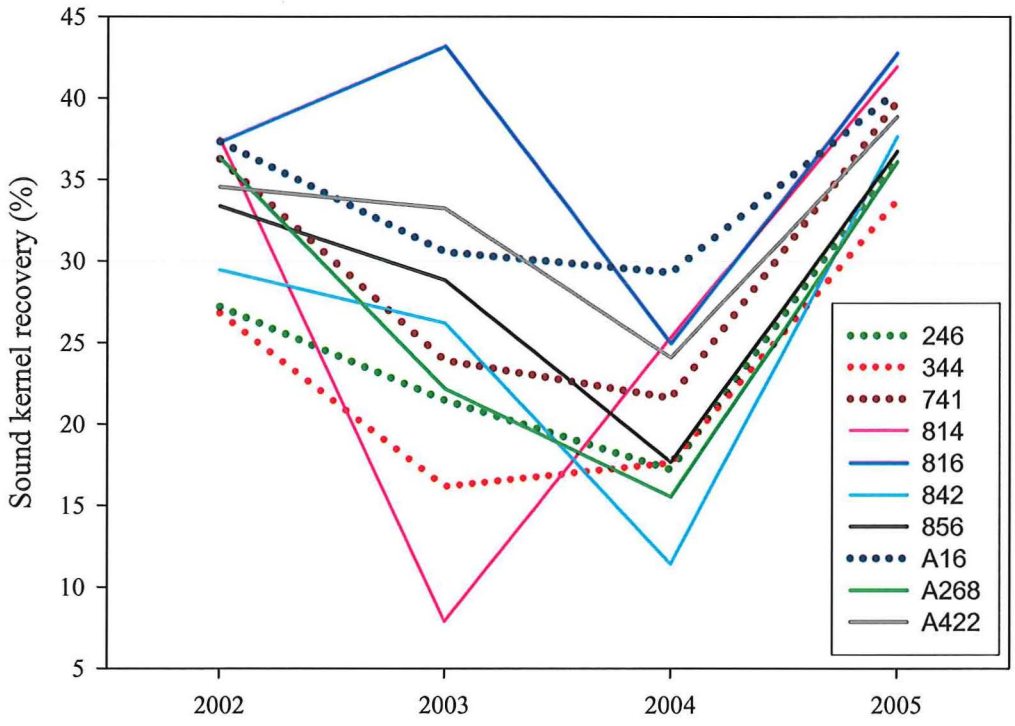

Figure 7. Sound kernel recovery of the top varieties, based on cumulative yield of sound kernel, and the industry standard variety, 344, at Winfield from 2002 to 2005.

Unsound kernel recovery

Very large levels of unsound kernel recovery (USK) were recorded at Winfield, particularly in the drought years (2003 and 2004, Fig 8) although the main cause of unsoundness was discolouration, particularly basal discolouration, mainly at severity level (SL)1 (Table 5). Although SL1 basal discolouration is still considered to be premium kernel, this could change if the world market becomes more discerning. The levels of unsound kernel in the 2005 season are more acceptable.

Categories of unsound kernel

The assessment of unsound (reject) kernel has developed as the macadamia industry has refined its quality standards. For example, more detailed information has been collected since 2003 on various types of discolouration. Because of concerns about the difficulty of getting consistent qualitative kernel quality data, the industry encouraged the adoption of a quality assessment system based on 3 severity levels (SL) for each defect. The lowest is SL1 (often accepted as premium kernels) and the highest severity is SL3 (reject kernels). This system is complicated by the fact that some defects at the lowest severity level are still classed as premium.

Table 5 shows that discolouration has been the most serious defect at Winfield over the period 2002 to 2005, ranging from an average of 2.2% to 9.3%. Most of this was due to basal discolouration, although the majority of discolouration was at severity level (SL1) which is still currently classed as premium kernel. Levels of mould, pre-germination and pitted centres have been very low. Insect damage was very low in 2003 and 2005 and did not exceed 1.01% in the other years. Immaturity was quite high in the drought year of 2003 and to a lesser extent in 2004 which was also dry. Although the orchard is irrigated, water has been limiting and this may account for the immaturity levels at Winfield. The incidence of O-rings was also high during 2003 and 2004. The incidence of all other disorders was generally low.

Table 5. The average percentage of unsound kernel in various categories (all severity levels included) across 36 varieties at Winfield from 2002 to 2005.

	2002	**2003**	**2004**	**2005**
Germination	0.04	0.00	0.00	0.00
Mould	0.04	0.20	0.04	0.09
Insect	0.82	0.13	1.01	0.29
Immaturity (shrivelled)	0.56	5.84	1.70	1.00
Discoloured crest		0.57	0.17	0.25
Basal discolouration		2.85	6.85	8.24
Internal discolouration		0.01	0.00	0.02
O-Rings		2.32	2.19	0.16
Discoloured suture		0.00	0.09	0.34
Total Discoloured	**2.22**	**5.74**	**9.30**	**9.02**
Pitted centre		0.20	0.03	0.07
Irregular shape		0.59	0.00	0.00
Other		0.82	0.39	0.13

Although Table 5 gives an overview of the incidence of unsound kernel at Winfield, of more importance is the incidence in individual varieties. Table 6 shows the levels of unsound kernel of the top 10 varieties based on cumulative sound kernel yield over the years 2002 to 2005. Only one variety, 842, had a higher level of unsound kernel (1.8%) than the industry standard 344 (1.4% and 246 (1.4%). The lowest average levels of unsound kernel were for 856, A16 and A422, all at 0.8%. In comparison, other common varieties averaged 1.8% (849), 1.1% (A38), 0.8% (788), 0.6% (A4), and o.5% Daddow and NG8.

Basal discolouration

Basal discolouration was the most common disorder , although most of it was only at SLs 1 and, to a lesser extent, 2. Varieties which had >10% basal discolouration, mainly in 2004 and 2005 (av>7.6%), were 344, 816, 842, and A268 . Only one of these top varieties at Winfield had <5% basal discolouration in each of the four years, A16! In 2005, the highest levels of SL2 basal discolouration, often classed as commercial kernel depending on the disorder, occurred at the early (April) harvest.

Table 6. The percentage of unsound kernel in various categories (all severity levels included) of the top varieties for cumulative sound kernel yield and the industry standard 344 for comparison, at Winfield from 2002 to 2005.

Unsound disorder	Year	246	344	741	814	816	842	856	A16	A268	A422
Mould	2002	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0
	2003	0.0	0.6	1.1	0.6	0.0	0.0	0.0	0.0	0.0	0.0
	2004	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
	2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0
Insect	2002	0.0	0.2	0.8	0.0	2.6	0.9	0.0	0.7	0.3	0.4
	2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2004	0.9	0.1	0.8	1.8	2.4	1.0	1.2	1.9	0.4	1.9
	2005	0.0	0.1	0.3	0.4	0.1	0.0	0.0	0.4	0.2	0.0
Shrivelled	2002	1.1	0.7	0.0	1.0	1.5	0.4	0.0	0.0	0.5	0.0
	2003	5.6	9.1	4.5	16.9	0.4	4.8	2.9	3.8	9.4	2.5
	2004	1.3	2.7	0.5	2.7	5.7	2.0	1.6	1.2	2.8	1.4
	2005	4.1	0.0	0.0	1.1	0.4	0.0	0.4	1.3	0.3	0.0
Discoloured crest	2003	0.3	0.0	0.0	0.0	0.0	0.0	0.3	3.5	0.0	0.0
	2004	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Basal discolouration	2002	2.5	3.2	0.6	0.8	3.6	2.5	0.0	2.3	0.4	2.2
	2003	3.4	0.0	2.4	1.0	1.4	6.3	2.6	2.8	4.2	2.4
	2004	8.5	10.3	8.9	5.3	10.3	11.3	5.3	2.5	8.9	6.3
	2005	9.0	11.9	7.4	3.0	3.4	14.1	6.6	3.1	10.3	6.8
Internal discolouration	2003	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
O-Rings	2003	3.0	3.2	5.1	0.0	0.0	4.9	2.6	0.0	4.5	0.0
	2004	1.3	2.5	0.0	0.7	0.0	10.8	2.4	0.0	3.1	0.3
	2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Discoloured suture	2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2004	0.0	0.3	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0
	2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0
Pittered centre	2003	0.0	0.0	0.4	0.0	0.0	0.0	0.0	1.2	0.0	0.0
	2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	2005	0.0	0.0	0.6	0.0	0.8	0.4	0.0	0.0	0.0	0.0
Other	2003	4.3	1.3	4.7	2.3	0.0	1.2	0.0	0.0	0.0	2.4
	2004	0.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
	2005	0.1	0.0	0.0	1.1	0.0	0.3	0.0	0.0	0.0	0.7
Average unsound kernel		1.4	1.4	1.1	1.1	1.0	1.8	0.8	0.8	1.4	0.8

Shrivelled kernel
The second most prevalent kernel disorder was shrivelled kernel, averaging 6% in 2003 but <1% in the 'normal' years 2002 and 2005. In 2003 varieties with above average shrivelled kernel for the year were: 814 (16.9%), A268 (9.4%), 344 (9.1%), and 246 (5.6%). In 2004, varieties with above average shrivelled kernel were: 816 (5.7%), A268 (2.8%), and 344 and 814 (2.7% each). In 2005, shrivelled kernel (sum of all SLs), was greatest at the early (April) harvest. There was little incidence of SL3 shrivelled kernel.

Discoloured suture
Most varieties did not have discoloured sutures, the highest being 1.7% for A16, most being at SL1 (Premium kernel). The total incidence of discoloured suture (sum of SLs) did not vary much between harvests.

Discoloured 0- ring
All the top varieties had zero discoloured rings in 2005 although this disorder was more prevalent during the drought years (2003 and 2004), the highest being 10.8% for 842, 0.7% for 814 and 5.1% for 741. All other varieties had <5% o-rings.

Mould and insect damage
Good orchard management is indicated by the low levels of mould and insect damage recorded (most <0.5%, all < 1% for mould and all <2.6% for insects).

All other categories of unsound kernel , if present at all, were at very low levels. These quality assessments were carried out on composite samples. Thus, the data should be viewed with caution as there is no statistical analysis to indicate confidence limits.

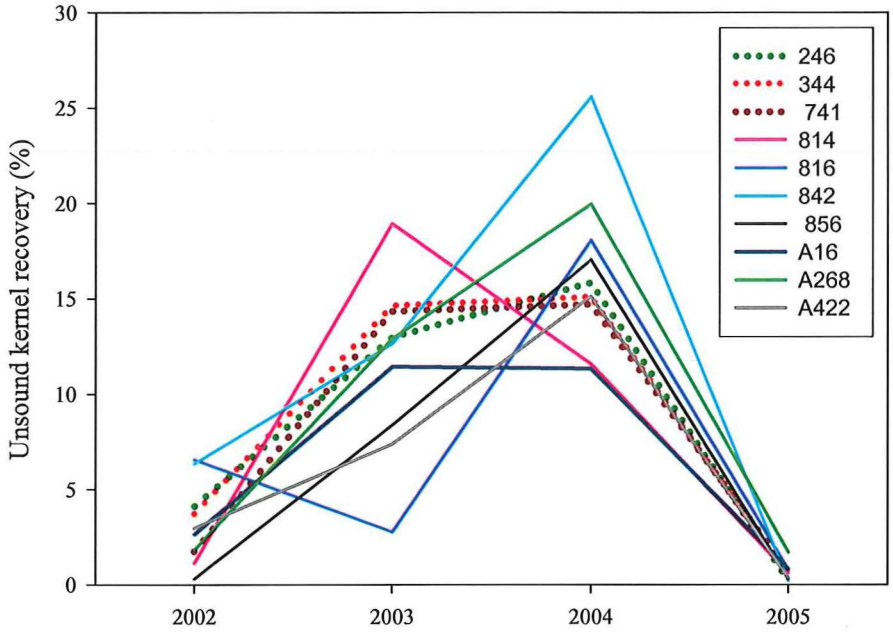

Figure 8. Unsound kernel recovery of top varieties based on cumulative yield of sound kernel, and the industry standard, 344, for comparison, at Winfield from 2002 to 2005.

Commercial quality
Different processors may vary the allocation of SLs to their premium and commercial grades. Table 7 shows premium kernel recovery which includes SL1 defects except for pitted centres which is classed as commercial and open micropyle, internal discolouration, pink staining and insect and mould damage all of which is reject. Commercial grade also includes SL2 for shrivelled, discoloured crests, basal discolouration, discoloured rings and suture lines. In 2005, average sound (premium) kernel recovery (SKR) was 34.3%. SKR of many varieties was slightly lower than at Hinkler Park, but for 814, it was

slightly higher (38.3 compared with 6.4% at Hinkler Park). The average % premium and commercial kernels were 34.3% and 4% respectively, although one variety had 13.1% commercial. Average unsound kernel was 5% and the highest was 13.6%, mainly due to high commercial grade kernel.

Only 3 of the varieties in the top 10 for cumulative sound kernel yield, 814, 816 and A16 were also in the top 10 for sound kernel recovery (SKR). These levels were much higher than those recorded over the past 2 seasons and were generally similar to the levels recorded in 2002. Of the top 10 for SKR, A16 was lowest with 40.4%. Other varieties in the top 10 for SKR include 849, A387, A437, 2/5 Mc, and 1/40 B. The industry standards of 344, 246 and 741 had SKR of 33.7%, 36.3%, and 39.8 respectively.

Table 7. Kernel quality, incorporating commercial categories based on severity levels, at Winfield in the 2005 season compared with the average total kernel recovery from 2002 to 2004.

Variety	Premium (Sound) KR%	Commercial KR%	USK (%)	TKR (%)	Av TKR 2002-2004
246	32.21	4.08	4.3	36.5	32.5
344	29.83	3.86	4.3	34.1	31.3
741	36.27	3.48	4.2	40.4	34.2
705	31.42	1.56	3.8	35.2	35.4
783	31.73	5.87	7.6	39.3	36.5
788	34.17	4.09	5.2	39.4	38.0
814	38.30	3.59	4.2	42.5	34.1
816	40.86	1.88	2.7	43.5	44.3
835	31.25	6.65	8.0	39.2	33.9
842	30.40	7.24	7.4	37.9	37.2
849	41.30	1.25	1.6	42.9	40.7
853	37.60	1.30	1.4	39.0	39.9
856	34.82	1.93	2.2	37.1	35.2
Daddow	35.54	1.29	1.4	36.9	35.1
NG8	37.00	1.01	1.4	38.4	35.2
Own Venture	35.30	3.22	4.2	39.5	36.2
A4	36.38	3.10	4.7	41.1	42.3
A16	38.58	1.86	2.7	41.2	40.9
781	35.47	1.67	2.3	37.7	37.3
A38	30.66	5.09	6.2	36.8	33.3
A104	39.35	2.04	2.8	42.1	40.1
A199	34.19	1.53	1.8	36.0	34.9
A203	36.11	1.05	1.4	37.5	35.6
A268	29.48	6.63	8.3	37.8	36.3
A387	39.74	1.59	1.8	41.5	40.0
A417	29.29	8.36	10.4	39.7	35.6
A422	34.80	4.05	4.4	39.2	39.1
A423	26.73	13.08	13.6	40.3	37.4
A437	40.56	3.02	6.4	47.0	41.9
1/40B	33.57	7.72	9.4	42.9	42.5
2/5Mc	37.78	3.74	5.9	43.8	42.6
2/12 Mc	27.63	6.93	9.7	37.4	37.8
2/18Mc	28.11	7.35	7.8	35.9	42.9
2/48B	32.15	2.71	5.0	37.2	35.8
4/7Mc	36.47	4.20	4.5	41.0	37.7
4/44Mc	31.10	5.08	7.8	38.9	38.9

First Grade kernel

Data on first grade kernel (G1K) are presented in Appendix 1, Table 39). Floatation tests were carried out on sound kernel after visual sorting which is designed to identify kernel defects, including

immaturity. The visual sorting obviously did not identify all kernels with < 72% oil, although most of the top varieties in the Winfield trial had reasonable G1K, except in 2004 when 246, 741, 856 and A268 were low. Although G1K tests are not widely carried out commercially now, they may provide additional useful information in these studies.

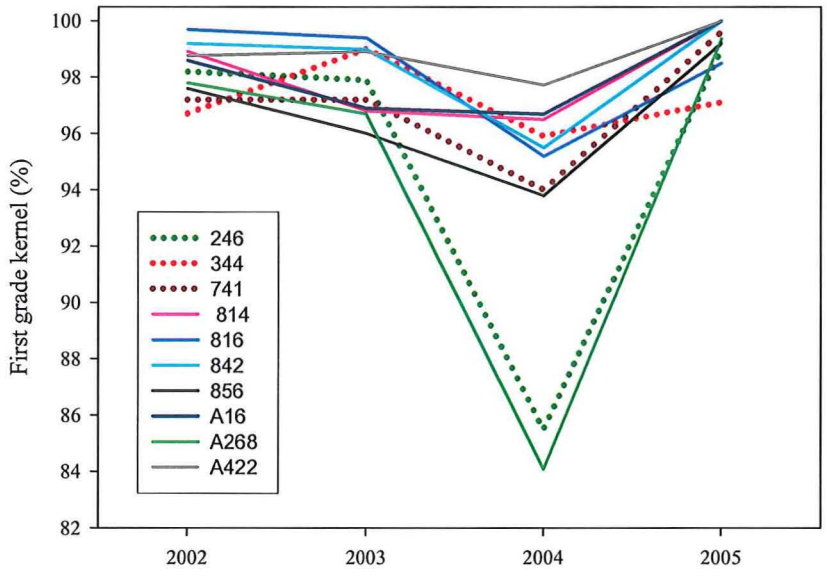

Figure 9. First grade kernel of the top varieties, based on cumulative yield of sound kernel, and the industry standard variety, 344, at Winfield from 2002 to 2005.

Whole kernel

The percentage whole kernels after cracking varied widely with season (Fig 10). It seemed to be greatest in the drought years 2003 and 2004. Of these top varieties, the industry standard variety, 344, had the most stable but lowest whole kernel percentage (av.25.2%). The highest was A422 with an average of 55.5%.

Nut and kernel mass

The nut and kernel mass data for all varieties are shown in Appendix 1, Tables 41 and 42. The largest nut was A268 averaging 8.2g (6.5-9.6g range), followed by Own Venture at 7.8g, 246 at 7.3g and 344 at 7g. Nut size decreased in the drought year (2003) by an average of 1.5g across all varieties, particularly for A268 which was over 3g smaller in 2003 compared with 2002. The smallest nut was 814 at 4.3g.

As expected, A268 had the largest kernel of the top varieties, averaging 3.0g although in 2002 it was 3.7g and in 2003, 2.3 g. The kernel of A16 averaged 2.8g, 741, 246 and 856 averaged 2.5g each, A422 was 2.4g and 344 averaged 2.3g.

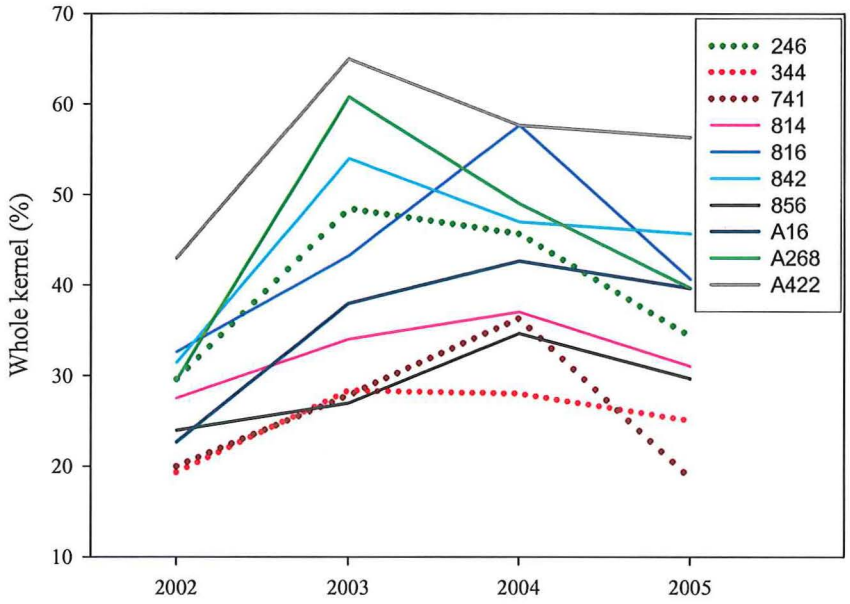

Figure 10. Whole kernel of the top varieties, based on cumulative yield of sound kernel, and the industry standard variety, 344, at Winfield from 2002 to 2005.

Tree size

Tree size measurement data are presented in Appendix 1, Tables 43-49). All measures of tree size were highly correlated (P = 0.001) (Table 8). It is easier to measure trunk girth, for example, than tree height to which it is highly correlated. Since the N-S canopy diameter is constrained by crowding of trees within the row, it was not as highly correlated with other tree size measurements as E-W canopy diameter was. Canopy area is commonly used as the industry index of tree size and yields are often expressed per unit of canopy area to select trees for high density plantings. High correlations of trunk cross sectional area (CSA) with girth, and canopy area with measures of canopy diameter, are not of interest as the variables are derived from each other. Although tree height is more difficult to measure, it is useful to calculate canopy volume.

Table 8. Correlation matrix of tree size measurements at Winfield.

Av.canopy diameter (m)	1						
E-W canopy diameter (m)	0.961	1					
N-S canopy diameter (m)	0.913	0.764	1				
Trunk CSA* (cm^2)	0.832	0.822	0.726	1			
Canopy area (m^2)	0.989	0.952	0.901	0.835	1		
Trunk girth (mm)	0.847	0.828	0.754	0.989	0.836	1	
Tree height (m)	0.738	0.736	0.633	0.814	0.721	0.825	1
	Av. canopy diam.	E-W canopy diam.	N-S canopy diam.	Trunk CSA	Canopy area	Trunk girth	Tree height

* CSA = cross sectional area

Hinkler Park

Although average NIS yield was depressed during the drought year of 2003, it recovered in 2004 which was also dry (Fig 11.). It seems, however, that yield of sound kernel was more sensitive to the dry seasonal conditions and did not recover in 2004. Yields continue to increase so it is important to continue collecting data for several more years until yield plateau.

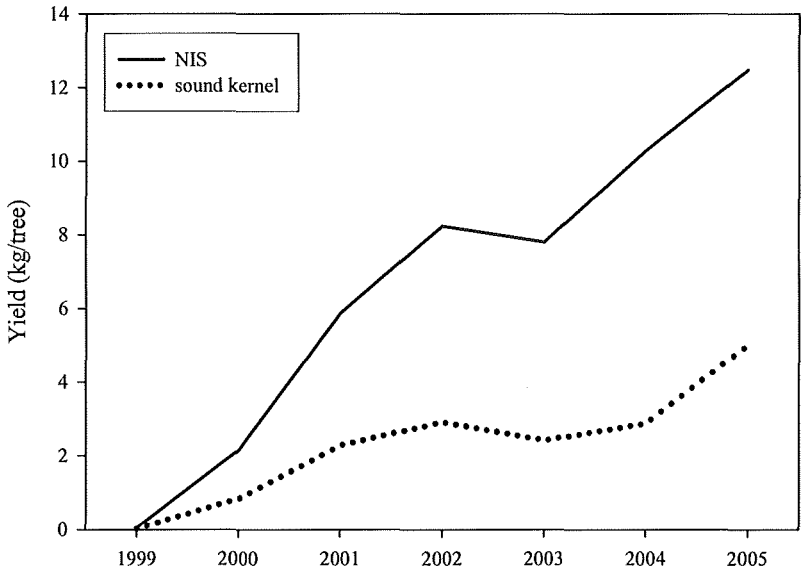

Figure 11. Mean nut-in-shell (NIS) and sound kernel yield of 36 varieties at Hinkler Park from 1999 to 2005.

Sound kernel yield

Table 9 shows that the cumulative yield of SK (years 1999-2005) varied with variety from 14.4kg/tree for A4 up to 19.0kg/tree for 816 at Hinkler Park (an equivalent range of 4.5 – 5.94t/ha over the seven years). This is a much smaller range than that recorded at Winfield. The cumulative yield of the industry standard variety, 344 was 16.6kg/tree and no variety in this trial produced significantly more or less cumulative SK than 344. Cumulative SK yield of 816 was, however, significantly greater than the other commercial varieties, 246, 741 and A4. Also, the second to fourth highest yielders, A203, 842, and 788 produced significantly higher yield of cumulative SK than 741 and A4. In individual years, several varieties produced higher yields of sound kernel recovery than 344 but not consistently so. Only 816 (in 2001 and 2004), 788 (in 2000 and 2004), A203 (in 2000 and 2001), A104 (in 2000 and 2004), NG 8 (in 1999 and 2000), 772 (in 2000 and 2001) and Daddow (in 2003 and 2004) produced higher yields than 344 in two years. The top 13 varieties (344 and above for cumulative SKR) all produced within 2.4kg sound kernel/tree of each other over the seven year period and the 20 of the 27 varieties were not significantly different from each other. Only seven varieties produced significantly lower cumulative yields of sound kernel than 816, only two produced significantly less than A203, 842 and 788. These indecisive results make it difficult to make recommendations of varieties and decisions will be based on other attributes, particularly quality.

Table 9. Sound kernel yield of 27 macadamia varieties at Hinkler Park from 1999 to 2005 (with LSDs) and cumulative sound kernel yield from 1999-2005, ranked. Data for 1999-2001 were derived from nut-in-shell yields using mean sound kernel recovery. Note cumulative yield was analysed separately so the sum of individual year means may differ from the cumulative yield.

	Sound kernel yield (kg/tree)								
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1999-05**	
816	0.0	0.9	3.1	3.3	2.4	3.6	6.6	19.0	a*
A203	0.1	1.4	3.1	3.4	2.2	3.0	5.6	18.3	ab
842	0.0	0.9	2.9	3.7	3.1	2.5	5.6	18.2	ab
788	0.0	1.4	2.8	3.3	2.9	3.3	4.9	18.2	ab
772	0.1	1.3	4.2	2.9	2.8	2.4	4.5	17.7	abc
Daddow	0.0	0.4	1.5	3.7	3.4	3.4	5.3	17.6	abc
A16	0.0	1.1	2.7	3.0	3.0	3.2	4.7	17.5	abc
A104	0.0	1.3	2.7	2.8	2.3	3.6	4.9	17.2	abc
Heilscher	0.0	0.4	1.4	3.2	3.0	3.7	5.6	17.1	abc
783	0.0	0.9	2.3	3.1	2.4	2.7	5.9	17.1	abc
A38	0.0	0.6	2.0	2.5	2.1	4.3	5.9	17.1	abc
A199	0.0	1.3	2.7	3.2	2.6	2.6	4.5	16.9	abc
344	0.0	0.5	1.7	3.6	2.2	2.3	6.2	16.6	abc
781	0.0	0.3	1.3	2.7	2.9	3.1	5.9	16.3	abc
849	0.0	0.6	3.4	3.1	2.6	2.1	3.8	16.0	abc
A268	0.0	1.2	2.4	2.9	2.1	3.1	4.1	16.0	abc
814	0.0	1.7	2.4	2.4	1.6	2.5	5.1	15.9	abc
Own Venture	0.0	0.5	2.2	3.0	2.2	2.8	4.9	15.9	abc
A422	0.0	0.7	2.6	3.0	2.4	1.7	4.6	15.5	bc
837	0.0	0.7	1.9	2.3	2.1	2.6	4.9	15.3	abc
804	0.0	0.3	1.8	2.6	1.9	2.9	5.3	15.3	abc
246	0.0	0.7	1.6	2.7	2.2	2.8	4.5	14.9	bc
NG8	0.1	1.1	1.7	2.6	1.8	2.7	4.4	14.9	bc
A423	0.0	0.4	1.9	2.7	2.2	2.6	4.6	14.9	bc
A426	0.0	0.8	2.0	2.3	2.7	2.3	4.2	14.9	bc
741	0.0	0.5	2.0	2.1	2.0	3.0	4.5	14.6	c
A4	0.0	0.7	1.4	2.6	2.0	2.7	4.3	14.4	c
LSD (P=0.05)									
Maximum	0.076	0.895	1.652	1.285	1.149	1.184	1.586	4.252	
Minimum	0.062	0.642	1.192	1.003	0.854	0.827	1.126	3.419	
Average	0.064	0.677	1.256	1.043	0.895	0.875	1.189	3.539	

*values of cumulative sound kernel yield followed by the same letter are not significantly different.

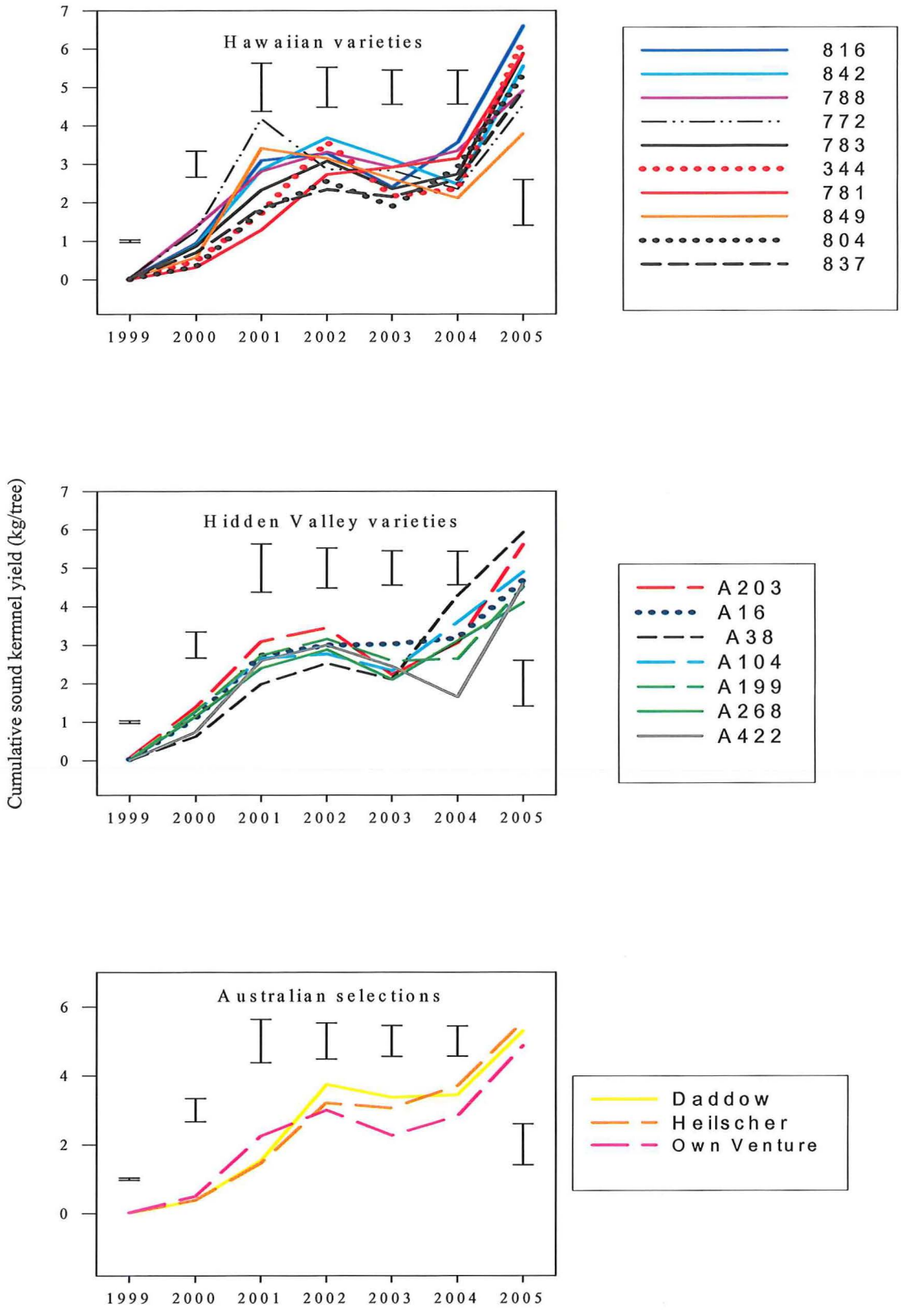

Figure 12. Cumulative sound kernel yield of the top varieties at Hinkler Park from 2001 to 2005. Bars indicate average LSD (P = 0.05) for each season.

Because of the large number of top yielding varieties at Hinkler Park that had similar yields (not significantly lower than the 816 that had the largest cumulative yield of sound kernel from 2001 to 2005), varieties are plotted according to their source: Hawaii, Hidden Valley Plantation and earlier Australian selections (Fig 12). The yield of most varieties was adversely affected by the dry conditions of 2003 and 2004, despite irrigation. The yields of some varieties bounced back in 2004, also a dry year, whereas others remained depressed. The drought seems to have reduced the yield differential between varieties from 2002 to 2004 and it is only in 2005 that the spread of yields is increasing and better varieties are starting to show up. It may be several years of 'normal' seasons before the best varieties for Hinkler Park are identified with confidence.

Although these data are limited, there may be some advantage with varieties that recover promptly from adverse conditions. The relative ranking of varieties at Hinkler Park, based on cumulative yield of sound kernel, changed considerably over the past 5 years, again stressing the importance of continuing data collection until variety yields stabilise. For example, although 816 was the top variety in 2005 and for 2001-2005, in 2001 it was third, in 2004, fourth, in 2002, sixth and second in 2003. Varieties that appeared most in the top 5 varieties most were A203 and 788 both four times during the early years), 842 and A104, three times and 344, 816, 814, and A199, two times each.

Nut-in-shell yield

Fig. 13 shows that the recovery of NIS yield from the previous drought seasons was less marked for 246, 741 and 788 than for 344, 816, 781, 783 and 842 within the better Hawaiian varieties. Within the Australian varieties, the recovery of A268, and to a lesser extent, A16, was less marked than that of A38, A203 and Daddow. Because of the limited data, caution should be exercised in interpreting these trends.

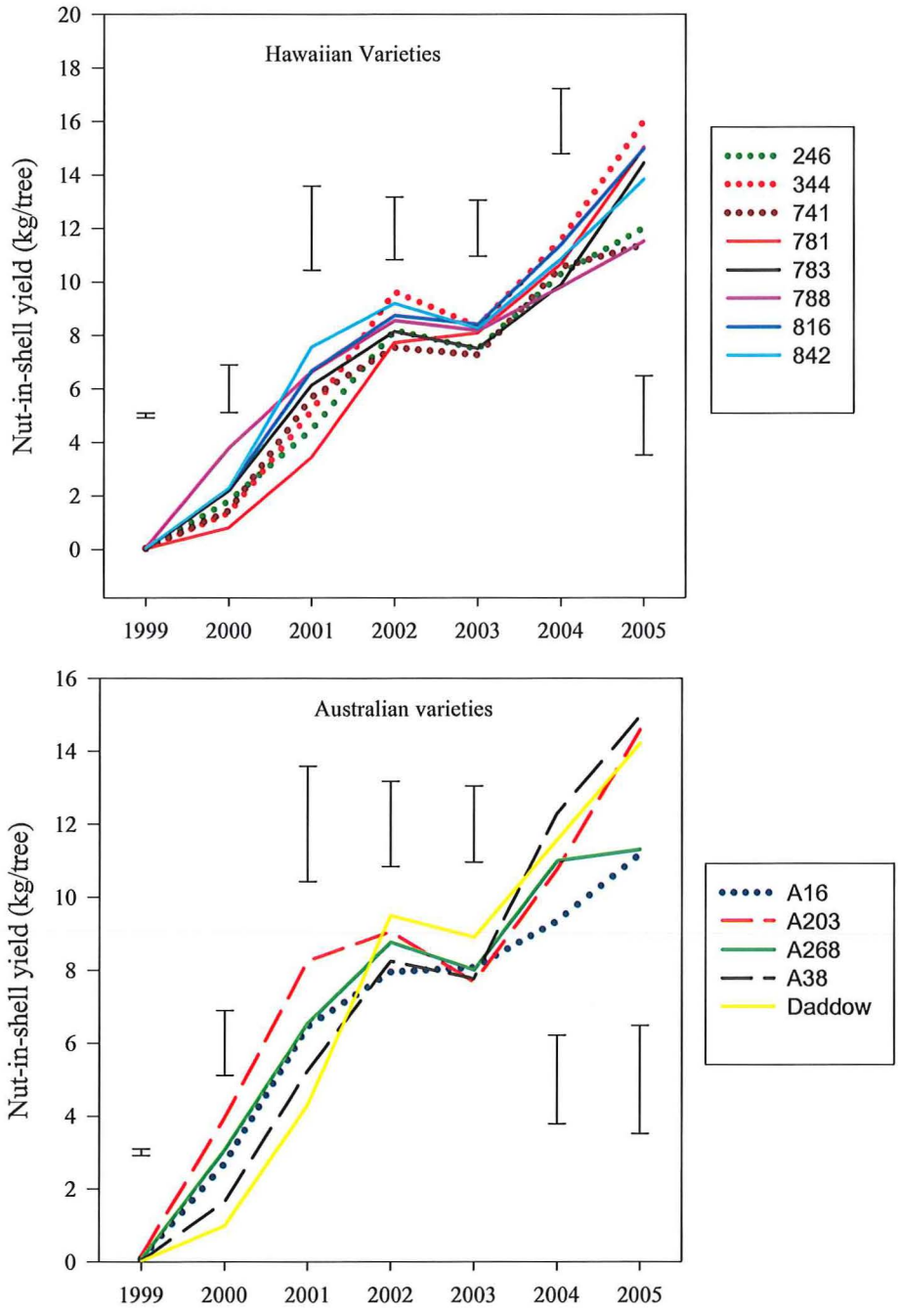

Figure 13. Nut-in-shell yield of selected varieties at Hinkler Park from 2000 to 2005. Bars indicate average LSD (P = 0.05) for each season.

Sound kernel yield per unit tree size

Table 10 shows that a group of the A series varieties produced the highest cumulative sound kernel yield per unit trunk cross sectional area. Although the yield of A16 was not significantly higher than that of A199, A38, A104, A203 or 814, it was significantly higher than the remaining 21 varieties (P+0.01). The expression of yield per unit projected canopy area is more common in the macadamia industry so the data in Table 11 are more relevant where varieties are being considered for high density plantings. Table 10 shows a similar ranking for sound kernel yield per unit canopy area with A16 again being significantly higher than 21 other varieties, this time including A38. Heilscher replaced A38 as a variety that was not significantly different to A16. Although trunk cross sectional area was generally highly correlated with projected canopy area, it seems that the canopy area of A38 was relatively greater than the trunk size.

Table 10. Sound kernel yield per unit trunk cross sectional area of 27 macadamia varieties at Hinkler Park from 2002 to 2005 (with LSDs) and cumulative sound kernel yield from 2002-2005, ranked.

	Sound kernel yield (kg/cm^2 trunk cross sectional area)					
	2002	**2003**	**2004**	**2005**	**2002-05**	
A16	0.039	0.036	0.033	0.040	0.142	a*
A199	0.043	0.032	0.028	0.038	0.136	ab
A38	0.030	0.023	0.041	0.046	0.132	ab
A104	0.034	0.026	0.038	0.039	0.127	abc
A203	0.038	0.021	0.025	0.037	0.118	abcd
814	0.027	0.016	0.025	0.043	0.117	abcdef
849	0.037	0.027	0.018	0.029	0.114	bcde
A268	0.034	0.021	0.026	0.031	0.109	cdef
Daddow	0.036	0.028	0.024	0.032	0.105	cdefg
772	0.026	0.024	0.017	0.028	0.104	cdefg
783	0.032	0.021	0.019	0.037	0.104	cdefg
A4	0.034	0.023	0.025	0.035	0.101	defg
A422	0.034	0.025	0.013	0.033	0.101	defg
A426	0.023	0.028	0.020	0.031	0.099	defg
842	0.035	0.025	0.015	0.030	0.096	defg
816	0.026	0.017	0.020	0.033	0.095	defg
781	0.025	0.025	0.022	0.035	0.095	defg
NG8	0.031	0.019	0.024	0.032	0.094	efg
A423	0.030	0.022	0.021	0.031	0.094	efg
Own Venture	0.029	0.020	0.020	0.029	0.092	efg
Heilscher	0.028	0.024	0.022	0.030	0.091	efg
344	0.034	0.018	0.015	0.035	0.091	efg
741	0.018	0.019	0.026	0.032	0.091	fg
804	0.022	0.016	0.021	0.034	0.087	fg
837	0.020	0.019	0.020	0.033	0.086	efg
788	0.026	0.020	0.019	0.025	0.084	g
246	0.026	0.019	0.019	0.028	0.084	g
LSD (P=0.05)						
Maximum	0.0136	0.0112	0.0114	0.0115	0.0340	
Minimum	0.0097	0.0081	0.0076	0.0084	0.0236	
Average	0.0102	0.0085	0.0081	0.0088	0.0250	

*values of cumulative sound kernel yield followed by the same letter are not significantly different.
NB Data for 1999, 2000 and 2001 are not available.

Table 11. Sound kernel yield per unit projected canopy area of 27 macadamia varieties at Hinkler Park from 2002 to 2005 (with LSDs) and cumulative sound kernel yield per unit projected canopy area from 2002-2005, ranked. Note cumulative yield was analysed separately so the sum of individual year means may differ from the cumulative yield.

	Sound kernel yield (kg/m^2 canopy area)					
	2002	**2003**	**2004**	**2005**	**2002-05**	
A16	0.49	0.32	0.27	0.37	1.31	a*
A104	0.51	0.22	0.33	0.38	1.25	ab
A199	0.45	0.23	0.23	0.34	1.20	abc
A203	0.50	0.18	0.23	0.37	1.16	abcd
Heilscher	0.55	0.31	0.27	0.36	1.12	abcde
814	0.35	0.14	0.23	0.40	1.07	abcdef
772	0.36	0.24	0.17	0.28	1.04	bcdef
A38	0.31	0.15	0.28	0.36	1.02	cdefg
NG8	0.53	0.20	0.26	0.34	1.01	cdefg
A423	0.36	0.20	0.21	0.33	1.00	cdefg
816	0.35	0.17	0.22	0.34	1.00	cdefg
783	0.43	0.20	0.18	0.35	0.97	defgh
842	0.54	0.26	0.16	0.29	0.95	defghi
741	0.24	0.20	0.25	0.32	0.95	defghi
849	0.45	0.23	0.17	0.24	0.94	defghi
344	0.65	0.18	0.16	0.35	0.93	defghi
Daddow	0.45	0.25	0.20	0.27	0.90	efghi
A4	0.40	0.18	0.21	0.30	0.88	efghi
Own Venture	0.37	0.19	0.20	0.30	0.88	efghi
A422	0.38	0.21	0.12	0.28	0.87	fghi
A426	0.25	0.24	0.17	0.27	0.86	fghi
788	0.36	0.19	0.18	0.24	0.84	fghi
781	0.29	0.20	0.18	0.30	0.81	ghi
837	0.20	0.19	0.17	0.29	0.79	fghi
A268	0.36	0.14	0.19	0.22	0.75	hi
804	0.27	0.13	0.18	0.28	0.74	hi
246	0.29	0.17	0.17	0.25	0.73	i
LSD (P=0.05)						
Maximum	0.174	0.098	0.096	0.110	0.323	
Minimum	0.112	0.068	0.066	0.078	0.224	
Average	0.124	0.073	0.072	0.084	0.243	

*values of cumulative sound kernel yield followed by the same letter are not significantly different.
NB Data for 1999, 2000 and 2001 are not available.

Nut drop pattern

Fig. 14 shows the drop pattern of early varieties, ie those that drop 90% of their crop by the end of June, at Hinkler Park. The earliest of these was 741 and to a lesser extent 816, followed by 788, A203 and
246.

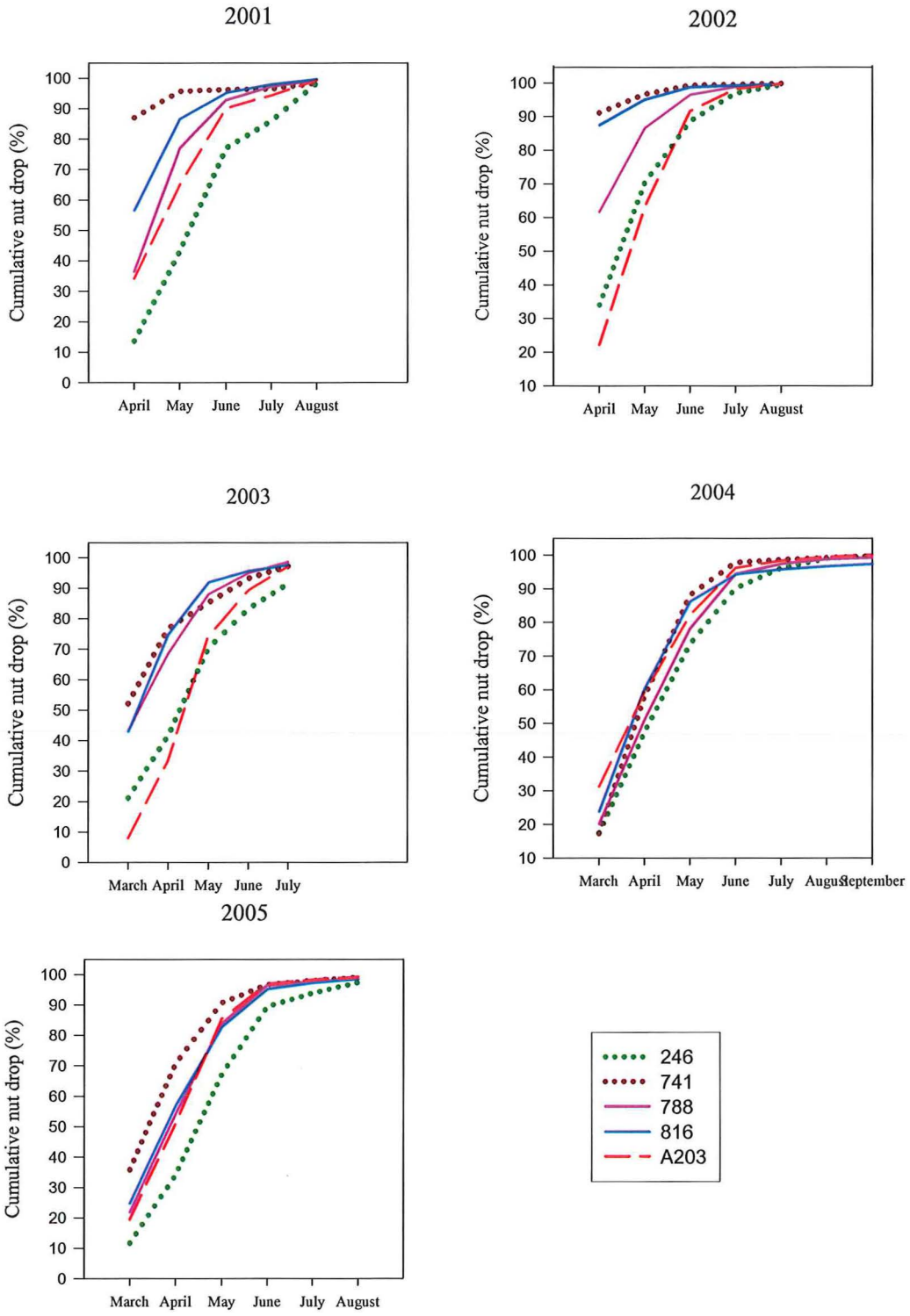

Figure 14. Cumulative nut drop of early varieties at Hinkler Park from 2001 to 2005.

Fig. 15 shows that 344, A268 and A4 were mid season varieties, dropping 90% of their crop before the end of July, at Hinkler Park. Of these, 344 commenced dropping earliest (early to mid season).

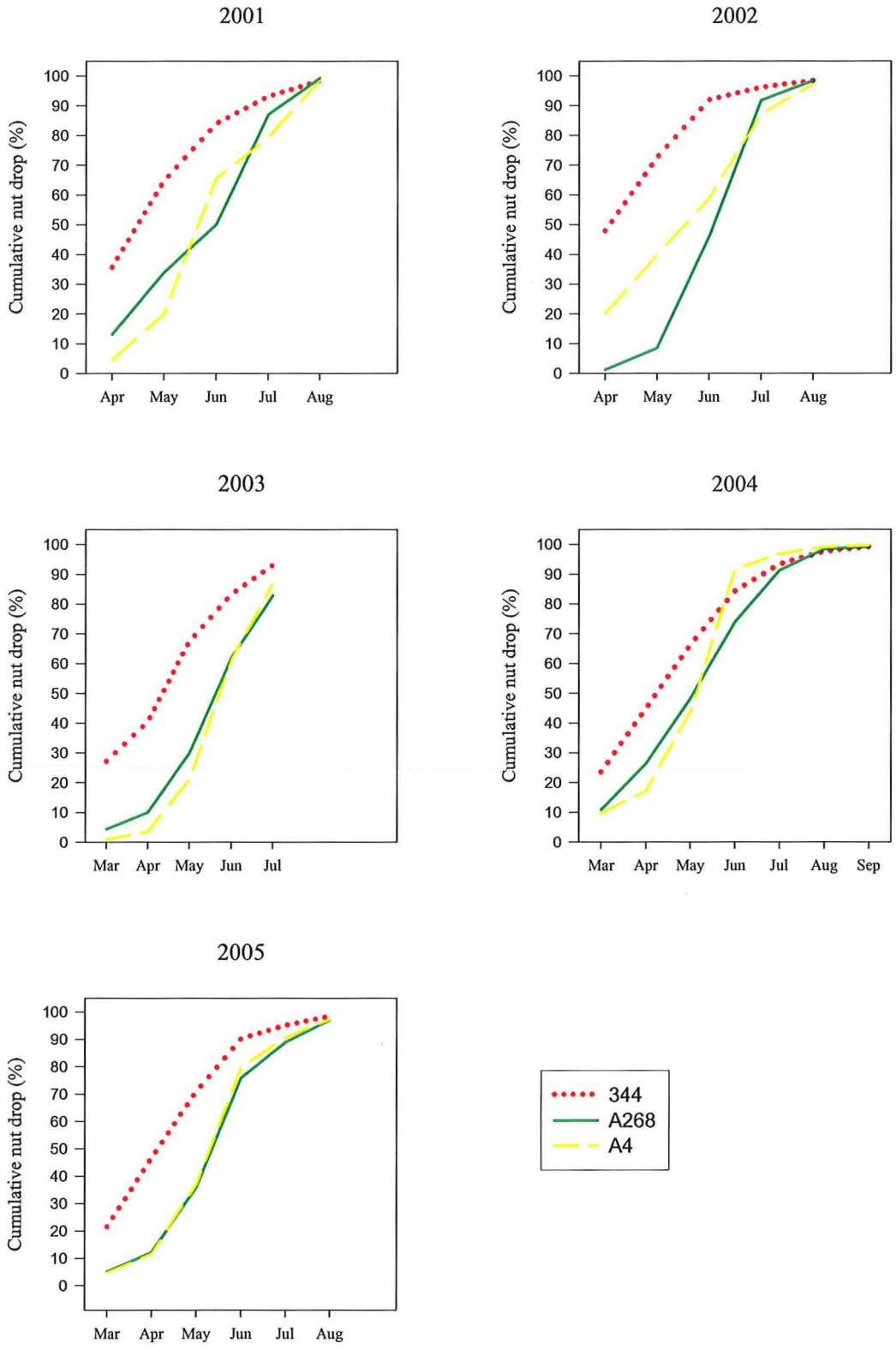

Figure 15. Cumulative nut drop of mid-season varieties at Hinkler Park from 2001 to 2005.

Late season varieties, those that dropped 90% of their crop by the end of August, in the trial at Hinkler Park were 783, 814, 842, 849, A38 and Daddow (Fig 16). Their relatively dropping patterns changed over the seasons. Heilscher was also late at Hinkler Park.

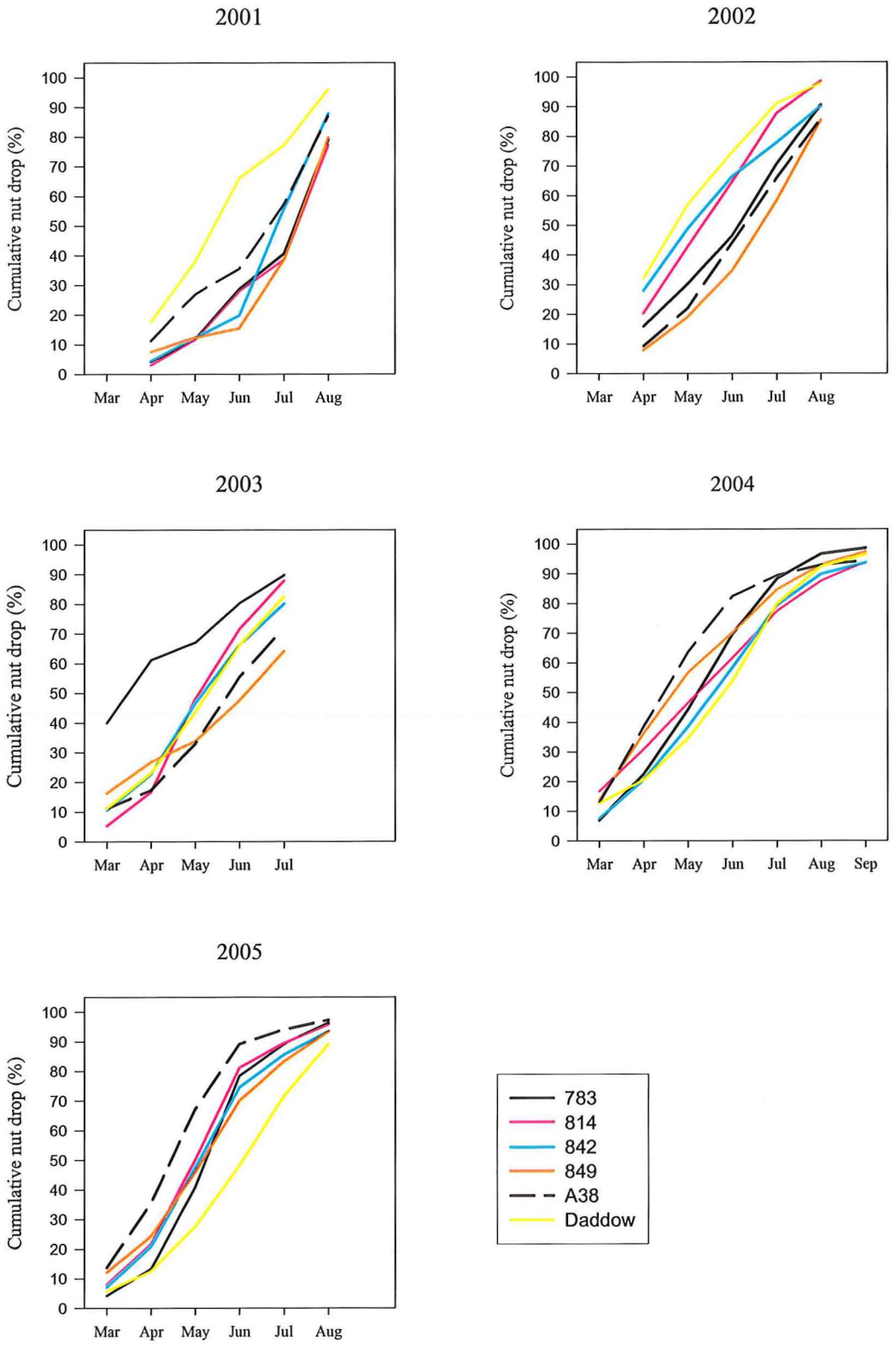

Figure 16. Cumulative nut drop of late varieties at Hinkler Park from 2001 to 2005.

Very late varieties often retained about 20% of their crop after the end of August (Fig 17). The latest varieties were Own Venture, A199 and 772. By the end of September in 2004, 772 and Own Venture had only dropped about 70% of their crop, hence resulting in a very long season.

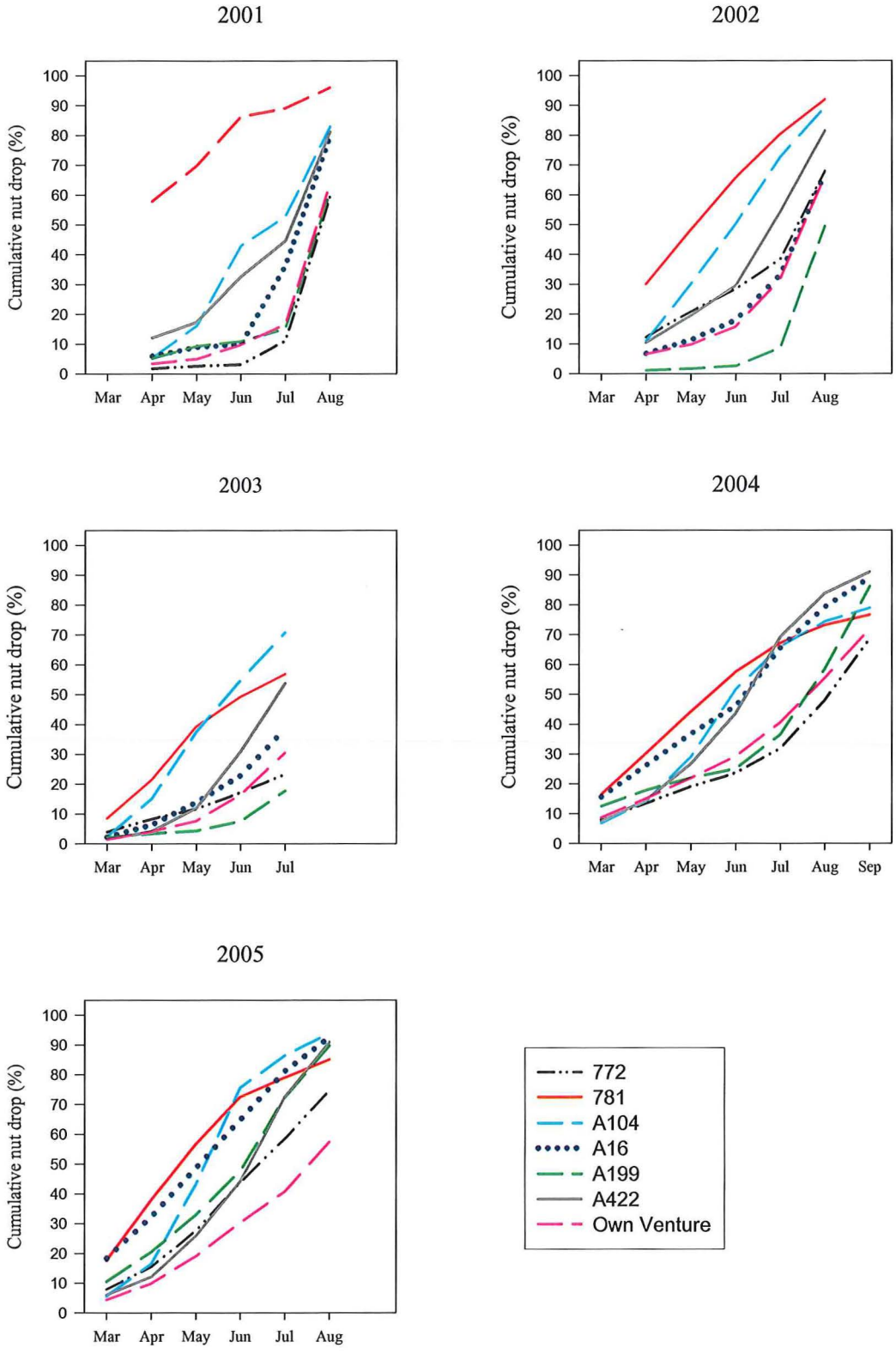

Figure 17. Cumulative nut drop of very late varieties at Hinkler Park from 2001 to 2005.

Sound kernel recovery

Fig. 18 shows the sound kernel recovery (SKR) of the top Hawaiian and Australian varieties at Hinkler Park. The harsh drought conditions of 2003 and 2004 resulted in a large decline in SKR of many varieties. However, of the Hawaiian varieties, 788 had consistently high SKR and 246 and 741 were consistently medium. Consistency in SKR over different seasons is a distinct advantage in a variety. Of the Australian varieties, A16 and Heilscher were consistently high, and to a lesser extent A104; A199 was consistently within the medium SKR range. Australian varieties that had poor SKR over this period were Own Venture, A268, A38, and A203. A422 had a dramatic drop in SKR in 2004.

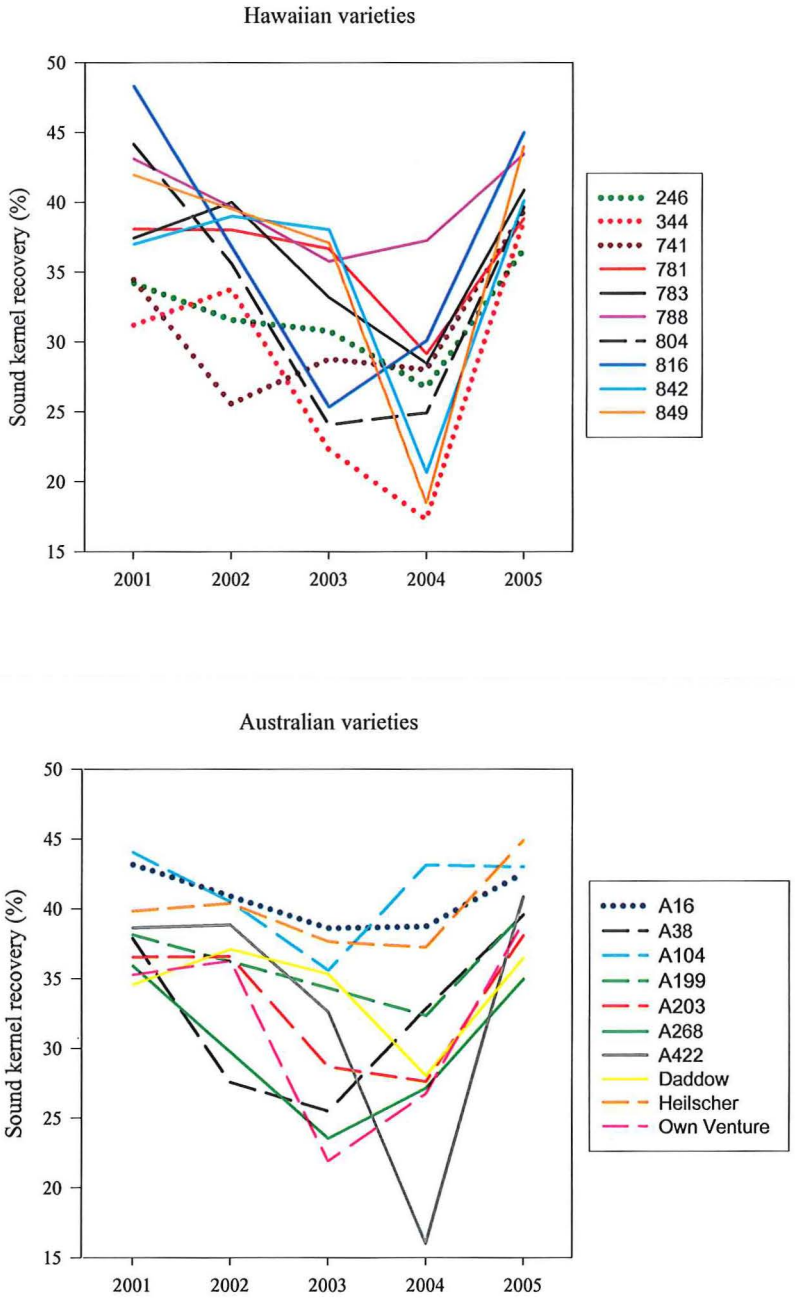

Figure 18. Sound kernel recovery of selected Hawaiian and Australian varieties at Hinkler Park from 2001 to 2005.

Unsound kernel recovery

In this study, unsound kernel is any kernel having any level of defect, including SL1 which, for many kernel defects, is considered to be premium kernel. Thus, Fig. 19 shows the worst case scenario in

which there could be a price penalty for even low SL's in the future world market. Of the Hawaiian varieties, 788 stands out for its consistently low level of USK, a distinct advantage for the future. Most varieties had increased unsound kernel during the dry years (2003 and 2004). The peaks in unsound kernel for 849, 842 and 344 in 2004 are of concern, even though most of the unsound kernel was at SL1, still premium kernel. Of the Australian varieties, Heilscher and A199 tended to have consistently low USK whereas Own Venture and A422 were very high during 2003-2004. Again, most of the unsoundness was due to basal discolouration, SL1 so most of this kernel would be classed as premium. It is interesting that A16 generally had <5% USK at Hinkler Park in this trial, levels which were much lower than that for 344, 246 and 741!

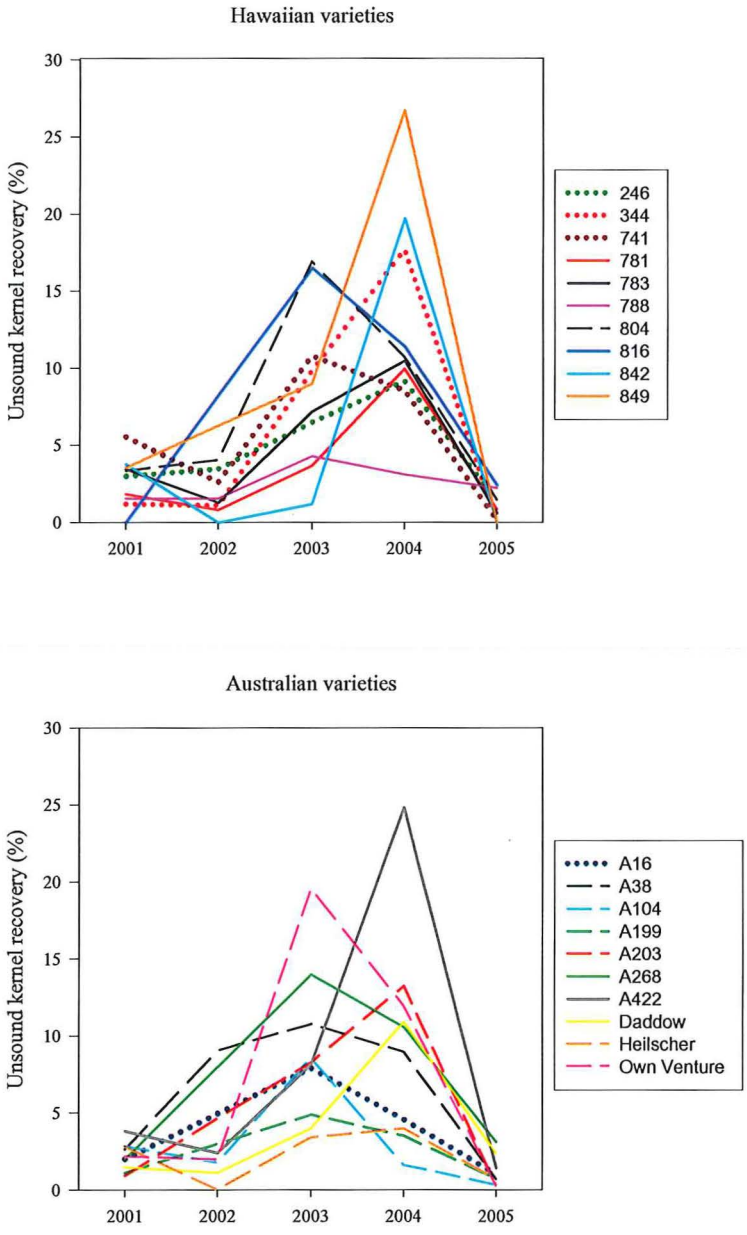

Figure 19. Unsound kernel recovery of selected Hawaiian and Australian varieties at Hinkler Park from 2001 to 2005.

Categories of unsound kernel

Table 12 shows that discolouration has been the most serious defect at Hinkler Park over the period 2001 to 2005, ranging from an average of 2.9% to 9.6%. Most of this was due to basal discolouration, although the majority of discolouration was at severity level (SL1) which is still currently classed as

premium kernel. Levels of mould, pre-germination and pitted centres have been very low. Insect damage was very low in 2001 and 2002 and did not exceed 1.0% in the other years. Immaturity was quite high in the drought year of 2003, despite a good irrigation regime. The incidence of O-rings has tended to be higher in recent years. The incidence of all other disorders was generally low.

Table 12. The average percentage of unsound kernel in various categories (all severity levels included) across 36 varieties at Hinkler Park from 2002 to 2005.

	2001	2002	2003	2004	2005
Germination	0	0	0	0	0
Mould	0.2	0	0	0.1	0.1
Insect	0.1	0.1	0.4	1.0	0.5
Immaturity (shrivelled)			5.8	0.9	0.7
Discoloured crest			0.4	0.4	0.1
Basal discolouration			2.1	8.2	8.1
Internal discolouration			0	0	0.1
O-Rings			0.4	0.9	0.7
Discoloured suture			0	0.1	0.5
Total Discoloured			**2.9**	**9.6**	**9.4**
Pitted centre			0.1	0	0.1
Irregular shape			0.1	0	0
Other			0.3	0	0.2

The incidence of unsound categories in selected varieties is shown in Table 13. The low incidence of mould and insect damage reflects the high standard of orchard management. There was very little mould detected. Mould was detected in A422 in 4 years out of 5 but all other varieties had low levels in 0-2 years only. Similarly, the incidence of insect damage was generally low. One variety, A422, stood out as having slightly higher and more frequent insect damage (up to 4%) but the data are limited and have not been analysed statistically as the samples were composite samples of the four replicates. Further monitoring is needed to determine whether or not A422 is more prone to insect attack. Individual replicate samples are currently being assessed and will be analysed statistically.

Shrivelled kernel

The second most prevalent kernel disorder was shrivelled kernel, averaging 3.4% of total kernel weight for SL 1 (Premium), 0.7% SL2 (Commercial) and 0.2% of total kernel weight for SL3 (Reject). Shrivelled kernel (sum of all SLs), as would be expected, was greatest at the early (April) harvest (av 7.7%). As expected, the largest incidence of shrivelled (immature) kernel occurred in 2003, the drought year.Varieties with high levels were Own Venture (16.5%), 804 (15.7%), 816 (14.1%), 344 (9.3%), A38 (9%), 741 (7.6%), and A203 (5%). In most other years, shrivelled kernel was< 5%.

Basal discolouration

Although basal discolouration was widespread, most of this was severity level 1 (SL1, least severe, Premium grade) and, to a lesser extent, SL2 (Commercial grade). There was little SL3 basal discolouration (most severe, reject), particularly from mid to late season harvests. Because of this, we will not continue with the extended harvest season in 2006.

Basal discolouration was the most common defect in 2003 to 2005. The industry standard, 344, had 13.2% basal discolouration in 2004 only but this was mainly SL1 (premium kernel). Varieties that had >10% basal discolouration were 344, 804, Own Venture in one year only and 842, 849, A203, and A422 in two years each. The highest level recorded was 17.3% for 842. Where it occurred, discoloured crest was mostly < 1%. A16 had 2,3% discoloured crests in 2003 only. Internal discolouration was rarely detected and only occurred at very low levels (< 1%). Similarly, o-rings were not common but mainly occurred in the Hawaiian varieties: the highest being 11.2% for 849 in 2004 and up to 3% in 246 and 2% in 783.

Discoloured suture lines
Discoloured suture lines averaged 1.2% of the total kernel weight for SL1 (Premium kernel) and 0.1% for SL2 (Commercial kernel) but there was no incidence of SL3 (Reject kernel due to suture lines). Again, levels of discoloured sutures were low, the highest being 4.6% in A38 in one year only.

Pitted centres were rarely detected and only occurred sporadically at low levels, mainly < 1%. Irregular kernel shape was rare as were other defects, all < 1%.

Table 13. The percentage of unsound kernel in various categories (all severity levels included) of the Hawaiian varieties at Hinkler Park from 2001 to 2005 (NB years in which no disorder was detected have been deleted).

Hawaiian varieties

Unsound category	Year	246	344	741	781	783	788	804	816	842	849
Mould	2001	0	0.3	1.1	0	0	0	0	0	0	0
	2004	0	0	0	0	0	0	0	2.0	0	0
Insect	2001	0	0	0	0	0	0	0.5	0	0	0
	2002	0	0	0	0	0	0	0.3	0	0	0
	2004	1.7	0.8	0	0	0	0	0	2.4	0	1.8
	2005	0.3	0	0.2	0.8	0.6	0	1.5	0.9	0	0
Shrivelled	2003	1.6	9.3	7.6	2.4	1.3	2.2	15.7	14.1	1.2	3.8
	2004	0.7	2.9	0.3	0.9	0	1.8	1.1	3.4	0.2	0.4
	2005	1.9	0.1	0.2	1.1	0.7	1.3	0.6	0	0.9	0
Crest	2003	0	0	0	0.5	0	0	0.7	0	0	0.5
	2004	0.3	0.4	0	0.3	0	0	0.6	0	0	0
	2005	0	0	0	0	0	0	0	0	0	0.3
Basal discolouration	2003	1.7	0.3	1.9	0.3	1.6	1.6	0.5	2.4	0	4.7
	2004	6.4	13.2	6.4	8.4	5.5	1.1	9.0	3.6	17.3	13.3
	2005	7.1	8.5	3.2	2.4	8.6	9.5	14.2	4.1	15.5	14.8
Internal discolouration	2004	0	0	0	0	0	0.2	0	0	0	0
	2005	0	0	0	0	0	0.8	0	0.3	0	0
O-ring	2003	3.0	0	0	0	3.7	0.5	0	0	0	0
	2004	0	0.4	1.9	0.4	4.7	0	0	0	2.3	11.2
	2005	1.4	0	0	0.9	2.0	0	0	0.4	0.5	4.4
Suture	2005	1.4	0	0	0	1.3	0	0	0	0	0
Pitted centre	2003	0.1	0	0.6	0.5	0	0	0	0	0	0
	2005	0.4	0	0	0.3	0.6	0	0	0	0	0
Other	2003	0	0.2	0.7	0	0	0	0	0	0	0
	2004	0	0	0	0	0.3	0	0	0	0	0
	2005	0	0	0	0	1.3	0	0	0	0	0.4

Table 13 (cont)
Australian varieties

Unsound category	Year	A16	A38	A104	A199	A203	A268	A422	Daddow	Heilscher	Own Venture
Mould	2001	0	0	0	0.4	0.3	0	0.7	0	0	0.7
	2002	0	0	0	0	0	0	0.4	0	0	0
	2003	0	0	0	0	0	0	0.2	0	0	0
	2004	0	0	0	0	0.3	0	0.2	0	0	0
	2005	0.1	0	0	0	0	0.4	0	0.7	0	0
Insect	2001	0	0	0.8	0.2	0	0	0	0	0	0
	2002	0	0.2	0	0	0	0	0	0.5	0	0
	2003	1.1	0	0	1.0	0	1.6	2.9	0	0.2	0
	2004	1.7	1.3	0.8	0.3	0	0.7	4.0	0.3	0.3	0.8
	2005	0.1	0.1	0.3	0.7	0.1	0.6	1.1	1.7	0	0
Shrivelled	2003	2.1	9.0	3.8	2.5	5.1	5.7	3.1	2.4	2.9	16.5
	2004	0.7	0	0	0	0.4	0.9	2.9	0	0.2	0.5
	2005	0	1.8	2.8	0.7	0.2	1.6	0	0	0.9	0
Crest	2003	2.3	0.2	0.5	0	0	0	0	0	0	1.0
	2004	0	0	0	0	0.9	0	0	0	0.3	0
	2005	0	0	0.3	0.4	0	0	0	0	0	0
Basal discolouration	2003	1.9	1.1	2.7	1.5	3.1	6.7	1.9	0.2	0.4	2.0
	2004	1.7	7.6	0.8	3.1	11.2	8.9	15.9	7.9	2.4	10.7
	2005	4.6	8.1	5.6	6.8	10.6	8.3	14.4	4.3	5.5	7.0
Internal discolouration	2003	0	0	0.2	0	0	0	0	0	0	0
	2004	0	0	0	0	0	0	0.3	0	0	0
	2005	0	0	0	0	0	0	0	0	0.7	0
O-ring	2004	0.4	0	0	0	0	0	0	2.6	0.8	0
	2005	0	0	0	0	0.6	0.9	0	2.0	0	0.9
Suture	2003	0	0	0	0	0	0	0	0	0	0
	2004	0	0	0	0	0	0	1.6	0	0	0
	2005	0	4.6	0	0.7	0	0.2	0.8	0	0	0
Pitted centre	2003	0	0	0	0	0	0	0	0.5	0	0
	2004	0	0	0	0.1	0.5	0	0	0	0	0
	2005	0.6	0	0	0	0	0	0	0	0	0
Irregular shape	2003	0	0	1.4	0	0	0	0	0	0	0
Other	2003	0.5	0.4	0	0	0	0	0	0.9	0	0
	2005	0.3	0.7	0	0.4	0.4	0	0.5	0.3	0	0

Commercial quality

Different processors may vary the allocation of SLs to their premium and commercial grades. Table 14 shows premium kernel recovery which includes SL1 defects except for pitted centres which is classed as commercial and open micropyle, internal discolouration, pink staining and insect and mould damage all of which is reject. Commercial grade also includes SL2 for shrivelled, discoloured crests, basal discolouration, discoloured rings and suture lines. The total kernel recovery was generally also higher than the six year average at Hinkler Park, although it was lower for 849 and A4. In 2005, average sound kernel recovery (SKR) was a high 37.2%. SKR of many varieties was slightly higher than at Winfield, but for 814, it was slightly lower. The average % premium and commercial kernels were 37.2% and 2.4% respectively. Only one varieties had slightly >5% commercial grade (842, 849, and A426). Average unsound kernel was 3.4% and the highest was 7.1%.

Table 14. Kernel quality, incorporating commercial categories based on severity levels, at Hinkler Park in the 2005 season compared with the average total kernel recovery from 2002 to 2004.

	Premium (Sound) KR (%)	Commercial KR (%)	USK (%)	Total KR (%)	Av TKR 1999-2004 (%)
246	33.96	2.46	3.7	37.7	36.0
344	34.69	1.23	1.2	36.0	33.4
741	37.21	1.62	2.1	39.3	37.5
772	33.04	2.58	4.7	37.7	35.9
781	38.39	0.44	1.0	39.4	39.0
783	37.89	2.70	3.2	41.1	40.1
788	38.12	2.21	3.2	41.3	42.0
804	35.68	3.07	4.5	40.1	41.5
814	36.36	2.46	3.4	39.7	37.4
816	43.18	0.99	2.9	46.1	45.4
837	39.53	2.10	3.0	42.5	41.1
842	33.95	5.14	5.6	39.6	39.9
849	36.34	5.81	7.1	43.5	45.4
A4	40.83	1.54	2.0	42.8	46.7
A16	40.77	1.57	3.1	43.8	43.9
A38	34.82	3.94	4.5	39.3	37.9
A104	42.56	0.59	0.8	43.3	44.0
A199	36.82	1.94	2.3	39.2	38.3
A203	35.89	1.74	2.2	38.1	37.4
A268	33.53	2.61	3.8	37.3	37.7
A422	36.26	2.81	5.1	41.4	40.7
NG8	37.56	3.02	3.4	41.0	39.4
A423	35.84	3.26	5.0	40.8	40.7
Daddow	36.65	0.88	2.4	39.0	37.9
Heilscher	43.28	0.46	0.8	44.1	41.2
Own Venture	36.56	2.27	3.2	39.7	37.4
A426	34.84	5.27	7.1	41.9	42.7

First Grade kernel

Although the floatation test is seldom done commercially, it is used here as a failsafe way of checking on the visual assessment of sound kernel. The floatation test is carried out only on kernel assessed as sound by visual examination. Thus, G1K should be close to 100%. However, Fig 20 shows that although some varieties have stable and high first grade kernel % (float in tap water) as would be expected, eg 842, 344, 783, A16, A199, A422, Daddow and Heilscher, others have lower and more variable levels, eg. 246, 741, 781, 804, 816, A38, A104, A203, A268 and Own Venture). Varieties with low (certainly <95% first grade kernels within the sound kernel category) and variable G1K are undesirable and should be treated with caution.

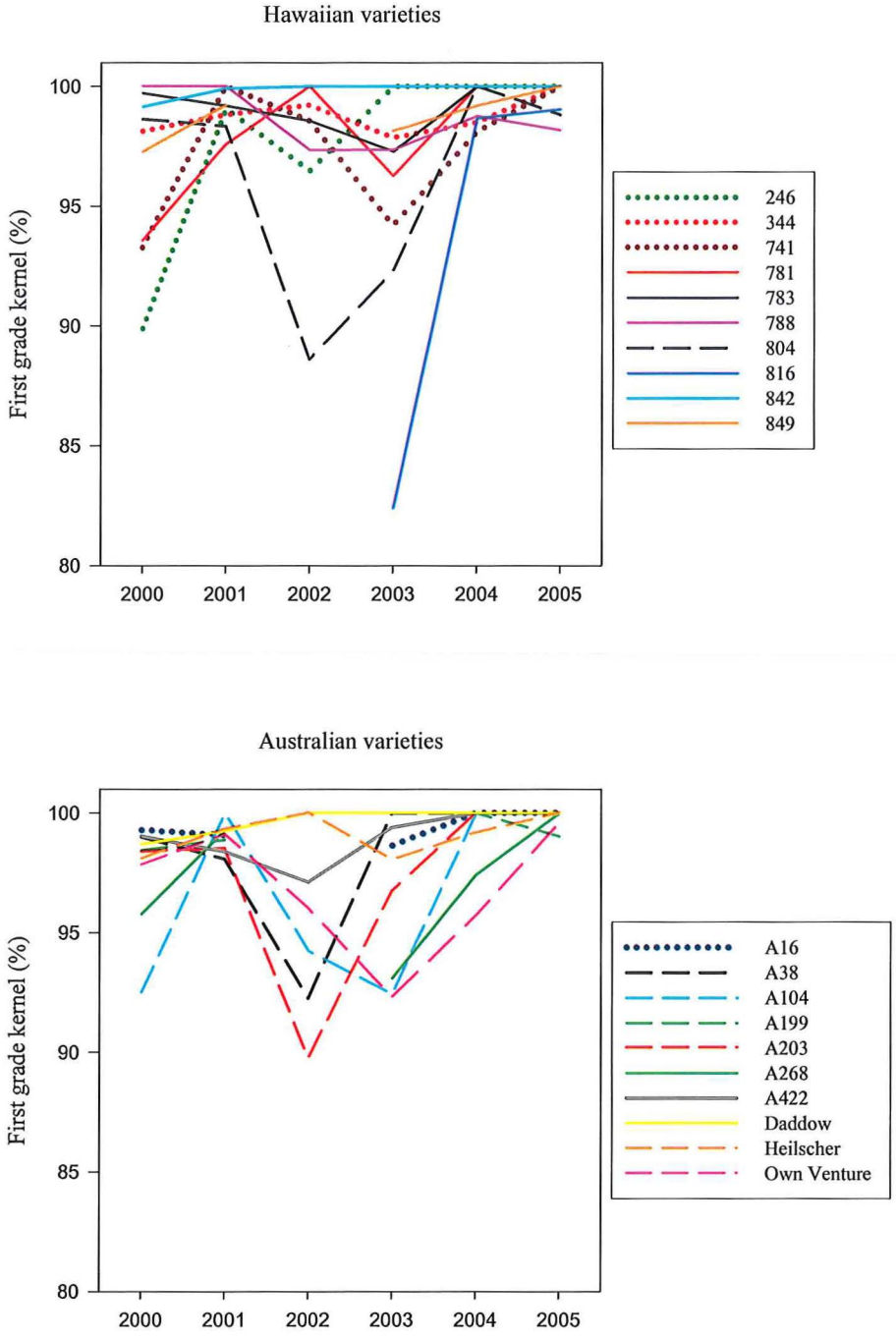

Figure 20. First grade kernel of the top varieties, based on cumulative yield of sound kernel, and the industry standard variety, 344, at Hinkler Park from 2000 to 2005.

Whole kernel

Fig 21 shows that the percentage of whole kernels varies a lot from year to year. Of the Hawaiian varieties, 344 and 804 had low and variable whole kernel %, 246 was intermediate and relatively stable, 741 was quite variable, 788 was high and stable and 781, 816, 842, and 849 were high but unstable. The Australian variety Heilscher was extremely low and A203, A104 and Daddow were low and variable and A38, A422 and Own Venture were high but variable. More detailed studies are needed to confirm differences in whole kernel recovery from different varieties. Individual replicate samples are being analysed now so data can be statistically analysed.

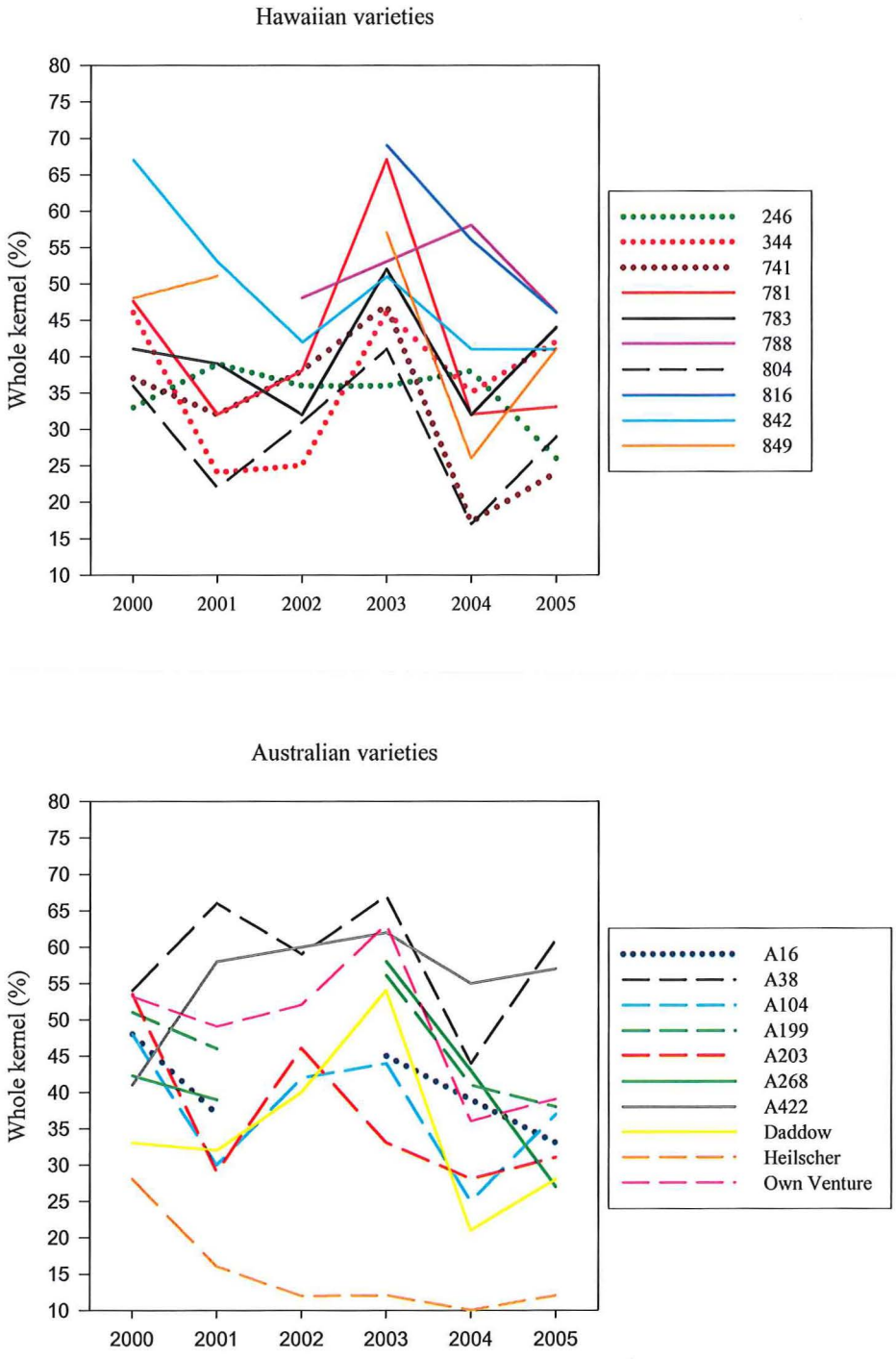

Figure 21. Whole kernel of the top varieties, based on cumulative yield of sound kernel, and the industry standard variety, 344, at Hinkler Park from 2000 to 2005.

Nut and kernel mass

The nut and kernel mass data for all varieties are shown in Appendix 2, Tables 58 and 59. The largest nut was A268 averaging 8g (6.2-9.0g range), slightly smaller than at Winfield. The size of 246 and 344, in comparison, was 7.5g and 7.3g (both slightly larger than at Winfield). Nut size decreased in the drought year (2003) by an average of 1.0g across all varieties, particularly for A268 which was 2.8g smaller in 2003 compared with 2005. The smallest nut was 814 at 4.7g, and was larger than this variety at Winfield.

Unlike at Winfield, A268 did not have the largest kernel at Hinkler Park averaging 3g (range of 2.3 to 3.4g) although the average size was similar (3.03g) at Winfield. The largest kernel was for A4 at an average of 3.3g although in 2002 it was 2.8g and in 2003, 2.6g. Three varieties (837, Own Venture and 849) had average kernel size of 3.1g and three (816, A268 and 781) averaged 3g, compared with 2.7g for 246 and 2.6g for 344.

Tree size

Tree size measurement data are presented in Appendix 2, Tables 60-66). All measures of tree size were highly correlated (P = 0.001) so they can be interchanged (Table 15). It is easier to measure trunk girth, for example, than tree height to which it is highly correlated. Since the N-S canopy diameter is constrained by crowding of trees within the row, it was not as highly correlated as E-W canopy diameter or canopy area with average canopy diameter. Canopy area is commonly used as the industry index of tree size and yields are often expressed per unit of canopy area to select trees for high density plantings. Since trunk cross sectional area (CSA) is calculated from trunk girth measurements, the high correlation between them is expected. Although tree height is more difficult to measure, it is useful to calculate canopy volume.

Table 15. Correlation matrix of tree size measurements at Hinkler Park.

Av.canopy diameter (m)	1						
E-W canopy diameter (m)	0.961	1					
N-S canopy diameter (m)	0.884	0.720	1				
Trunk CSA* (cm^2)	0.817	0.800	0.696	1			
Canopy area (m^2)	0.990	0.939	0.895	0.825	1		
Trunk girth (mm)	0.830	0.813	0.708	0.993	0.828	1	
Tree height (m)	0.777	0.804	0.589	0.777	0.757	0.795	1
	Av. canopy diam.	E-W canopy diam.	N-S canopy diam.	Trunk CSA	Canopy area	Trunk girth	Tree height

* CSA = cross sectional area

Forest Glen

Yields increased steadily until 2001after which they declined substantially (Fig 22). The decline coincided with a change in management, exacerbated by drought years. In 2003, all varieties produced yields less than 6.3kg NIS. Because of the steep decline in production over the last two seasons, and since yields were levelling off in the 2001 season, perhaps yield performance up to then only should be considered in evaluating these cultivars. The relative ranking of varieties based on cumulative sound kernel yield per tree, however, did not change over the last three years.

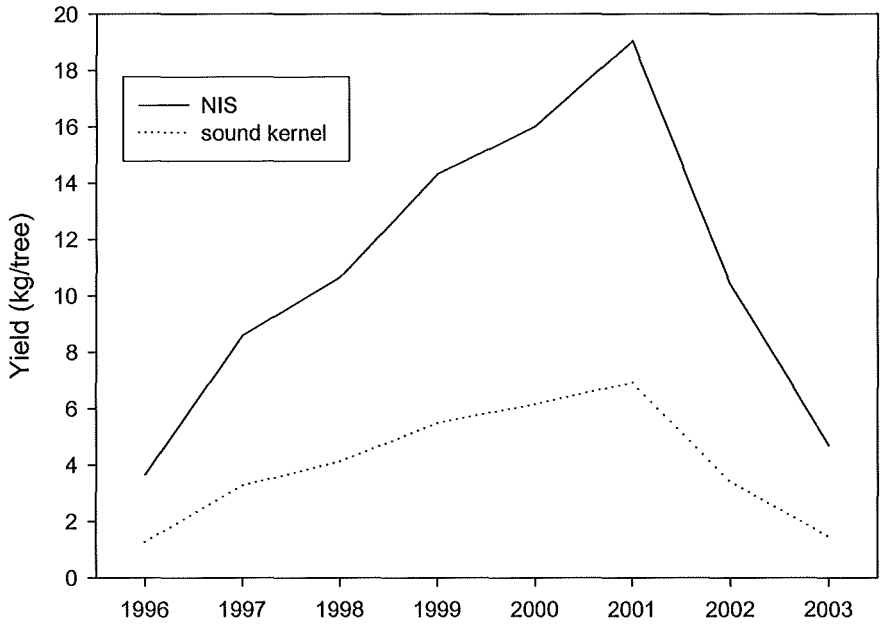

Figure 22. Mean nut-in-shell (NIS) and sound kernel yield of 10 varieties at Forest Glen from 1999 to 2005.

Sound kernel yield

In this trial, the A series varieties (A29, A38, A268, A16 and A4) performed better than the industry standard, 344, H2, 741 and 772 (Table 16). Cumulative sound kernel yields extended over a wide range from 23.2kg/tree for 741 to 40.5kg/tree for A29, equivalent to a range of 7.2 to 12.7t/ha. In contrast, the cumulative sound kernel yield of 344 was 27.6 kg/tree (8.6t/ha). A29 produced 47% higher yield than 344, A38 produced 43% more and A268 and A16 both produced 32% more than 344. In contrast, 741 produced 16% less than 344. Most of the top yielding varieties were in the top five in most years: the highest yielders, A29 and A38 were in the top 5 varieties in seven of the 8 years, A16 was in the top five in six of the 8 years and A268 and A4 in four of the eight. The top four varieties which were not significantly different to each other (A29, A38, A268, and A16) yielded within 4.1 kg of each other over the eight years.

Fig. 23 confirms the view that the last two years contribute little to the identification of the best varieties compared with the preceding years. Although the yields of A29 and A38 were consistently good, the yields of the top five varieties tended to be similar. The yield of 344 and 741 were significantly lower than all other varieties in 1996 and 1997. It was lower than A29 in six of the eight years (1996, 1997, 1998, 1999, 2000 and 2001), lower than A38 in five years (1996, 1997, 1999, 2000 and 2001), lower than A16 in four years (1997, 1997, 2000 and 2003), lower than A4 in four years and lower than A268 in three years.

Table 16. Sound kernel yield of 10 macadamia varieties at Forest Glen from 1996 to 2003 (with LSDs) and cumulative sound kernel yield from 1996-2003, ranked (values of cumulative sound kernel yield followed by the same letter are not significantly different).

	Sound kernel yield (kg/tree)									
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**1996-03**	
A29	0.53	3.85	5.72	7.41	8.82	7.98	3.95	1.58	40.52	a*
A38	1.80	4.16	4.69	7.09	7.82	7.77	3.84	1.62	39.43	a
A268	2.22	5.01	4.03	5.15	6.98	8.13	3.50	1.35	36.49	ab
A16	1.67	4.34	4.89	5.77	7.52	6.83	3.33	1.82	36.39	ab
A4	1.19	3.67	3.56	5.17	7.26	8.14	3.25	1.40	33.61	bc
A203	1.38	3.01	3.92	5.23	5.18	6.31	3.45	1.24	29.48	cd
344	0.90	1.72	4.14	5.31	4.41	6.37	3.55	1.27	27.56	de
H2	1.16	2.74	3.85	4.15	5.35	5.88	3.35	1.23	27.34	de
772	1.08	2.61	3.47	4.68	4.61	5.80	3.16	1.50	26.64	de
741	0.67	1.65	2.95	4.91	3.58	6.01	2.55	1.45	23.15	e
LSD (P=0.05)										
Maximum	0.754	0.828	1.042	1.424	1.428	1.378	0.704	0.457	5.258	
Minimum	0.670	0.721	0.922	1.263	1.248	1.224	0.633	0.419	4.597	
Average	0.704	0.764	0.971	1.329	1.322	1.287	0.662	0.435	4.866	

*values of cumulative sound kernel yield followed by the same letter are not significantly different.

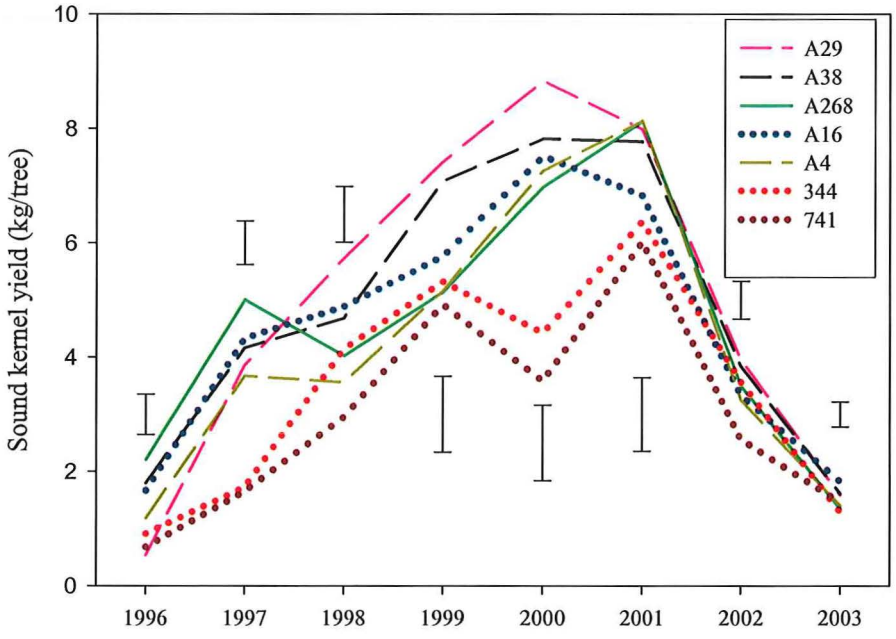

Figure 23. Sound kernel yield of the top five varieties, based on cumulative sound kernel yield, and the industry standard varieties, 344 and 741 at Forest Glen from 1996 to 2003. Bars indicate average LSD (P = 0.05) for each season.

Nut-in-shell yield

Apart from 1997 when most varieties produced significantly higher yield than 344 and 2000 when A29, A38, A268 and A16 produced significantly higher yields of nut-in-shell than 344, in other years, 344 produced similar yields to the other varieties (Fig 24). The other commercial variety, 741, performed relatively poorly at this site. It is not known why both 344 and 741 experienced a slump in yield compared with the other varieties in 2000.

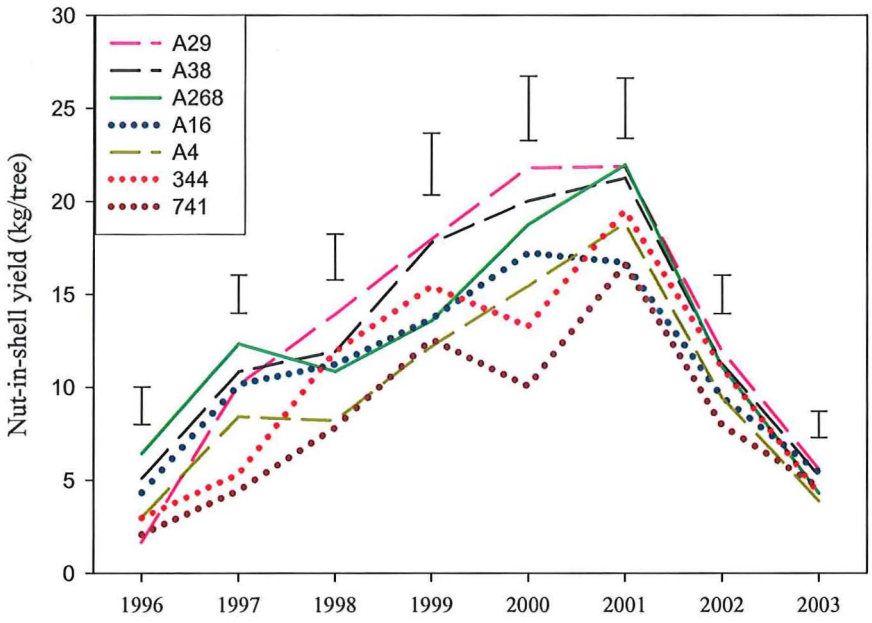

Figure 24. Nut-in-shell yield of the top five varieties, based on cumulative sound kernel yield, and the industry standard variety, 344 at Forest Glen from 1996 to 2003. Bars indicate average LSD (P = 0.05) for each season.

Sound kernel yield per unit tree size

Tree measurements were only taken in 2002 and 2003 when only A16 produced higher sound kernel yields per unit trunk cross sectional area than 344 (Table 17). However, the cumulative yield per unit trunk cross sectional area in 2003 shows that apart from A16, the highest yielder, other varieties were more productive than 344: A38, A4, A268, A29, A203 and 772.

Yields of sound kernel per unit effective canopy area (ECA) were similar for all varieties in 2002 but in 2003, A16 produced the highest yields (Table 18). This variety also produced the highest cumulative yield of sound kernel (1996-2003) per ECA (in 2003) than all other varieties . A38, A203 and A4 also produced higher yields of sound kernel per ECA than 344.

Table 17. Sound kernel yield per unit trunk cross sectional area of 10 macadamia varieties at Forest Glen in 2002 and 2003 and cumulative sound kernel yield from 1996 to 2003 (with LSDs) , ranked. Numbers followed by the same letter within years are not significantly different.

	Sound kernel yield (kg/cm^2 trunk cross sectional area)					
	2002		**2003**		**1996-03**	
344	0.016	bc*	0.005	bc*	0.114	e*
741	0.013	c	0.007	bc	0.109	e
772	0.017	b	0.008	b	0.134	d
A16	0.025	a	0.014	a	0.262	a
A203	0.017	b	0.005	bc	0.135	cd
A268	0.016	bc	0.006	bc	0.154	bc
A29	0.016	bc	0.006	bc	0.141	cd
A38	0.017	b	0.007	bc	0.167	b
A4	0.017	b	0.007	bc	0.163	b
H2	0.015	bc	0.005	c	0.112	e
LSD (P=0.05)						
Maximum	0.0041		0.0033		0.0214	
Minimum	0.0036		0.0029		0.0186	
Average	0.0038		0.0031		0.0198	

*values of cumulative sound kernel yield followed by the same letter are not significantly different.

Table 18. Sound kernel yield per unit projected canopy area of 10 macadamia varieties at Forest Glen in 2002 and 2003 and cumulative sound kernel yield per unit projected effective canopy area (ECA) from 1996 to 2003 (with LSDs) , ranked. Numbers followed by the same letter within years are not significantly different.

	Sound kernel yield/ECA (t/ha)					
	2002		**2003**		**1996-03**	
344	2.32	ab*	0.57	bc*	12.76	cde*
741	1.97	b	0.76	bc	12.27	de
772	2.16	ab	0.78	b	13.67	bcde
A16	2.40	a	1.07	a	20.73	a
A203	2.43	a	0.63	bc	15.98	b
A268	2.12	ab	0.56	bc	15.00	bc
A29	2.16	ab	0.61	bc	14.69	bcd
A38	2.22	ab	0.70	bc	16.21	b
A4	2.23	ab	0.64	bc	15.35	b
H2	2.21	ab	0.50	c	11.29	e
LSD (P=0.05)						
Maximum	0.403		0.290		2.773	
Minimum	0.375		0.260		2.435	
Average	0.386		0.272		2.573	

*values of cumulative sound kernel yield followed by the same letter are not significantly different.

Nut drop pattern

The nut drop patterns from 1997 and 1998 are shown in Fig. 25. The early varieties, A203, 741, A29 and 344 (early to mid season) are grouped together with >90% of the crop dropped by the end of June, mid season varieties A268 and A4 dropped >90% of their crop by the end of July, and all the very late varieties, 772, A16, A38 and H2 dropped 80% of their crop or less by the end of August. The latest variety of all, 772, only dropped about 60% of its crop by the end of August and hence is unsuitable for commercial orchards, having a high proportion of sticktight nuts.

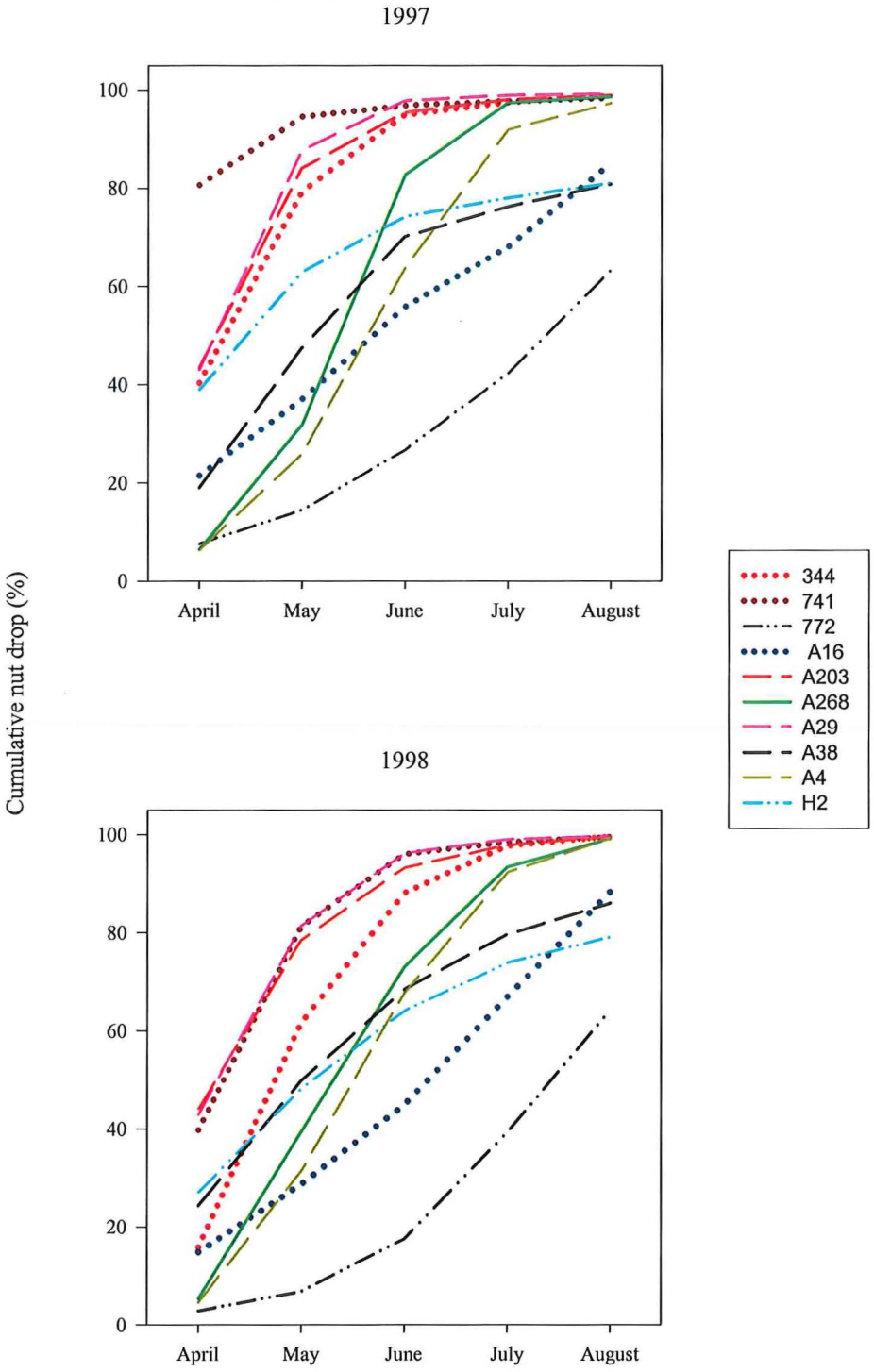

Figure 25. Cumulative nut drop pattern of 10 varieties at Forest Glen in 1997 and 1998.

Total kernel recovery

Assessment of quality on the basis of sound kernel recovery was only introduced in the last few years. Fig. 26 shows the total kernel recovery (TKR, severe reject kernels only removed) of 10 varieties at Forest Glen. Prior to 2001 when the orchard came under new management, the total kernel recovery would have been largely sound kernel recovery because of the reputation of this orchard for excellent kernel quality with the processor. Varieties that stood out with high TKR were A16 and A4 whereas those with relatively low TKR were 344, A203, 772, and, to a lesser extent, H2.

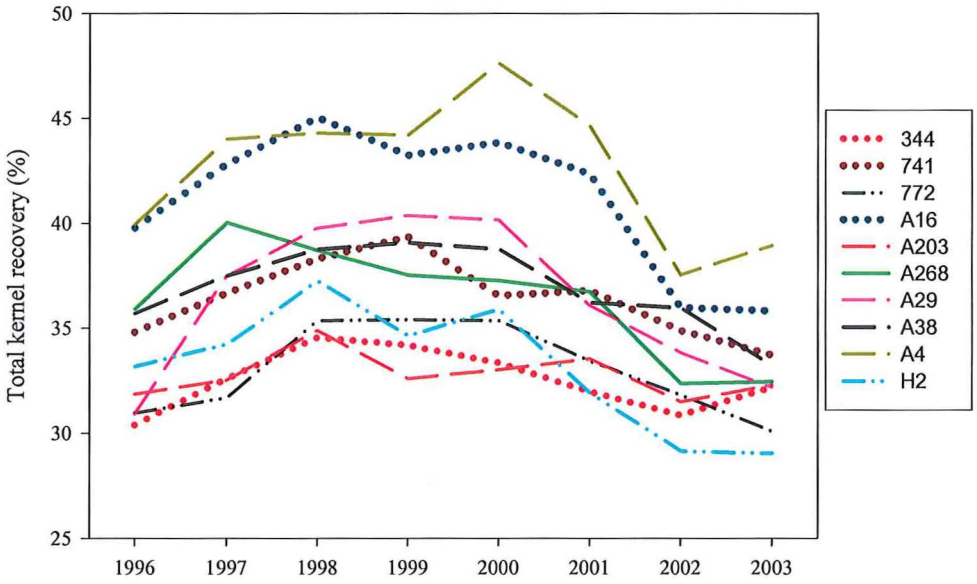

Figure 26. Total kernel recovery of ten varieties at Forest Glen from 1996 to 2003.

Unsound kernel recovery

Fig. 27 confirms the high quality of kernel produced at this orchard from 1997 to 2001, ie the low percentage of reject kernel. Changes to the management of the orchard, exacerbated by drought conditions, are reflected in the increase in unsound kernel in 2002 and 2003 (Table 19). Detailed assessment of unsound kernel was not carried out prior to 2003 but levels were very low (Fig 27). Insect control measures were less effective in 2002 but a better result was obtained in 2003. The large amount of discolouration in 2003 is probably largely due to the second drought season.

The percentage of unsound categories for each of the varieties is shown in Table 20. Despite the improved insect control in 2003, the thinner shelled A series varieties (and A203 which had lower TKR) had unacceptably high levels of insect damage, the highest being A29 with 12% and A38 with 9%. A16, A203, and A268 all had >6% insect damage. The drought conditions probably contributed to high levels of immaturity (shrivelled kernel), particularly in A29 with 20%, H2 and A268 both with >12% and 344, 741, 772, and A203 all with >5% . Levels of discoloured crest were also high with 20% in 772, 15% in H2, 12% in A268 and 9% in A38. Only 344, 741 and A29 did not have discoloured crests. All remaining varieties has >6%. Levels of basal discolouration were also high, A38, A203, A16, and A29 all having >18%. A268, H2, A4 and 344 all had > 5% basal discolouration whereas 741 and 772 had little or none. Only four varieties had high levels of o-rings: A29 with a very high 32% and 741, 772 and A203 each with >12%. Other defects were minor.

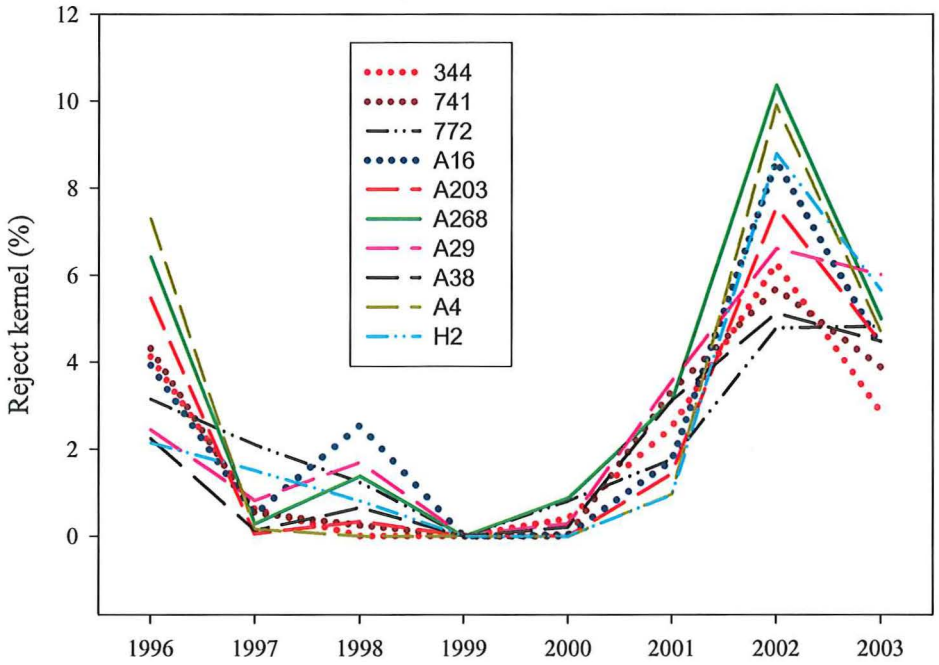

Figure 27. Reject kernel recovery of ten varieties at Forest Glen from 1996 to 2003.

Table 19. The percentage of unsound kernel in various categories (all severity levels included) of 10 varieties at Forest Glen in 2001.

	2001	**2002**	**2003**
Germination	4.1	8.0	0
Mould	0.8	0	2.0
Insect	1.3	11.3	5.7
Immaturity (shrivelled)	4.5	3.4	8.4
Discoloured crest	-	-	10.9
Basal discolouration	-	-	13.6
Internal discolouration	-	-	0
O-Rings	-	-	20.0
Discoloured suture	-	-	0
Total Discoloured	**6.3**	**13.9**	**44.4**
Pitted centre	-	-	1.7
Irregular shape	-	-	11.0
Other	-	-	4.0

Table 20. The percentage of unsound kernel in various categories (all severity levels included) of ten varieties at Forest Glen in 2003.

Unsound disorder	344	741	772	A16	A203	A268	A29	A38	A4	H2
Mould	0	0	0	0	0	0	0	0	0	2
Insect	3	4	2	8	6	7	12	9	5	1
Shrivelled	5	5	5	0	6	12	20	0	1	13
Discoloured crest	0	0	20	6	8	12	0	9	6	15
Basal discolouration	13	0	1	19	20	9	18	24	13	5
Internal discolouration	0	0	0	0	0	0	0	0	0	0
O-Rings	0	17	12	0	19	0	32	0	0	0
Discoloured suture	0	0	0	0	0	0	0	0	0	0
Pittered centre	0	2	0	0	0	0	0	1	2	0
Other	0	0	0	0	0	0	0	4	0	0

First Grade kernel

Since the floatation test was carried out on all kernel, apart from serious rejects, kernel that would now be considered to have defects (SL1 and SL2) may have contributed to the levels of G1K. All varieties had acceptable G1K in 1998, 2001 and 2002 (Fig. 28). If 96% G1K is accepted as being the desirable level, some varieties fell short of this: 344 in four out of eight years, A268 and A203 in three years and A29, A38 and 72 in one year only. Varieties with consistently acceptable G1K were 741, A16 and A38.

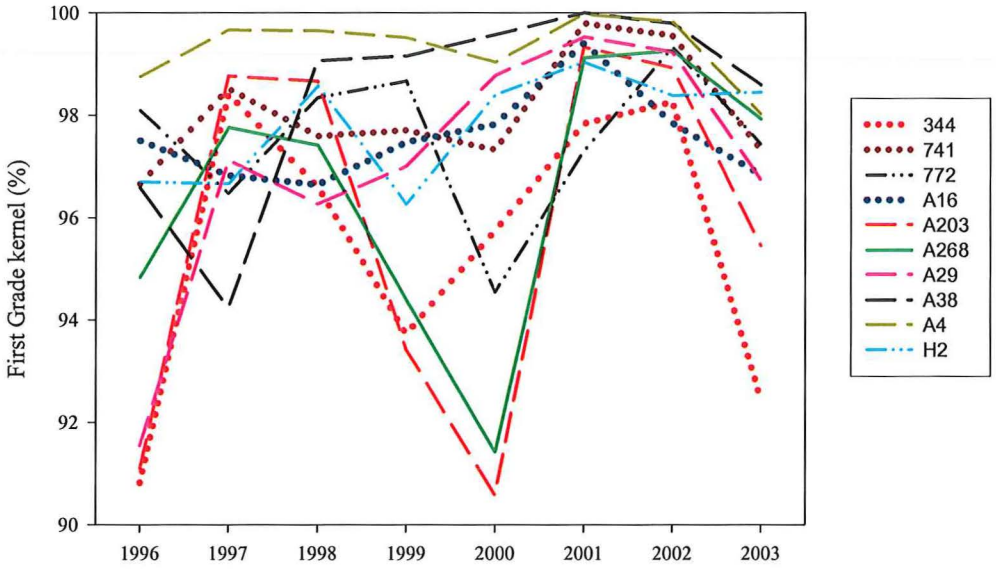

Figure 28. First grade kernel of ten varieties at Forest Glen from 2002 to 2005.

Whole kernel
Only H2 and A38 had higher levels of whole kernel than 344 (Fig 29). Varieties with low percentages of wholes were 741, A268, A4, A29.

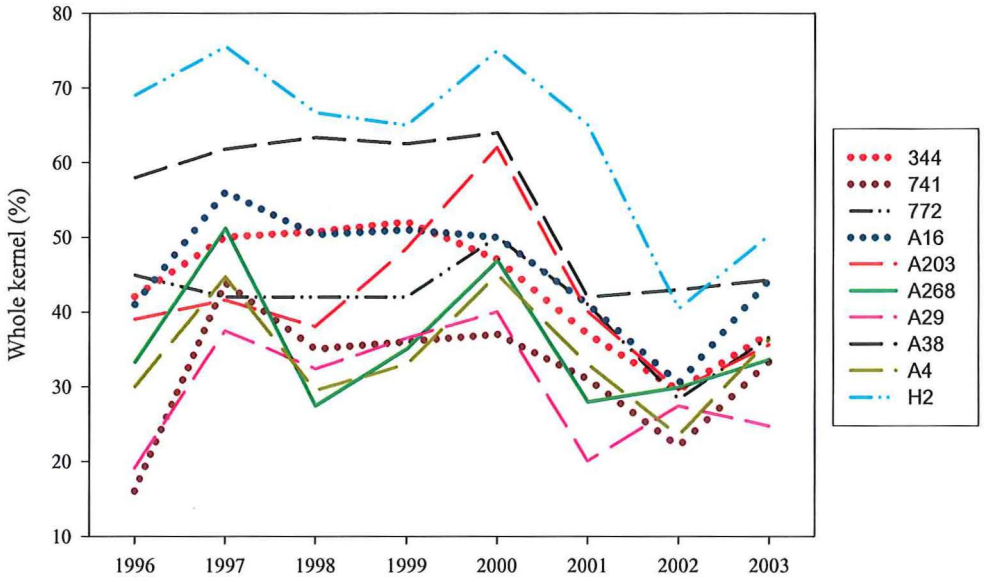

Figure 29. Whole kernel of ten varieties at Forest Glen from 1996 to 2003.

Nut and kernel mass
The nut and kernel mass data are shown in Tables 21. The largest nut was A268 averaging 8.9g (7.3-10.1g range), >0.8g larger than at Hinkler Park and Winfield. The size of 344, in comparison, was 7.5g, slightly larger than at Winfield and Hinkler Park. Nut size decreased in 1997 and 2000 but, unlike at Hinkler Park, this was not spread evenly across varieties. For example, in 1997 A268, A203, A16 and A38 were smaller by 1.6g, 1.2g, 0.7g and 0.6g respectively and A29, A4, H2, 741 and A38 were smaller in 2000 by 0.9g., 0.7g., 0.6g. and 0.5g respectively whereas other varieties were similar in size to their average over the eight years. The smallest nut was 741 at 6.2g, smaller than this variety at Hinkler Park and Winfield.

A268 and A4 had the largest kernel at Forest Glen, each averaging 3.3g (range of 2.7 to 3.8g for A268 and 2.8g. to 3.7g. for A4). The only other varieties with kernels larger than those of 344 (2.5g) were A29 (3.1g), A16 (2.9g), A302 (2.8g) and A38 (2.6g).

Table 21. Nut-in-shell and kernel mass of ten varieties at Forest Glen from 1996 to 2003.

	1996	1997	1998	1999	2000	2001	2002	2003	Variety av.
				Nut mass (g)					
344	7.4	7.6	6.7	7.6	7.6	7.4	7.7	7.8	**7.5**
741	5.9	5.9	5.4	5.8	6.8	6.3	6.9	6.7	**6.2**
772	9.0	7.8	7.9	7.8	7.9	7.6	7.9	7.8	**8.0**
A16	8.0	6.3	6.9	7.0	6.7	6.9	7.1	7.3	**7.0**
A203	8.4	7.2	8.4	8.6	8.5	9.2	8.8	7.9	**8.4**
A268	9.3	7.3	9.2	10.1	8.9	9.1	8.8	8.3	**8.9**
A29	10.5	8.2	8.6	8.1	7.4	8.0	7.7	8.3	**8.4**
A38	7.5	6.3	7.2	7.1	6.4	6.9	6.8	7.1	**6.9**
A4	7.6	7.5	8.3	7.9	6.7	7.4	7.9	7.2	**7.6**
H2	6.2	6.1	5.9	6.6	5.7	6.9	6.6	7.2	**6.4**
Year Av.	**8.0**	**7.0**	**7.5**	**7.6**	**7.3**	**7.6**	**7.6**	**7.6**	**7.5**
				Kernel mass (g)					
344	2.2	2.5	2.3	2.6	2.5	2.5	2.6	2.5	**2.5**
741	2.1	2.1	2.1	2.3	2.5	2.5	2.6	2.3	**2.3**
772	2.8	2.3	2.8	2.8	2.8	2.7	2.7	2.3	**2.6**
A16	3.2	2.7	3.1	3.0	2.9	3.0	2.9	2.6	**2.9**
A203	2.7	2.3	2.9	2.8	2.8	3.2	3.1	2.5	**2.8**
A268	3.3	2.8	3.6	3.8	3.3	3.6	3.3	2.7	**3.3**
A29	3.3	3.1	3.4	3.3	3.0	3.2	2.9	2.7	**3.1**
A38	2.7	2.3	2.8	2.8	2.5	2.7	2.6	2.4	**2.6**
A4	3.0	3.2	3.7	3.5	3.2	3.4	3.4	2.8	**3.3**
H2	2.0	2.1	2.2	2.3	2.1	2.3	2.3	2.1	**2.2**
Year Av.	**2.7**	**2.5**	**2.9**	**2.9**	**2.8**	**2.9**	**2.8**	**2.5**	**2.8**

Tree size

Tree size measurement data are presented in Appendix 3, Tables 70-72). All measures of tree size were highly correlated (P = 0.001) (Table 22). It is easier to measure trunk girth, for example, than tree height to which it is highly correlated. Since the N-S canopy diameter is constrained by crowding of trees within the row, it was not as highly correlated as E-W canopy diameter or canopy area with average canopy diameter. Canopy area is commonly used as the industry index of tree size and yields are often expressed per unit of canopy area to select trees for high density plantings. Since trunk cross sectional area (CSA) is calculated from trunk girth measurements, the high correlation between them is expected. Although tree height is more difficult to measure, it is useful to calculate canopy volume.

Table 22. Correlation matrix of tree size measurements at Forest Glen.

Av.canopy diameter (m)	1						
E-W canopy diameter (m)	0.862	1					
N-S canopy diameter (m)	0.948	0.656	1				
Trunk CSA* (cm^2)	0.626	0.581	0.567	1			
Canopy area (m^2)	0.991	0.904	0.909	0.625	1		
Trunk girth (mm)	0.615	0.564	0.563	0.997	0.611	1	
Tree height (m)	0.050	-0.004	0.078	0.391	0.038	0.412	1
	Av. canopy diam.	E-W canopy diam.	N-S canopy diam.	Trunk CSA	Canopy area	Trunk girth	Tree height

* CSA = cross sectional area

Nambucca

Fig. 30 shows the pattern of nut-in-shell and kernel yield at Nambucca. Whereas yields at other sites levelled off or declined in 2002, they continued to increase here but declined in 2003. Although it would have been useful to continue yield monitoring for a few more years to confirm that yield had plateaued, the steep slope and other management considerations prevented this. The average yields achieved in 2002 were respectable, equivalent to ca 6.6t/ha NIS and 2.64t/ha kernel in 2002.

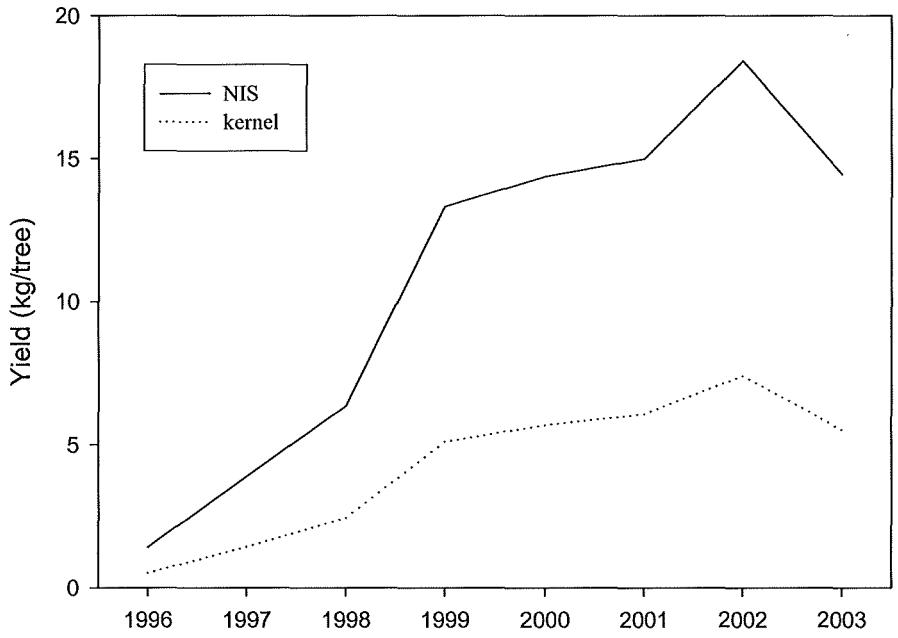

Figure 30. Mean nut-in-shell (NIS) and total kernel yield of 14 varieties at Nambucca from 1996 to 2003.

Sound kernel yield

Two varieties, A29 and A38 produced significantly higher cumulative yield of kernel than 344, 54% and 25% higher respectively (Table 23, Fig 31). Although the mean cumulative kernel yields of 246, A4, A268 and A203 were 18.9%, 18.4%, 15.6% and 13% higher than that of 344, these yields were not significantly different from that of 344. Cumulative kernel yields ranged from 27.6 kg/tree for A192 to 48.8kg/tree for A29, equivalent to 9.9-17.4t/ha. In comparison, 344 produced 31.58kg/tree or 11.3 t/ha over the eight years of the trial. As Beaumont and Fernleigh Special were topworked, there are no yield data in 2003 but their cumulative yield would have been lower than this. A29 was consistently the highest yielder from 1999 to 2003, consistently significantly higher than 344 in all five years. A268 and A38 were significantly higher than 344 in 1996-1997 and 1998-1999 respectively.

Table 23. Total kernel yield of 14 macadamia varieties at Nambucca from 1996 to 2003 (with LSDs) and cumulative sound kernel yield from 2002-2005, ranked (values of cumulative sound kernel yield followed by the same letter are not significantly different).

	Total kernel yield (kg/tree)									
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**1996-2003**	
A29	0.2	1.5	2.2	7.8	8.5	7.9	11.4	8.3	48.8	a
A38	0.4	1.4	3.4	7.1	6.3	6.4	7.6	6.3	39.5	b
246	0.3	0.9	1.7	5.3	8.1	7.0	8.3	5.9	37.6	bc
A4	0.7	1.8	2.3	5.4	6.4	7.2	7.9	5.2	37.4	bc
A268	1.8	1.8	3.2	4.7	6.2	6.0	7.8	4.8	36.5	bcd
A203	0.8	1.4	1.8	5.0	5.7	5.8	8.3	6.8	35.8	bcd
344	0.5	0.8	2.1	4.5	5.5	4.7	8.5	5.1	31.6	cde
A199	0.2	1.8	2.8	5.2	3.8	5.9	6.7	4.5	31.1	cde
A16	0.4	1.6	3.1	4.7	5.2	4.0	7.3	4.8	31.0	cde
A323	0.5	1.6	3.2	4.0	5.7	5.3	6.0	4.8	31.0	cde
508	0.1	0.9	1.2	4.2	6.1	6.1	6.1	5.4	29.8	de
A192	0.2	0.9	1.8	4.2	5.0	5.0	6.6	4.3	27.6	e
Beaumont	0.2	1.9	3.0	5.1	3.5	6.5	5.5			
Fernleigh Sp	0.7	1.5	2.4	3.9	3.5	7.0	5.8			
LSD (P<0.05)										
Minimum	0.4685	0.844	0.9492	1.78	1.878	1.807	2.364	1.536	7.26	
Maximum	0.5004	0.9207	1.15	3.091	1.999	1.908	2.503	1.632	7.729	
Average	0.473	0.8553	1.004	1.974	1.895	1.822	2.384	1.552	7.338	

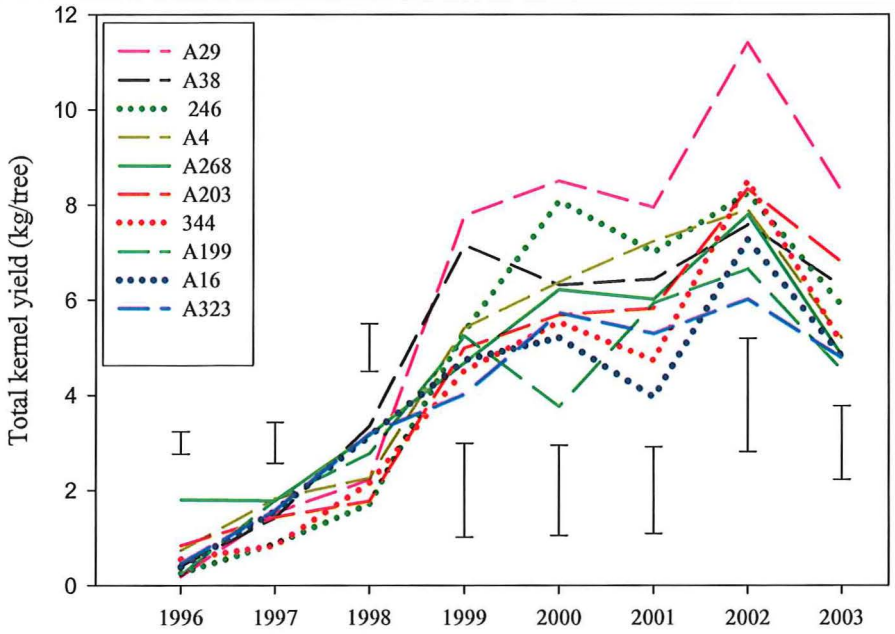

Figure 31. Sound kernel yield of the top ten varieties, based on cumulative sound kernel yield at Nambucca from 1996 to 2003. Bars indicate average LSD (P = 0.05) for each season.

Nut-in-shell yield

As for cumulative kernel yield, the cumulative NIS yield of A29 (123.3kg/tree) only was significantly higher than that of 344 (85.8kg/tree, See Appendix 4, Table 73, equivalent to 30.7t/ha). Cumulative yields ranges from 69.4kg/tree for A192 to 123.3kg/tree for A29, equivalent to a range of 24.8t/ha for A192 to 44t/ha for A29. A29 was consistently the highest yielder each year from 1999 to 2003, in all cases significantly higher than that of 344 (Fig. 32). At various times, 246, A38 and A268 produced significantly more NIS than 344 at Nambucca.

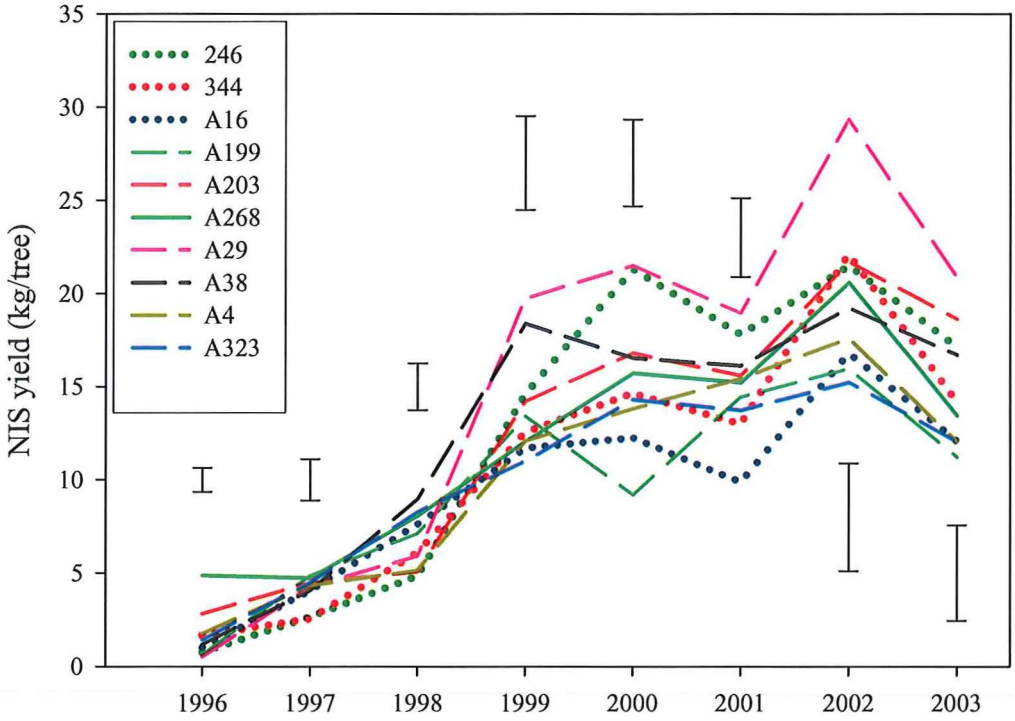

Figure 32. Nut-in-shell yield of the top ten varieties, based on cumulative kernel yield, at Nambucca from 1996 to 2003. Bars indicate average LSD (P = 0.05) for each season.

Sound kernel yield per unit tree size

Although there were significant differences in the yield of kernel per tree, when yield was expressed per unit effective canopy area, differences were not significant (Table 24). The large tree size of A29 compensated for its high kernel yield per tree.

Table 24. Total kernel yield per unit projected effective canopy area of 14 macadamia varieties at Nambucca from 2002 to 2005 (with LSDs) and cumulative sound kernel yield per unit projected canopy area from 2002-2005, ranked.

	Total kernel yield (t/ha effective canopy area)			
	2002	**2003**	**1996 2003**	
A38	0.1796	0.1381	0.8231	a
A203	0.1793	0.1355	0.804	a
A4	0.1773	0.1253	0.8038	a
A29	0.1787	0.131	0.8005	a
A16	0.1773	0.1252	0.7949	a
A199	0.1752	0.124	0.7948	a
A268	0.1756	0.1211	0.7948	a
A323	0.1736	0.1247	0.7938	a
A192	0.176	0.123	0.7891	a
246	0.1738	0.1217	0.7844	a
344	0.1766	0.1216	0.7823	a
508	0.1701	0.12	0.7727	a
LSD (P<0.05)				
Minimum	0.02602	0.03383	0.1222	
Maximum	0.02616	0.03428	0.1228	
Average	0.02604	0.03391	0.1223	

Nut drop pattern

Fig. 33 shows how the latitude at Nambucca influences the drop pattern compared with other more northerly sites. Normally an early-mid-season variety, 344, is much later at Nambucca and is much later than the early A29 and A203. Also normally an early variety, 246 at Numbucca it is about a month later than at other sites. Fig. 34 shows that 246 is earlier than A268 and 344. The late varieties by our definition (90% of the crop dropped by the end of August) include A4 which is earlier than A38 and much earlier than A16 and A199. All these late-very late varieties dropped over 90% of their crop by November (Fig. 35).

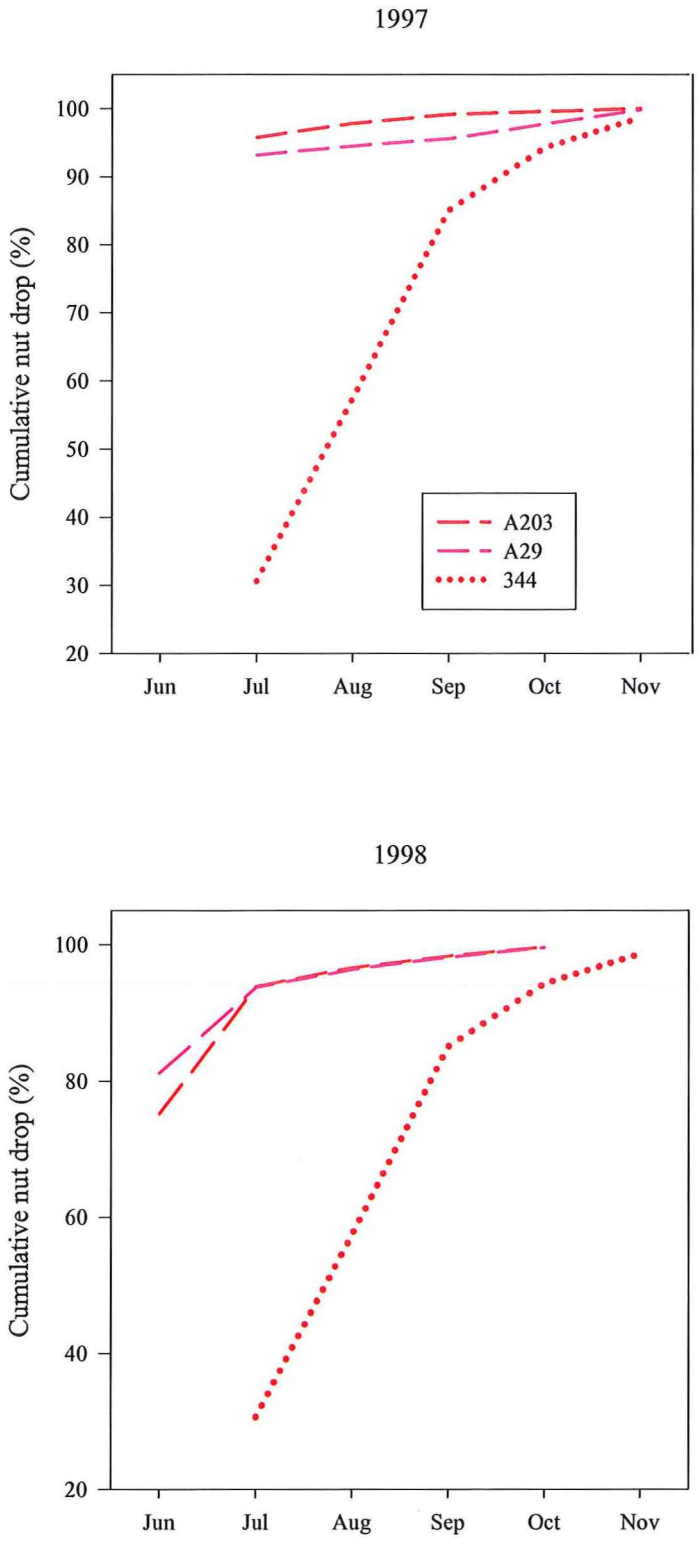

Figure 33. Cumulative nut drop pattern of early varieties, with the industry standard 344 for comparison, at Nambucca in 1997 and 1998.

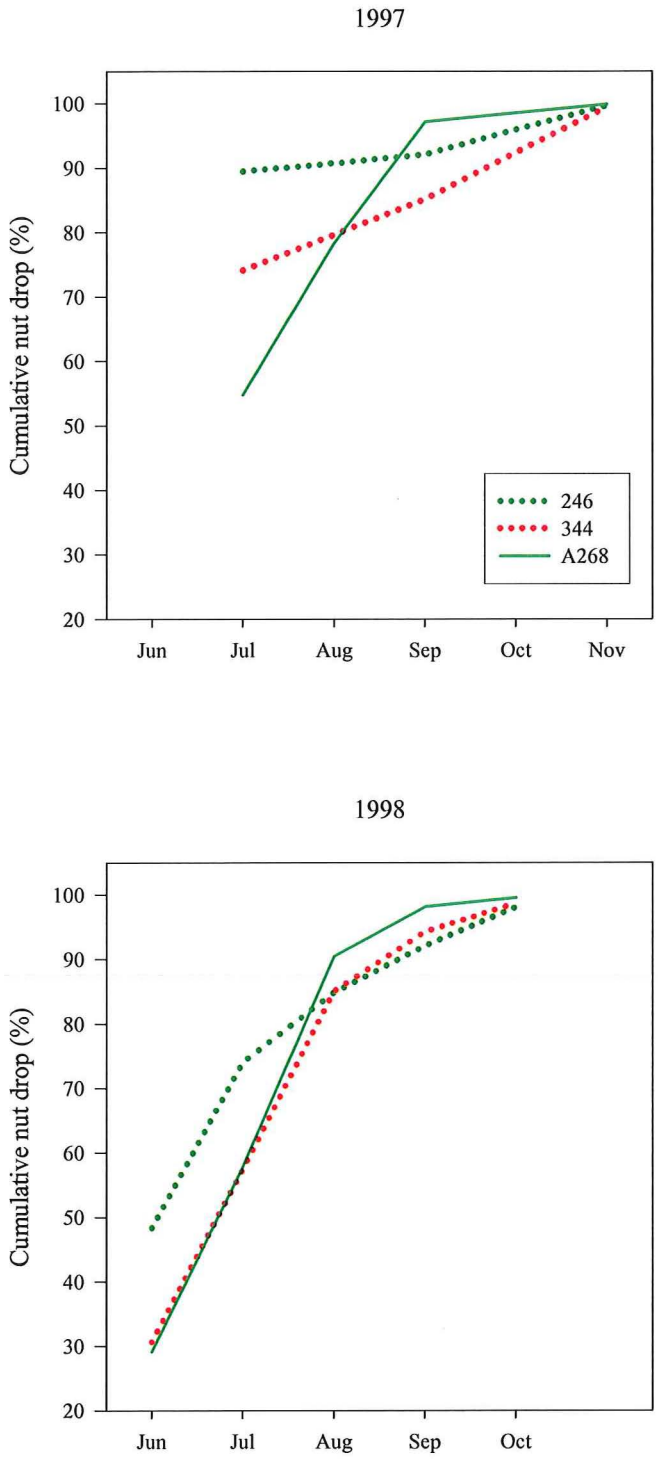

Figure 34. Cumulative nut drop pattern of mid-season varieties at Nambucca in 1997 and 1998.

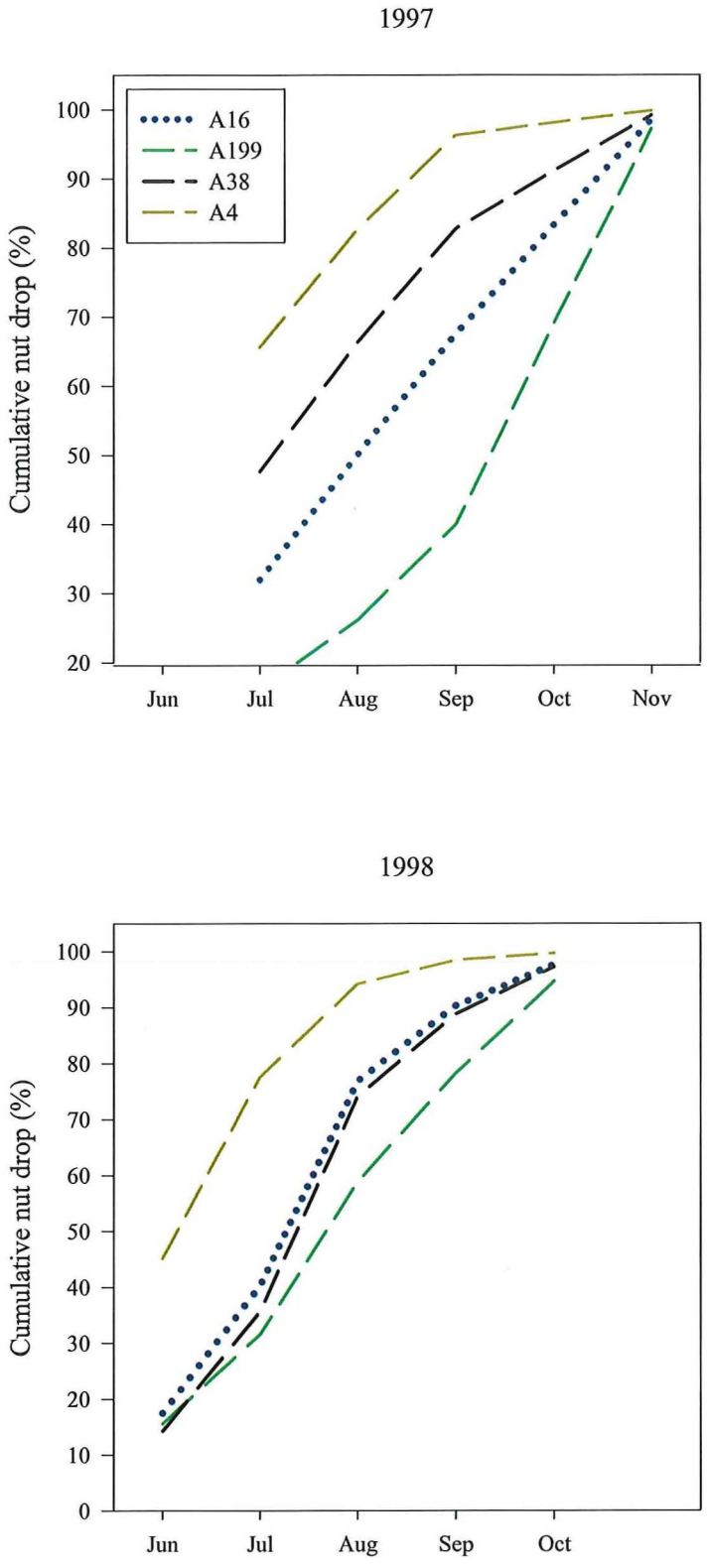

Figure 35. Cumulative nut drop pattern of late varieties at Nambucca in 1997 and 1998.

Total kernel recovery

Fig. 36 shows that A4, A16 and A29 have much higher total kernel recovery than the industry standards 344 and 246, effectively increasing the economic yield of these varieties. Total kernel recoveries are much more consistent than sound kernel recovery form season to season.

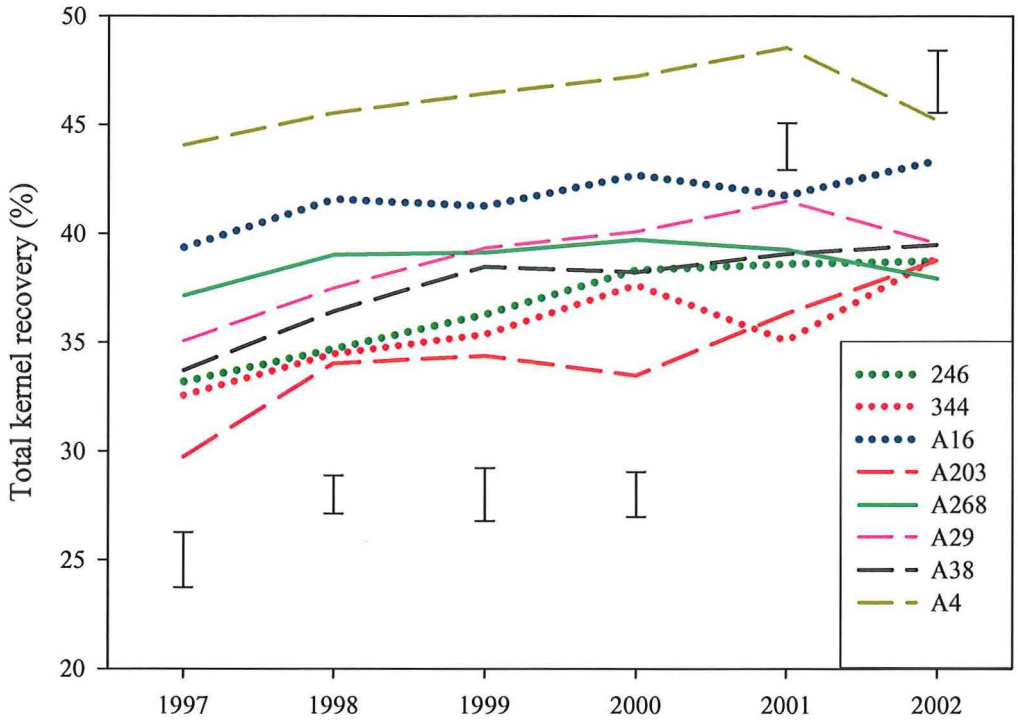

Figure 36. Total kernel recovery of selected varieties, based on cumulative yield of sound kernel, and the industry standard variety, 344, at Nambucca from 2002 to 2005. Bars indicate average LSD (P = 0.05) for each season.

Unsound kernel recovery

The effects of the prolonged drought in 2003 are reflected in the high average percentage of unsound kernel (Table 25). There was also relatively high unsound kernel in 1998 and 2000. There is a wide range of unsound levels for each variety over different seasons. For example, 344 a range of 0.3% to 5.4%, A203, 0.6% to 5.9%, A16, 0.6% to 5.5% and A38 1.0% to 4.8%. Averaged over all seasons, 344 and A4 had 2.2% unsound kernel, A38 and 508 had 3.3% and A268 and A203 had 2.4% each. Even A16 with an average of 2.5% is only 0.2% higher than 344.

Unsound defects were similar over three months at Nambucca (Table 26). The main defect was basal discolouration, followed by immature (shrivelled) kernel and discoloured crests. Insect and mould were present at low levels indicating the high standard of management. The average categories of unsound kernel for each of the varieties in this trial are shown in Table 27. Overall, the average incidence of basal discolouration was 1.4%, shrivelled kernel 0.8% and o-rings and discoloured suture both averaged 0.4% kernel recovery. Other defects occurred at low levels and sporadically.

The varieties with the highest average incidence of defects were A4, A16 and A29 with 0.5% kernel recovery each (Table 27). These varieties had 2.6%, 1.1% and 2.1% basal discolouration respectively and A4 also had 2.4% discoloured suture, A16 also had 1.9% discoloured crests and 1.5% shrivelled kernel and A29 also had 1.4% shrivelled kernel and 0.6% discoloured suture. Both A38 and 246 averaged 0.4% unsound kernel recovery consisting of 1% basal discolouration, 0.8% shrivelled kernel, 0.8% discoloured suture and 0.7% insect damage for A38 and 2.4% o-rings, 1.1% shrivelled kernel and

1% basal discolouration for 246. All other defects in all other varieties generally occurred at a very low frequency.

Table 25. Unsound kernel recovery of 12 varieties at Nambucca from 1997 to 2003.

	1997	1998	1999	2000	2001	2002	2003
A323	1.4	1.2	0.7	2.0	0.8		2.9
A199	1.1	1.5	1.6	2.7	1.4		3.0
A268	1.5	2.6	2.0	3.8	1.5		3.3
A192	0.7	1.7	1.7	1.4	0.7		1.6
246	0.8	1.5	1.5	2.6	1.0		3.5
A203	0.6	2.8	1.0	2.6	1.3		5.9
344	0.3	2.1	1.4	2.4	1.8		5.4
A4	0.3	2.4	2.6	3.0	1.5		3.8
A16	0.6	3.0	1.5	3.0	1.2		5.5
A38	1.1	2.5	1.4	2.9	1.0		4.8
A29	3.2	2.3	0.8	1.3	0.8		2.6
508	3.5	1.8	1.5	2.6	0.9		3.4
Average	1.3	2.1	1.5	2.5	1.2		3.8

Table 26. The average unsound kernel recovery in various categories (all severity levels included) across 14 varieties at Nambucca in the 2003 season.

	August	September	October
Germination	**0**	**0**	**0**
Mould	**0.1**	**0.1**	**0.1**
Insect	**0.2**	**0.2**	**0.2**
Immaturity (shrivelled)	**1.4**	**1.4**	**1.3**
Discoloured crest	**0.5**	**0.6**	**0.3**
Basal discolouration	**2.4**	**2.5**	**2.5**
Internal discolouration	**0.1**	**0.2**	**0.2**
O-Rings	**0.2**	**0.2**	**0.2**
Discoloured suture	**0.2**	**0.2**	**0.2**
Total Discoloured	**3.4**	**3.7**	**3.4**
Pitted centre	**0**	**0**	**0**
Irregular shape	**0**	**0**	**0**
Other	**0.2**	**0.2**	**0.2**

Table 27. The average percentage of unsound kernel in various categories (all severity levels included) of varieties at Nambucca in 2003.

Unsound disorder	**A323**	**A199**	**A268**	**A192**	**A203**	**A4**	**A16**	**A38**	**A29**	**246**	**344**	**508**
Mould	0.0	0.2	0.2	0.0	0.1	0.1	0.3	0.0	0.2	0.1	0.0	0.1
Insect	0.0	0.1	0.0	0.0	0.2	0.0	0.3	0.7	0.0	0.0	0.0	0.2
Shrivelled	0.8	1.0	0.6	0.1	0.6	0.3	1.5	0.8	1.4	1.1	0.4	0.9
Discoloured crest	0.0	0.2	0.3	0.4	0.2	0.0	1.9	0.1	0.4	0.0	0.1	0.3
Basal discolouration	0.9	0.5	1.9	1.0	1.9	2.6	1.1	1.0	2.1	1.0	2.1	1.1
Internal discolouration	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.2	0.0	0.0	0.5
O-Rings	0.3	0.5	0.0	0.0	0.0	0.4	0.0	0.0	0.4	2.4	0.0	0.3
Discoloured suture	0.8	0.3	0.2	0.0	0.0	2.4	0.0	0.8	0.6	0.0	0.0	0.0
Pittered centre	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0
Irregular shape	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other	0.0	0.1	0.1	0.0	0.1	0.1	0.3	0.6	0.3	0.3	0.0	0.0
Average	0.3	0.3	0.3	0.1	0.3	0.5	0.5	0.4	0.5	0.4	0.2	0.3

First Grade kernel

The average first grade kernel (G1K) across all varieties was below the desirable 96% level in 1997-1999 and in 2001 (Table 28). In the harsh 2003 season, however, the overall average G1K was 98%, a high standard. Only four varieties averaged 96% G1K or better: A199 (98.1%), A4 (98.9%), A16 (95.7%) and A38 (97.9%), compared with 94.1% for 344, 89.9% for 246 and 88.2% for 508. The range of G1K was reasonably consistent for A199 (93.5-99.2%), A4 (95.7-100%), and A38 (95.9-98.2%) but was less so for A16 (92.8%-98.4%) and 344 (85.9-99%).

Table 28. First grade kernel of selected varieties at Nambucca from 1997 to 2003. (Data from 2003 were not subjected to statistical analysis).

	1997	1998	1999	2000	2001	2003
246	76.8	87.6	85.6	98.36	93.55	98.94
344	85.9	95.92	93.19	99.02	91.31	98.29
508	88.72	87.15	71.34	96.98	90.75	97.10
A16	92.77	94.38	96.59	96.86	92.74	98.42
A192	74.28	90.56	70.78	95.44	88.6	97.86
A199	93.53	96.45	98.28	99.2	95.23	98.09
A203	78.9	90.74	87.97	96.19	93.31	99.76
A268	78.65	84.33	92.02	97.25	94.42	97.07
A29	82.25	91.32	95.51	99.4	92.57	99.62
A323	76.72	91.83	84.25	95.99	91.99	99.16
A38	96.51	95.9	97.43	98.22	96.54	96.83
A4	97.72	95.71	98.13	99.03	97.98	100.00
Beaumont	87.05	91.62	89.26	96.19	95.81	
Fernleigh Sp	88.53	89.23	89.26	92.33	87.58	
LSD (P<0.05)						
Minimum	8.074	5.766	0.452	2.813	4.776	
Maximum	14.08	11.24	20.74	3.396	5.047	
Average	10.21	6.881	7.859	2.924	4.815	

Whole kernel

Whole kernel recovery was not determined, except for 2003 when 344 achieved 40.3% wholes. The only varieties that exceeded this were A199 at 41.3% and A4 at 47% wholes.

Nut and kernel mass

The nut and kernel mass data are shown in Tables 29 a. The largest nuts were A203, A268 and A29 averaging 9.3g (8.8-10.1g range), 9.1g (8.1-9.6g) and 8.5r (7.6-9.7g) respectively compared with 7.4g average (6.5-7.9g range) for 344. The size of 344 nuts was similar at the other trial sites. Nut size was generally small in 2000. The smallest nuts were Beaumont and Fernleigh Special at 6.1 and 6.0g respectively.

The A series varieties A268, A4, A29 all had the largest kernels (3.5, 3.4 and 3.3 respectively) at Nambucca (Table 29 b). The range for A268 was 3.2 to 3.7g compared with 2.5-2.7g (av 2.6g) for 344. Fernleigh Special kernels were quite small and variable, averaging 2.4g and ranging from 2.0g to 2.9g.

Table 29. Nut-in-shell and kernel mass of varieties at Nambucca Glen from 1996 to 2003.

	1997	1998	1999	2000	2001	Variety av.
			(a) Nut mass (g)			
246	8.11	8.17	7.43	6.90	7.98	7.72
344	7.88	7.71	7.18	6.52	7.86	7.43
508	7.79	7.96	7.22	6.42	6.56	7.19
A16	7.60	8.72	7.82	7.15	7.00	7.66
A192	8.55	8.64	7.74	7.62	7.81	8.07
A199	8.36	8.44	7.48	7.85	7.57	7.94
A203	8.95	10.12	8.79	8.81	9.59	9.25
A268	9.31	9.55	8.90	8.07	9.59	9.08
A29	9.49	9.67	7.85	7.80	7.64	8.49
A323	8.85	8.30	7.98	7.10	7.69	7.99
A38	8.95	8.62	7.15	7.05	7.69	7.89
A4	7.39	7.78	7.68	6.92	7.31	7.42
Beaumont	5.99	5.72	7.64	5.70	5.39	6.09
Fernleigh Sp	8.25	5.33	6.10	4.78	5.39	5.97
Year av.	**8.25**	**8.19**	**7.64**	**7.05**	**7.51**	**7.73**
LSD (P<0.05)						
Minimum	0.9898	0.931	0.7808	0.7377	0.7004	
Maximum	2.511	1.065	1.77	0.9324	0.7538	
Average	1.407	0.9508	0.9473	0.7744	0.708	
			(b) Kernel mass (g)			
246	2.70	2.84	2.72	2.65	3.10	2.80
344	2.61	2.67	2.53	2.46	2.74	2.60
508	2.60	2.61	2.38	2.40	2.43	2.48
A16	2.94	3.61	3.25	3.05	2.93	3.16
A192	3.03	3.19	2.92	3.04	3.07	3.05
A199	2.99	3.28	3.00	3.16	3.17	3.12
A203	2.70	3.45	3.09	2.94	3.45	3.12
A268	3.44	3.73	3.51	3.20	3.73	3.52
A29	3.32	3.62	3.19	3.12	3.19	3.29
A323	2.94	3.18	2.95	2.83	2.93	2.96
A38	3.03	3.14	2.76	2.70	3.03	2.93
A4	3.19	3.52	3.52	3.21	3.54	3.40
Beaumont	2.32	2.33	2.95	2.30	2.29	2.44
Fernleigh Sp	2.91	2.10	2.49	2.04	2.46	2.40
Year av.	**2.91**	**3.09**	**2.95**	**2.79**	**3.00**	**2.95**
LSD (P<0.05)						
Minimum	0.3491	0.3664	0.2637	0.2985	0.2926	
Maximum	0.8487	0.419	0.8333	0.3759	0.3144	
Average	0.489	0.3741	0.3552	0.313	0.2957	

Tree size

Tree size measurement data are presented in Appendix 4, Table 76). All measures of tree size were highly correlated (P = 0.001) (Table 30). Since the N-S canopy diameter is constrained by crowding of trees within the row, it was not as highly correlated as E-W canopy diameter or effective canopy area with average canopy diameter. Canopy area is commonly used as the industry index of tree size and yields are often expressed per unit of canopy area to select trees for high density plantings. Although tree height is more difficult to measure, it is useful to calculate canopy volume.

Table 30. Correlation matrix of tree size measurements at Nambucca.

Av.canopy diameter (m)	1				
E-W canopy diameter (m)	0.903	1			
N-S canopy diameter (m)	0.816	0.49	1		
Effective canopy area (m^2)	0.996	0.908	0.803	1	
Tree height (m)	0.524	0.51	0.378	0.531	1
	Av. canopy diam.	E-W canopy diam.	N-S canopy diam.	Effective canopy area	Tree height

* CSA = cross sectional area

Discussion

Successful commercial macadamia production depends on selecting the best varieties for particular environments. Varietal performance is often variable and thus it is difficult to predict how a variety will perform in a new orchard. Local knowledge is invaluable as environment, soils and management profoundly affect yield and quality. Varieties will perform better, and approach their genetic potential, if they are given non-limiting environmental, nutrition, water and management conditions.

Any variety with serious defects should be avoided. Select varieties with high and consistent sound kernel production from mature (ca 10 year old) trees and better total and sound kernel recovery (>36%) , and % whole kernels than current commercial varieties (>50%). At least 3 of the best performing varieties should be selected to spread risk and to enhance prospects for good cross-pollination. Cross-pollination is desirable and is enhanced by having rows of at least 2 varieties with overlapping flowering in orchard blocks. The canopy diameter of selected varieties should be appropriate for the planned planting density. Production, and hence profitability, can be greatly increased by choosing smaller trees with high yield of sound kernel, planted at high density. Yield per m^2 of effective canopy area (area projected horizontally, within the drip-zone) may be used as a rough indicator of long term yield per hectare. At all sites (Tables 31-33), differences between varieties in yield per canopy area were generally minor. It seems that significant improvements will depend on identifying dwarfing rootstocks to increase productivity from high density plantings. These tables also show how misleading it is to compare varieties based on nut-in-shell and even kernel yields of mature trees, compared with the cumulative yield of sound kernel over the life of the tree (the economic value of the tree).

It is clear that there is considerable potential for new varieties to produce higher yields of sound kernel, and higher sound kernel recoveries, than 344. In trials in the Bundaberg area, at least six varieties produced more cumulative sound kernel than 344. At Winfield, A268, A16, 814, 842, 741 and 816 all produced significantly more sound kernel than 344 and at Hinkler Park, three of these varieties (816, 842 and A16) also produced more than 344, but not significantly so. Other varieties with slightly higher cumulative yields of sound kernel than 344 at Hinkler Park (but not significantly so), were A203, 788 and Daddow. High yields were largely related to large tree size. The highest production per unit projected canopy area was from A16 at 2.8t/ha of projected canopy, compared with 1.7-2.3t/ha for 344.

Since this trial has endured several years of drought and rodent suppressed yields, significant differences may be achieved after several more 'normal' years. Because of its small kernel size and generally poor quality, 814 has subsequently lost favour with growers. In some areas, 842 has also fallen from favour with some growers because of the tendency to produce discoloured kernels under certain conditions and the large tree size. It is still highly regarded, however, in other areas because of its high kernel yields. A268 also featured as one of the better varieties at Hinkler Park, its yield being not significantly lower than 344.

From these trials in the Bundaberg area, promising early varieties are 816, 741, 344, and possibly A203 and 788 if the latter two perform well at Hinkler Park over the next few years. The susceptibility of 344 to AVG in the Bundaberg area makes it risky in AVG-susceptible soils. The only promising mid-season variety in the Bundaberg area is A268, and possibly 842 (mid-late season) although the latter is unpopular in some areas due to susceptibility to basal discolouration. The only promising late variety in these trials was A16 although Daddow appears to have potential in the Hinkler Park trial. In fact, A16 was very late at Hinkler Park.

At Forest Glen in south east Queensland, A series varieties (A29, A38, A268, A16 and A4) all produced significantly higher sound kernel yields than 344 and A203 was also higher, but not significantly so. Both A29 and A38 were also the top yielders at Nambucca where A268 was also one of the better yielding varieties. The only early variety at Forest Glen was A26, followed by 344 which tended to be more mid-season at this site. High yielding mid-season varieties were A268 and A4 and late varieties were A16 and A38. All the A varieties, particularly A16, had excellent quality and very little discolouration at Forest Glen. Good management and frequent harvesting contributed to this good result.

The A series varieties (A29, A38, A4 A268 and A203) appeared to yield well at the southern Nambucca site and, although the yield of A16 was not significantly higher than that of 344, it was slightly higher. Promising early varieties were A29, and to a lesser extent A203. High yielding mid-season varieties were 246 and A268 and A4 and A38 yielded well as a mid-late season and late varieties respectively at Nambucca.

Table 31. Some promising varieties for the Bundaberg area (provisional), based on early variety trial performance at Winfield and Hinkler Park.

Variety	**A268**	**A16**	**842**	**741**	**816**	**A203[2]**	**788[2]**	**Daddow[2]**	**344[4]**
Yield NIS[1] (kg/tree)	10.4	9.3	11.5	10.1	7.5	11.0	9.8	11.6	9.3-12.0
Yield sound kernel[1] (kg/tree)	2.8	3.4	3.3	3.2	3.0	3.6	3.7	4.0	2.5-3.6
Cumul. yield sound kernel[3] (kg/tree)	12.0	11.7	10.9	10.8	10.6	18.3	18.2	17.6	8.1-16.6
Yield sound kernel[1] (t/ha canopy area)	1.7	2.8	1.9	2.4	2.5	2.6	2.0	2.4	1.7-2.3
Av. canopy diameter (m)	5.3	4.6	5.3	4.7	4.7	4.9	6.1	5.5	5.0-5.6
Sound kernel recovery (%)	27.5	34.4	26.2	30.4	37.0	33.5	39.8	34.3	23.6-28.6
First grade kernel (%)	94.5	98.0	98.4	97.0	98.2	97.2	97.9	99.7	97.2-98.7
Whole kernels (%)	44.7	35.8	44.5	25.7	43.6	36.7	51.3	34.7	25.2-36.3

[1] Average annual yield of mature trees (over last 3 years) @ 10% moisture
[2] Yields of top varieties at Hinkler Park were not significantly higher than that of 344.
[3] Cumulative 2000-2005 at Winfield and 1999-2005 at Hinkler Park. NB trees at Hinkler Park are a year older, and hence yields are higher.
[4] from Winfield and Hinkler Park respectively.

Table 32. Some varieties recommended for South East Queensland, based on variety trial performance at Forest Glen.

Variety	A29	A38	A268	A16	A4	A203[3]	344
Yield NIS[1] (kg/tree)	20.5	19.7	18.1	15.9	15.5	16.3	16.1
Yield sound kernel[1] (kg/tree)	8.1	7.6	6.8	6.7	6.9	5.6	5.4
Cumul. yield sound kernel[2] (kg/tree)	34.3	33.3	31.5	31.0	29.0	25.0	22.9
Yield sound kernel[4] (t/ha canopy area)	2.2	2.2	2.1	2.4	2.2	2.4	2.3
Av. canopy diameter (m)	5.9	5.6	5.6	4.9	5.4	5.1	5.4
Kernel recovery (%)	36.3	36.9	36.4	41.1	42.6	32.8[3]	32.5
First grade kernel (%)	96.7	98.1	95.8	97.6	99.4	95.3	95.5
Whole kernels (%)	30.9	58.6	37.0	48.2	35.9	44.8	46.4

[1] Average annual yield of mature trees (over last 3 years) @ 10% moisture
[2] Cumulative 1999-2001
[3] A203 may be worth considering in other areas where it is reported to have much higher KR. At Forest Glen, A203 cumulative kernel yield was not significantly different to that of 344.
[4] 2002 data only

Table 33. Some varieties recommended for Central New South Wales, based on variety trial performance at Nambucca.

Variety	A29	A38	246	A4	A268	A203	344
Yield NIS[1] (kg/tree)	23.2	17.3	20.2	15.6	17.2	18.0	16.6
Yield sound kernel[1] (kg/tree)	9.3	6.8	7.8	7.2	6.7	6.6	6.2
Cumul. yield sound kernel[2] (kg/tree)	48.8	39.5	37.6	37.4	36.5	35.8	31.6
Yield kernel[3] (t/ha canopy area)	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Av.canopy diameter (m)	5.0	4.6	4.9	4.5	4.6	4.5	4.6
Kernel recovery (%)	38.8	37.6	36.6	46.2	38.7	34.4	35.6
First grade kernel (%)	93.5	97.9	89.8	98.9	90.2	90.9	94.1

[1] Average annual yield of mature trees (2000-2002) @ 10% moisture
[2] Cumulative 1996-2003
[3] 2002 data only

Across all four trial sitesA268, A16, A29, A38 all produced significantly higher yields than 344 at two sites and A268 and A16 also produced similar yields to 344 at a third site. A4, 816 and 842 produced higher yields than 344 at one site and yields that were similar at a second site. Summaries of new promising varieties are presented in Appendix 5.

Technology Transfer

The results of trials will be presented at the AMS Annual conference and at regional MacGroup meetings. Articles will be published in the AMS News Bulletin. The booklet, "Selecting Better Macadamia Varieties' will be updated with the latest information.

Recommendations for Future Research

In close consultation with the Macadamia Industry Variety Improvement Committee (MIVIC), Series 3 regional varieties are planned to include appropriate candidate varieties from the industry (CSIRO) and Hidden Valley breeding programs in trials at Mackay, Bundaberg, northern NSW and Nambucca. The continued the evaluation of RVT Series 2 varieties at Winfield and Hinkler Park is recommended to confirm relative yield and quality performance from mature trees, hence providing more reliable information to growers on the performance of better varieties.

Appendix 1. Winfield macadamia regional variety trial data.

Table 34. Nut-in-shell yield (kg/tree) of 36 varieties at Winfield from 2002 to 2005.

	Nut-in-shell yield (kg/tree)							
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2000-2005**	
246	0.0	0.2	0.9	9.0	7.0	16.4	34.1	bc*
344	0.0	0.2	2.1	6.8	7.5	13.7	30.6	cde
705	0.1	0.1	1.4	3.8	2.7	9.6	17.3	klm
741	0.0	0.5	2.9	7.3	7.9	15.2	34.3	bc
781	0.0	0.1	1.1	6.2	4.4	8.7	20.5	ijklm
783	0.0	0.3	1.7	6.0	6.7	13.1	28.0	cdefg
788	0.2	0.4	1.1	4.9	3.8	8.7	18.9	jklm
814	1.0	2.2	5.6	6.2	6.0	13.1	34.5	bc
816	0.2	0.6	3.9	7.0	5.1	10.4	27.5	cdefghi
835	0.0	0.1	0.4	1.3	1.6	5.0	7.6	n
842	0.1	0.5	2.3	9.0	7.6	17.9	37.9	ab
849	0.1	0.4	2.7	6.1	5.3	10.7	25.2	cdefghijklm
853	0.0	0.7	1.8	3.4	3.1	8.0	16.6	lm
856	0.0	0.2	1.1	7.3	4.9	15.4	29.0	cdef
1/40B	0.1	1.6	3.3	6.3	4.7	9.5	25.5	defghij
2/12 Mc	0.1	0.6	3.0	6.1	4.7	10.4	24.9	defghij
2/18Mc	0.0	0.2	2.2	6.7	4.3	7.7	21.1	ghijklm
2/48B	0.0	0.1	0.6	2.7	4.2	9.4	16.3	lm
2/5Mc	0.0	0.2	1.7	6.5	4.7	12.5	25.7	defghij
4/44Mc	0.1	0.4	2.7	5.2	4.5	8.0	20.7	hijklm
4/7Mc	0.0	0.3	4.5	5.2	4.4	13.1	27.5	cdefghi
A104	1.0	1.9	3.8	5.8	3.4	11.7	27.7	cdefgh
A16	0.0	1.0	3.6	7.5	8.3	12.2	33.0	bc
A199	0.0	0.4	1.8	4.8	4.3	8.9	20.1	jklm
A203	0.2	0.9	3.1	5.4	4.4	10.2	24.2	defghijkl
A268	1.1	3.0	5.8	9.1	6.6	15.4	41.9	a
A38	0.0	0.3	1.7	4.9	4.6	13.8	25.2	defghij
A387	0.2	1.2	3.2	3.8	4.4	8.5	21.1	ghijklm
A4	0.1	0.6	1.7	3.5	2.8	7.8	16.0	m
A417	0.0	0.2	1.1	5.2	5.5	9.9	21.7	ghijklm
A422	0.0	0.2	2.5	5.8	7.7	15.1	31.5	bcd
A423	0.0	0.2	1.1	6.0	5.6	11.3	24.2	efghijk
A437	0.0	0.6	2.6	5.7	3.4	12.0	24.4	defghijk
Daddow	0.0	0.3	0.8	5.0	5.9	10.1	21.9	ghijklm
NG8	0.1	0.9	2.7	4.7	2.8	11.5	22.8	fghijklm
Own Venture	0.0	0.4	1.3	5.1	5.4	10.2	22.3	fghijklm
SEM								
Minimum	0.113	0.299	0.602	0.855	0.644	1.272	2.608	
Maximum	0.192	0.482	0.982	1.349	1.093	2.083	4.445	
Average	0.117	0.309	0.623	0.882	0.668	1.316	2.706	
LSD (P=0.05)								
Maximum	0.455	1.138	2.354	3.233	2.596	4.932	10.470	
Minimum	0.315	0.803	1.684	2.344	1.804	3.462	7.148	
Average	0.328	0.834	1.746	2.426	1.876	3.596	7.447	

Table 35. Nut-in-shell yield per unit trunk cross sectional area (kg/cm^2) of 36 varieties at Winfield from 2002 to 2005.

	Nut-in-shell yield (kg/cm^2 trunk cross sectional area)					
	2002	**2003**	**2004**	**2005**	**2000-2005**	
246	0.02	0.09	0.06	0.12	0.24	defg*
344	0.03	0.08	0.07	0.11	0.25	cdef
705	0.03	0.05	0.03	0.09	0.17	jkl
741	0.04	0.08	0.07	0.12	0.26	bcd
781	0.02	0.07	0.04	0.07	0.16	jklm
783	0.03	0.07	0.06	0.11	0.23	defghi
788	0.02	0.05	0.03	0.07	0.14	lm
814		0.07	0.06	0.12	0.31	abc
816	0.05	0.07	0.04	0.07	0.19	ghijkl
835	0.01	0.03	0.03	0.07	0.11	m
842	0.03	0.08	0.06	0.11	0.23	defgh
849	0.04	0.08	0.06	0.09	0.23	defghijk
853	0.03	0.05	0.04	0.08	0.16	jklm
856	0.02	0.08	0.04	0.11	0.20	efghijk
1/40B	0.04	0.07	0.04	0.07	0.17	ijkl
2/12 Mc	0.05	0.08	0.04	0.09	0.20	efghijk
2/18Mc	0.04	0.09	0.05	0.07	0.19	ghijkl
2/48B	0.01	0.04	0.05	0.09	0.16	jklm
2/5Mc	0.03	0.08	0.05	0.10	0.20	efghijk
4/44Mc	0.04	0.06	0.04	0.06	0.15	klm
4/7Mc	0.09	0.08	0.05	0.12	0.26	cde
A104	0.06	0.07	0.03	0.09	0.22	defghij
A16	0.06	0.11	0.10	0.13	0.36	a
A199	0.04	0.08	0.06	0.10	0.23	defgh
A203	0.05	0.07	0.05	0.09	0.21	defghij
A268	0.08	0.10	0.06	0.12	0.32	ab
A38	0.04	0.07	0.06	0.14	0.25	cdef
A387	0.05	0.05	0.05	0.08	0.20	efghijk
A4	0.04	0.06	0.04	0.09	0.19	fghijkl
A417	0.02	0.06	0.05	0.08	0.18	hijkl
A422	0.04	0.07	0.07	0.12	0.25	cdef
A423	0.02	0.08	0.06	0.11	0.23	defgh
A437	0.05	0.08	0.04	0.12	0.26	cde
Daddow	0.02	0.07	0.07	0.10	0.21	defghij
NG8	0.05	0.07	0.04	0.12	0.24	defg
Own Venture	0.02	0.06	0.05	0.08	0.17	ijkl
SEM						
Minimum	0.011	0.010	0.006	0.010	0.021	
Maximum	0.017	0.014	0.010	0.016	0.035	
Average	0.011	0.010	0.007	0.010	0.022	
LSD (P=0.05)						
Maximum	0.041	0.035	0.025	0.039	0.084	
Minimum	0.031	0.027	0.017	0.028	0.059	
Average	0.032	0.028	0.018	0.029	0.061	

*values of cumulative yield (2000-2005) followed by the same letter are not significantly different.

Table 36. Nut-in-shell yield per unit projected canopy area (kg/m^2) of 36 varieties at Winfield from 2002 to 2005.

	Nut-in-shell yield (kg/m^2 canopy area)					
	2002	**2003**	**2004**	**2005**	**2000-2005**	
246	0.14	0.79	0.49	0.95	2.00	bcdefg*
344	0.35	0.60	0.54	0.84	1.85	cdefghi
705	0.32	0.45	0.24	0.76	1.39	ijklm
741	0.56	0.73	0.63	1.00	2.30	abc
781	0.18	0.52	0.31	0.57	1.30	klm
783	0.25	0.52	0.54	0.85	1.83	cdefghij
788	0.17	0.41	0.26	0.56	1.18	m
814	0.67	0.52	0.47	0.97	2.62	a
816	0.57	0.66	0.43	0.74	1.95	bcdefg
835	0.10	0.15	0.15	0.43	0.63	n
842	0.26	0.67	0.45	0.91	1.92	bcdefg
849	0.35	0.55	0.42	0.79	1.90	bcdefghijk
853	0.43	0.43	0.30	0.64	1.32	klm
856	0.16	0.52	0.29	0.83	1.57	fghijklm
1/40B	0.47	0.52	0.34	0.65	1.69	defghijkl
2/12 Mc	0.49	0.70	0.45	0.87	2.10	bcd
2/18Mc	0.34	0.65	0.32	0.53	1.38	hijklm
2/48B	0.14	0.29	0.37	0.69	1.20	lm
2/5Mc	0.28	0.65	0.41	0.94	1.98	bcdef
4/44Mc	0.49	0.62	0.42	0.63	1.62	efghijklm
4/7Mc	0.78	0.53	0.35	0.93	1.99	bcdef
A104	0.71	0.56	0.32	0.87	2.09	bcde
A16	0.59	0.72	0.70	0.90	2.39	ab
A199	0.31	0.51	0.43	0.83	1.87	cdefghi
A203	0.54	0.61	0.50	0.92	2.20	abc
A268	0.66	0.66	0.42	0.83	2.21	abc
A38	0.29	0.48	0.33	0.89	1.67	defghijkl
A387	0.49	0.38	0.38	0.66	1.61	fghijklm
A4	0.31	0.42	0.29	0.66	1.33	jklm
A417	0.18	0.51	0.44	0.71	1.49	ghijklm
A422	0.36	0.49	0.57	0.94	2.00	bcdef
A423	0.19	0.59	0.49	0.89	1.92	bcdefg
A437	0.46	0.61	0.30	0.89	1.86	cdefghi
Daddow	0.15	0.47	0.45	0.66	1.42	hijklm
NG8	0.57	0.58	0.27	0.94	1.89	cdefgh
Own Venture	0.25	0.53	0.46	0.73	1.59	fghijklm
SEM						
Minimum	1.166	0.677	0.457	0.811	1.718	
Maximum	1.727	1.061	0.771	1.249	2.852	
Average	1.198	0.698	0.474	0.836	1.780	
LSD (P=0.05)						
Maximum	4.181	2.568	1.826	3.036	6.807	
Minimum	3.167	1.891	1.263	2.265	4.808	
Average	3.264	1.955	1.315	2.338	4.992	

*values of cumulative yield (2000-2005) followed by the same letter are not significantly different.

Table 37. Sound kernel recovery of 36 varieties at Winfield from 2002 to 2005.

	Sound kernel recovery (%)				
	2002	**2003**	**2004**	**2005**	**Average**
246	27.2	21.5	17.2	36.3	25.5
344	26.8	16.1	17.6	33.7	23.6
741	36.2	23.9	21.6	39.8	30.4
705	31.6	33.0	22.0	33.0	29.9
783	34.5	33.5	12.3	37.6	29.5
788	31.9	31.7	26.1	38.3	32.0
814	37.5	7.8	25.3	41.9	28.1
816	37.3	43.2	25.0	42.7	37.0
835		24.4	20.4	37.9	27.6
842	29.5	26.2	11.4	37.6	26.2
849	31.7	28.2	19.2	42.6	30.4
853	38.9	30.5	28.1	38.9	34.1
856	33.4	28.8	17.7	36.7	29.2
Daddow	33.2	30.0	24.6	36.8	31.2
NG8	35.2	20.3	28.9	38.0	30.6
Own Venture	31.2	27.8	22.0	38.5	29.9
A4	41.0	36.2	33.9	39.5	37.6
A16	37.3	30.6	29.3	40.4	34.4
781	30.5	32.9	16.1	37.1	29.1
A38	26.3	23.5	23.1	35.8	27.2
A104	39.2	29.5	24.0	41.4	33.5
A199	33.5	25.6	29.7	35.7	31.1
A203	33.7	27.2	25.2	37.2	30.8
A268	36.3	22.2	15.6	36.1	27.5
A387	36.6	32.0	32.5	41.3	35.6
A417	22.1	14.4	14.6	37.6	22.2
A422	34.6	33.2	24.1	38.8	32.7
A423	30.5	22.3	15.6	39.8	27.0
A437	39.0	20.3	20.5	43.6	30.9
1/40B	32.7	26.8	16.5	41.3	29.3
2/5Mc	39.4	21.3	18.6	41.5	30.2
2/12 Mc	31.4	19.0	16.3	34.6	25.3
2/18Mc	32.4	36.2	17.4	35.5	30.4
2/48B	24.2	39.3	19.6	34.9	29.5
4/7Mc	32.3	14.8	26.2	40.7	28.5
4/44Mc	37.0	32.0	23.9	36.2	32.3

Table 38. Average unsound kernel recovery (%) of 36 varieties at Winfield from 2002 to 2005.

	Unsound kernel recovery (%)				
	2002	**2003**	**2004**	**2005**	**Average**
246	4.1	13.0	15.8	0.2	8.3
344	3.7	14.6	15.1	0.4	8.4
741	1.7	14.3	14.7	0.7	7.9
705	1.5	4.2	13.8	2.2	5.4
783	1.9	6.0	21.4	1.7	7.7
788	5.4	6.5	12.3	1.1	6.4
814	1.1	18.9	11.5	0.6	8.0
816	6.6	2.8	18.1	0.8	7.0
835		13.6	21.2	1.3	12.0
842	6.4	12.7	25.6	0.2	11.2
849	9.6	13.4	19.9	0.3	10.8
853	1.1	8.9	12.3	0.1	5.6
856	0.3	8.4	17.1	0.3	6.5
Daddow	1.1	6.7	9.7	0.1	4.4
NG8	1.9	13.0	6.3	0.4	5.4
Own Venture	4.6	9.3	13.6	1.0	7.1
A4	2.4	8.1	5.3	1.6	4.3
A16	2.6	11.4	11.3	0.8	6.5
781	5.8	7.0	19.7	0.6	8.3
A38	4.5	11.4	11.2	1.1	7.0
A104	2.3	10.0	15.4	0.8	7.1
A199	2.0	9.3	4.7	0.3	4.1
A203	1.3	10.0	9.3	0.3	5.2
A268	1.8	12.9	20.0	1.7	9.1
A387	2.4	9.6	6.9	0.2	4.8
A417	9.3	23.7	22.5	2.0	14.4
A422	3.0	7.4	15.1	0.3	6.4
A423	5.5	16.3	22.1	0.5	11.1
A437	4.7	19.4	21.8	3.4	12.3
1/40B	8.2	17.2	26.1	1.7	13.3
2/5Mc	3.1	22.2	23.1	2.2	12.7
2/12 Mc	5.5	20.6	20.6	2.8	12.4
2/18Mc	2.6	22.7	17.5	0.4	10.8
2/48B	6.3	4.5	13.5	2.3	6.7
4/7Mc	6.5	20.6	12.6	0.3	10.0
4/44Mc	2.2	8.0	13.7	2.7	6.6

Table 39. First grade kernel of sound kernel of 36 varieties at Winfield from 2002 to 2005.

	First grade kernel (%)				
	2002	**2003**	**2004**	**2005**	**Average**
246	98.2	97.9	85.5	99.0	95.2
344	96.7	99.0	95.9	97.1	97.2
741	97.2	97.2	94.0	99.6	97.0
705	98.7	96.6	85.0	100.0	95.1
783	100.0	100.0	88.6	99.5	97.0
788	92.7	95.6	88.9	98.0	93.8
814	98.9	96.8	96.5	100.0	98.1
816	99.7	99.4	95.2	98.5	98.2
835		100.0	99.4	100.0	99.8
842	99.2	99.0	95.5	100.0	98.4
849	99.1	96.5	97.8	100.0	98.4
853	100.0	100.0	98.3	100.0	99.6
856	97.6	96.0	93.8	99.2	96.6
Daddow	100.0	98.8	96.0	100.0	98.7
NG8	99.8	96.5	99.2	99.7	98.8
Own Venture	100.0	94.8	95.7	100.0	97.6
A4	100.0	98.4	98.7	100.0	99.3
A16	98.6	96.9	96.7	100.0	98.0
781	98.7	98.9	94.4	98.1	97.5
A38	98.5	98.0	96.9	99.3	98.2
A104	95.1	93.5	90.5	99.3	94.6
A199	100.0	99.7	99.6	100.0	99.8
A203	99.4	99.4	95.0	99.9	98.4
A268	97.8	96.7	84.1	99.4	94.5
A387	99.8	100.0	99.6	100.0	99.9
A417	95.5	100.0	97.3	100.0	98.2
A422	98.8	98.9	97.7	100.0	98.9
A423	99.5	100.0	94.6	100.0	98.5
A437	99.4	96.1	95.7	100.0	97.8
1/40B	97.8	100.0	86.9	99.6	96.1
2/5Mc	99.6	100.0	96.9	99.1	98.9
2/12 Mc	97.3	94.5	95.2	99.3	96.6
2/18Mc	95.8	100.0	100.0	99.2	98.8
2/48B	70.2	97.0	97.1	97.5	90.4
4/7Mc	94.7	98.0	99.7	99.7	98.0
4/44Mc	97.3	98.6	96.7	97.0	97.4
Average	97.5	98.0	95.0	99.4	97.5

Table 40. Win Average percentage of whole kernels, after cracking, of 36 varieties at Winfield from 2002 to 2005

	Whole kernel (%)				
	2002	**2003**	**2004**	**2005**	**Average**
246	29.6	48.4	45.7	34.3	39.5
344	19.3	28.3	28.0	25.0	25.2
741	20.0	27.8	36.3	18.7	25.7
705	33.1	32.5	43.1	32.5	35.3
783	25.0	35.0	37.7	33.3	32.8
788	37.2	49.3	55.3	43.0	46.2
814	27.5	34.0	37.0	31.0	32.4
816	32.7	43.3	57.7	40.7	43.6
835		38.3	54.0	47.8	46.7
842	31.5	54.0	47.0	45.7	44.5
849	45.2	59.0	55.5	34.7	48.6
853	47.0	60.7	60.7	57.3	56.4
856	24.0	27.0	34.7	29.7	28.8
Daddow	21.8	46.3	44.7	26.3	34.8
NG8	12.5	28.0	21.7	15.3	19.4
Own Venture	34.9	39.3	53.0	43.3	42.6
A4	18.7	40.7	42.5	25.8	31.9
A16	22.7	38.0	42.7	39.7	35.8
781	31.6	37.7	41.3	26.0	34.2
A38	36.5	40.3	46.7	41.0	41.1
A104	30.5	32.0	41.0	31.0	33.6
A199	35.1	38.0	50.7	37.3	40.3
A203	29.5	37.7	36.7	23.9	32.0
A268	29.5	60.8	49.0	39.7	44.7
A387	19.5	42.0	45.3	36.3	35.8
A417	28.6	43.6	35.3	36.9	36.1
A422	43.0	65.0	57.7	56.3	55.5
A423	29.0	52.7	53.3	44.7	44.9
A437	22.0	40.0	32.3	26.3	30.2
1/40B	10.5	23.6	30.2	32.7	24.3
2/5Mc	34.3	56.7	46.3	39.0	44.1
2/12 Mc	35.8	39.7	46.5	37.7	39.9
2/18Mc	34.2	45.4	42.3	38.3	40.1
2/48B	67.9	37.4	30.1	31.7	41.8
4/7Mc	25.3	54.2	32.5	29.5	35.4
4/44Mc	29.0	49.0	49.3	33.0	40.1

Table 41. Mean nut mass of 36 varieties at Winfield from 2002 to 2005.

	Mean Nut-in-shell mass (g)				
	2002	**2003**	**2004**	**2005**	**Average**
246	8.83	6.64	6.78	6.96	7.30
344	7.47	6.43	6.81	7.39	7.02
741	7.41	5.90	6.38	6.28	6.49
705	7.30	6.04	7.08	6.90	6.83
783	7.42	7.36	6.86	7.01	7.16
788	7.14	6.30	6.54	6.18	6.54
814	5.18	3.23	4.46	4.50	4.34
816	7.11	6.99	6.51	7.21	6.96
835		6.20	6.67	6.63	6.50
842	6.98	5.64	5.81	6.40	6.21
849	5.88	5.22	6.56	6.64	6.07
853	5.22	4.55	5.36	5.35	5.12
856	8.02	6.62	6.59	6.57	6.95
Daddow	8.41	6.06	6.71	6.49	6.92
NG8	8.03	5.56	7.08	6.61	6.82
Own Venture	8.46	7.79	7.66	7.20	7.78
A4	7.64	5.66	6.65	7.76	6.93
A16	8.28	5.90	6.59	6.72	6.87
781	7.94	6.61	7.15	7.11	7.20
A38	7.91	5.87	7.10	7.14	7.00
A104	6.02	5.02	5.84	5.79	5.67
A199	7.60	5.30	6.10	6.73	6.43
A203	8.58	7.01	7.61	7.89	7.77
A268	9.64	6.50	8.34	8.41	8.22
A387	6.06	5.64	5.59	6.05	5.84
A417	6.97	6.02	7.39	7.02	6.85
A422	7.11	5.80	5.64	6.15	6.17
A423	7.99	6.28	6.26	6.03	6.64
A437	6.69	4.19	5.58	5.43	5.47
1/40B	8.44	6.21	7.20	6.57	7.10
2/5Mc	7.27	5.65	6.29	6.88	6.52
2/12 Mc	7.33	6.48	6.96	7.00	6.94
2/18Mc	7.76	4.40	7.64	7.47	6.82
2/48B	7.20	5.02	5.78	5.33	5.83
4/7Mc	8.24	4.82	7.53	7.34	6.98
4/44Mc	8.52	7.80	7.84	7.93	8.02
Average	7.49	5.91	6.64	6.70	6.67

Table 42. Mean kernel mass (g) of 36 varieties at Winfield from 2002 to 2005.

	Mean kernel mass (g)				
	2002	**2003**	**2004**	**2005**	**Average**
246	2.8	2.3	2.2	2.5	2.5
344	2.3	2.0	2.2	2.5	2.3
741	2.8	2.3	2.3	2.5	2.5
705	2.4	2.2	2.5	2.4	2.4
783	2.7	2.9	2.3	2.8	2.7
788	2.7	2.4	2.5	2.4	2.5
814	2.0	0.9	1.6	1.9	1.6
816	3.1	3.2	2.8	3.1	3.1
835		2.3	2.8	2.6	2.6
842	2.5	2.2	2.2	2.4	2.3
849	2.4	2.2	2.6	2.8	2.5
853	2.1	1.8	2.2	2.1	2.0
856	2.7	2.5	2.3	2.4	2.5
Daddow	2.9	2.2	2.3	2.4	2.4
NG8	3.0	1.9	2.5	2.5	2.5
Own Venture	3.0	2.9	2.7	2.8	2.9
A4	3.3	2.5	2.6	3.2	2.9
A16	3.3	2.5	2.7	2.8	2.8
781	2.9	2.6	2.6	2.7	2.7
A38	2.4	2.1	2.4	2.6	2.4
A104	2.5	2.0	2.3	2.4	2.3
A199	2.7	1.8	2.1	2.4	2.3
A203	3.0	2.6	2.6	2.9	2.8
A268	3.7	2.3	3.0	3.2	3.0
A387	2.4	2.3	2.2	2.5	2.4
A417	2.2	2.3	2.7	2.8	2.5
A422	2.7	2.4	2.2	2.4	2.4
A423	2.9	2.4	2.4	2.4	2.5
A437	2.9	1.7	2.4	2.6	2.4
1/40B	3.5	2.8	3.1	2.8	3.0
2/5Mc	3.1	2.5	2.6	3.0	2.8
2/12 Mc	2.7	2.6	2.6	2.6	2.6
2/18Mc	2.7	2.1	2.7	2.7	2.5
2/48B	2.2	2.1	1.9	2.0	2.0
4/7Mc	3.2	1.7	2.9	3.0	2.7
4/44Mc	3.3	3.1	3.0	3.1	3.1
Average	2.8	2.3	2.5	2.6	2.5

Table 43. Tree height of 36 varieties at Winfield from 2002 to 2006.

	Tree Height (m)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	4.197	4.465	4.895	5.353	5.814	efghijk*
344	4.311	4.667	5.14	5.523	5.867	defghij
705	3.873	4.491	4.855	5.041	5.301	lm
741	4.715	4.785	5.039	5.503	5.972	bcdefg
781	4.606	4.844	5.201	5.543	6.035	bcdef
783	4.442	4.805	5.039	5.523	5.962	cdefgh
788	4.179	4.472	4.733	5.141	5.626	fghijklm
814	4.343	4.53	4.896	5.202	5.301	lm
816	4.639	4.726	5.222	5.785	6.402	ab
835	3.151	3.806	4.305	4.739	5.5	ijklm
842	4.322	4.55	4.835	5.182	5.637	fghijklm
849	4.274	4.479	4.733	5.154	5.633	efghijklm
853	4.168	4.413	4.957	5.322	5.532	hijklm
856	4.518	4.805	5.303	5.805	6.339	abc
1/40B	4.387	4.726	5.252	5.563	5.857	efghij
2/12 Mc	4.157	4.413	4.814	5.061	5.899	defghi
2/18Mc	4.097	4.513	4.997	5.554	6.247	abcde
2/48B	3.219	4.124	4.409	4.9	5.412	jklm
2/5Mc	4.661	4.961	5.578	6.046	6.548	a
4/44Mc	4.081	4.354	5.028	5.925	6.486	a
4/7Mc	3.884	4.335	4.692	5.282	5.637	fghijklm
A104	4.595	4.746	5.446	5.684	5.815	efghijk
A16	3.982	4.295	4.672	5.101	5.584	ghijklm
A199	4.114	4.354	4.652	5.262	5.574	ghijklm
A203	3.973	4.416	4.754	5.177	5.549	ghijklm
A268	3.982	4.295	4.814	5.202	5.605	fghijklm
A38	4.387	4.589	5.059	5.342	5.7	fghijkl
A387	3.851	4.315	4.753	5.262	5.846	efghijk
A4	3.292	3.807	4.153	4.724	5.391	klm
A417	4.114	4.452	4.855	5.242	5.647	fghijkl
A422	4.365	4.628	4.977	5.383	5.815	efghijk
A423	4.081	4.413	5.018	5.624	6.297	abcd
A437	3.873	4.139	4.54	4.9	5.207	m
Daddow	3.731	4.315	4.652	5.041	5.49	ijklm
NG8	3.873	4.158	4.509	4.8	5.207	m
Own Venture	3.961	4.354	4.835	5.302	5.7	fghijkl
LSD (P=0.05)						
Maximum	0.5864	0.5279	0.5632	0.6151	0.6177	
Minimum	0.4035	0.3893	0.4066	0.4473	0.4374	
Average	0.4201	0.4024	0.4212	0.463	0.454	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 44. Canopy diameter (N-S) of 36 varieties at Winfield from 2002 to 2006.

	Canopy diameter, N-S along the row (m)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	3.75	3.96	4.23	4.25	3.75	ab*
344	2.89	3.74	4.05	4.15	2.89	abcde
705	2.45	3.63	3.74	3.72	2.45	defgh
741	2.80	3.65	3.97	4.01	2.80	bcdefg
781	3.30	3.80	3.96	3.83	3.30	bcdefgh
783	3.38	4.02	4.07	4.09	3.38	abcdef
788	3.16	3.83	4.27	4.15	3.16	bcdefg
814	3.20	3.88	3.87	3.73	3.20	cdefgh
816	2.96	3.71	3.87	3.98	2.96	bcdefgh
835	1.91	2.96	3.47	3.70	1.91	gh
842	3.30	3.77	4.14	4.18	3.30	abcd
849	3.21	3.72	3.85	3.75	3.21	bcdefgh
853	2.26	3.29	3.62	3.69	2.26	gh
856	3.53	4.32	4.46	4.43	3.53	a
1/40B	2.96	3.98	4.00	3.97	2.96	bcdefg
2/12 Mc	2.80	3.43	3.60	3.62	2.80	efgh
2/18Mc	3.10	3.72	4.05	3.95	3.10	bcdefg
2/48B	2.22	3.16	3.61	3.83	2.22	defgh
2/5Mc	3.18	3.78	3.97	4.10	3.18	abcdef
4/44Mc	2.62	3.35	3.63	3.80	2.62	bcdefgh
4/7Mc	2.80	3.61	3.74	3.91	2.80	bcdefg
A104	2.82	3.79	3.80	3.74	2.82	efgh
A16	2.86	3.74	3.84	4.00	2.86	bcdefg
A199	2.74	3.45	3.44	3.42	2.74	h
A203	2.66	3.53	3.64	3.78	2.66	defgh
A268	3.40	4.04	4.24	4.34	3.40	abc
A38	2.82	3.56	4.01	3.94	2.82	bcdefg
A387	2.90	3.61	3.74	3.85	2.90	efgh
A4	2.43	3.18	3.46	3.72	2.43	defgh
A417	2.78	3.60	3.88	4.00	2.78	bcdefg
A422	3.26	3.97	4.05	4.00	3.26	abcdef
A423	3.12	3.68	3.84	3.73	3.12	bcdefg
A437	2.96	3.52	3.87	3.86	2.96	defgh
Daddow	2.56	3.64	3.79	3.92	2.56	bcdefgh
NG8	2.56	3.22	3.78	3.82	2.56	fgh
Own Venture	2.82	3.64	3.86	3.93	2.82	bcdefgh
LSD (P=0.05)						
Maximum	0.7451	0.6421	0.5714	0.5937	0.6547	
Minimum	0.5379	0.4914	0.4441	0.484	0.5236	
Average	0.5572	0.5059	0.4565	0.4949	0.5366	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 45. Canopy diameter (E-W) of 36 varieties at Winfield from 2002 to 2006.

	Canopy diameter, E-W across the row (m)					
	2002	2003	2004	2005	2006	
246	3.19	3.55	4.23	4.84	5.28	cdefghi*
344	2.88	3.74	4.18	4.91	5.36	bcdefg
705	2.02	3.29	3.79	4.36	4.76	hijkl
741	2.61	3.49	4.11	4.73	5.13	defghijk
781	2.87	3.94	4.48	5.38	5.91	ab
783	2.75	3.48	3.91	4.66	4.89	fghijkl
788	3.11	3.88	4.38	4.88	5.21	defghij
814	3.06	3.83	4.23	4.71	5.30	cdefgh
816	3.06	3.57	3.93	4.52	5.17	defghijk
835	1.73	2.90	3.81	4.50	5.01	efghijkl
842	3.40	4.31	4.96	5.63	5.97	a
849	3.06	3.68	4.13	4.70	5.09	cdefghijkl
853	2.19	2.96	3.59	4.51	4.70	ijkl
856	3.38	3.97	4.56	5.16	5.83	abc
1/40B	2.96	3.79	4.28	4.81	5.38	bcdef
2/12 Mc	2.68	3.28	3.75	4.30	4.85	fghijkl
2/18Mc	2.80	3.48	4.20	4.92	5.63	abcd
2/48B	2.14	3.12	3.85	4.50	5.00	efghijkl
2/5Mc	2.64	3.34	3.78	4.07	4.56	l
4/44Mc	2.64	3.25	3.84	4.43	5.05	defghijkl
4/7Mc	2.64	3.46	4.02	4.54	4.97	efghijkl
A104	2.47	3.38	3.64	4.53	4.81	ghijkl
A16	2.70	3.50	3.98	4.41	4.95	efghijkl
A199	2.62	3.45	3.82	4.27	4.93	efghijkl
A203	2.19	3.23	3.39	3.85	4.63	jkl
A268	3.23	4.17	4.58	5.23	5.83	abc
A38	2.72	3.57	4.35	4.89	5.48	abcde
A387	2.81	3.53	3.94	4.44	4.97	efghijkl
A4	2.39	3.13	3.66	4.16	4.62	jkl
A417	2.70	3.46	4.01	4.63	5.19	defghij
A422	2.98	3.83	4.23	4.95	5.38	bcdef
A423	2.87	3.49	3.88	4.45	4.95	efghijkl
A437	2.60	3.32	3.91	4.38	4.62	kl
Daddow	2.68	3.69	4.39	5.04	5.48	abcde
NG8	2.34	3.22	3.57	4.10	4.85	fghijkl
Own Venture	2.64	3.30	3.94	4.57	5.11	defghijkl
LSD (P=0.05)						
Maximum	0.6344	0.6711	0.6884	0.7415	0.7677	
Minimum	0.4425	0.4991	0.5081	0.5392	0.5629	
Average	0.46	0.5154	0.5251	0.5581	0.5821	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 46. Average canopy diameter of 36 varieties at Winfield from 2002 to 2006.

	Average canopy diameter (m)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	3.498	3.769	4.25	4.602	5.07	abcd*
344	2.886	3.746	4.123	4.556	4.976	abcde
705	2.224	3.456	3.755	4.013	4.409	ghij
741	2.701	3.567	4.041	4.381	4.717	defghij
781	3.098	3.882	4.223	4.585	5.038	abcd
783	3.077	3.761	3.999	4.401	4.678	defghij
788	3.14	3.862	4.347	4.546	4.755	defghi
814	3.14	3.862	4.051	4.192	4.726	defghij
816	3.013	3.645	3.898	4.26	4.678	defghij
835	1.795	2.9	3.617	4.071	4.39	hij
842	3.363	4.051	4.561	4.929	5.303	ab
849	3.159	3.716	3.989	4.161	4.611	defghij
853	2.208	3.108	3.598	4.071	4.265	j
856	3.469	4.172	4.533	4.861	5.427	a
1/40B	2.96	3.896	4.142	4.396	4.851	bcdefgh
2/12 Mc	2.738	3.34	3.665	3.921	4.429	ghij
2/18Mc	2.96	3.601	4.128	4.436	4.977	abcdef
2/48B	2.154	3.111	3.708	4.147	4.538	efghij
2/5Mc	2.918	3.562	3.879	4.12	4.525	efghij
4/44Mc	2.621	3.287	3.727	4.1	4.621	defghij
4/7Mc	2.717	3.529	3.87	4.226	4.678	defghij
A104	2.642	3.587	3.717	4.11	4.409	ghij
A16	2.78	3.625	3.91	4.221	4.601	defghij
A199	2.674	3.442	3.608	3.78	4.265	j
A203	2.422	3.373	3.508	3.803	4.333	ij
A268	3.331	4.123	4.423	4.837	5.293	abc
A38	2.77	3.562	4.185	4.41	4.87	bcdefg
A387	2.854	3.572	3.836	4.139	4.496	fghij
A4	2.395	3.133	3.542	3.919	4.333	ij
A417	2.738	3.524	3.946	4.328	4.784	defghi
A422	3.13	3.911	4.146	4.478	4.928	bcdef
A423	3.003	3.587	3.86	4.061	4.592	defghij
A437	2.78	3.413	3.894	4.115	4.361	ij
Daddow	2.611	3.669	4.084	4.473	4.832	cdefgh
NG8	2.441	3.2	3.674	3.95	4.4	hij
Own Venture	2.727	3.471	3.898	4.25	4.649	defghij
LSD (P=0.05)						
Maximum	0.6493	0.6055	0.5809	0.5856	0.6263	
Minimum	0.454	0.4472	0.4317	0.4321	0.4641	
Average	0.4718	0.4621	0.4458	0.4465	0.4794	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 47. Projected effective canopy area of 36 varieties at Winfield from 2002 to 2006.

	Projected canopy area (m^2)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	9.637	11.22	14.29	16.65	20.19	abc*
344	6.64	11.11	13.41	16.28	19.46	bcd
705	4.051	9.53	11.16	12.6	15.2	ghij
741	5.837	10.07	13	15.07	17.48	cdefghi
781	7.566	11.94	14.1	16.01	19.44	bcd
783	7.434	11.12	12.57	15.18	17.18	cdefghij
788	7.896	11.82	14.94	16.18	17.67	cdefgh
814	7.795	11.79	12.92	13.74	17.33	cdefghij
816	7.184	10.48	11.97	14.26	17.06	cdefghij
835	2.74	6.77	10.46	12.96	14.98	ghij
842	9.095	12.93	16.43	18.88	22	ab
849	7.888	10.97	12.58	13.41	16.57	cdefghij
853	3.957	7.74	10.25	12.84	14.19	ij
856	9.53	13.82	16.34	18.69	23.32	a
1/40B	6.978	12.03	13.5	15.08	18.31	cdefgh
2/12 Mc	5.984	8.85	10.6	12.03	15.32	ghij
2/18Mc	6.891	10.22	13.45	15.3	19.16	bcde
2/48B	3.833	7.82	10.91	13.5	16.08	defghij
2/5Mc	6.679	9.98	11.83	13.29	16.04	defghij
4/44Mc	5.43	8.53	10.97	13.19	16.74	cdefghij
4/7Mc	5.87	9.81	11.9	14.1	17.24	cdefghij
A104	5.64	10.32	11.14	13.25	15.4	fghij
A16	6.121	10.33	12.03	14.02	16.57	cdefghij
A199	5.668	9.31	10.25	11.12	13.99	j
A203	4.917	9.02	9.75	11.44	14.74	hij
A268	8.876	13.48	15.45	18.36	21.96	ab
A38	6.175	10.18	13.85	15.08	18.4	cdefg
A387	6.44	10.07	11.56	13.43	15.72	efghij
A4	4.662	7.95	9.89	12.1	14.68	hij
A417	6.033	9.84	12.3	14.77	18.02	cdefgh
A422	7.784	12.07	13.54	15.57	18.85	bcdef
A423	7.084	10.13	11.78	12.85	16.47	defghij
A437	6.141	9.22	12	13.29	15.01	ghij
Daddow	5.487	10.58	13.08	15.53	18.02	cdefgh
NG8	4.738	8.12	10.64	12.24	15.08	ghij
Own Venture	5.886	9.47	11.94	14.11	16.84	cdefghij
LSD (P=0.05)						
Maximum	2.806	3.349	3.639	3.963	4.671	
Minimum	1.971	2.468	2.696	2.928	3.454	
Average	2.048	2.551	2.785	3.025	3.568	

*2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 48. Trunk girths of 36 varieties at Winfield from 2002 to 2006.

	Trunk girth (mm)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	305.5	353.3	393	415.2	454.3	abcde*
344	292.1	324.8	366.1	390.5	418.1	efghijklm
705	237.4	281.9	322.2	357.6	392.8	jklmno
741	302	336.9	379	401.7	432.5	cdefghij
781	272.4	342.2	376.8	403.9	460.1	abcd
783	286.2	324.1	364.2	393.5	428.8	defghijk
788	307.2	349.8	389.5	414.5	450.2	abcdef
814	300.2	322.3	353.7	375.1	404.1	ghijklmo
816	323.4	361.9	400.6	427.1	464.7	abcd
835	150.9	202.1	251.5	291.3	331	p
842	316.9	364.6	410.9	448.7	486.9	a
849	270.8	304.6	342.6	375.2	410	defghijklmno
853	254.3	286.1	323.1	356.3	391.9	klmno
856	301.8	345.8	391.5	426	464	abcd
1/40B	310.7	351.1	397.6	435.5	476.5	ab
2/12 Mc	279.4	318.1	361.3	389.2	426.2	defghijkl
2/18Mc	247	297.2	344.3	376.5	450.3	abcdef
2/48B	204.9	255.5	308.5	351.9	392	iklmno
2/5Mc	283.8	321.7	363.3	397.6	433.4	cdefghi
4/44Mc	281.6	326.3	373.1	422.1	470.3	abc
4/7Mc	256.7	291.6	328.8	365.8	401.7	ghijklmno
A104	288.4	319.9	363.5	398.9	436.3	cdefgh
A16	263.7	290.9	318.5	342.2	368.3	nop
A199	236.7	268.8	302.4	330.5	364.4	nop
A203	266.3	308	347.8	374	422.4	defghijklm
A268	303.1	339.6	375.7	404.3	439.8	bcdefg
A38	244	283.9	321.6	355	393.2	jklmno
A387	271.3	304.4	334.7	360.6	388	lmno
A4	207.8	243.1	280.9	314.5	361	np
A417	279.7	326.1	358.7	387.9	419.9	efghijklm
A422	295.6	333.2	370.7	396.1	431.2	cdefghijk
A423	259.5	298	334.7	361.7	397.6	hijklmno
A437	255.6	282.3	319.6	343.5	365.7	nop
Daddow	240.5	285.2	324.4	361.2	410.9	fghijklm
NG8	247.3	278.6	322.5	348.7	383.8	mno
Own Venture	281	323.4	375.5	407.2	462.5	abcd
LSD (P=0.05)						
Maximum	54.69	52.57	55.38	55.87	58.14	
Minimum	37.52	35.78	37.98	38.57	39.99	
Average	38.65	37.02	39.41	40.14	41.64	

* 2006 girths followed by the same letter are not significantly different (P = 0.05).

Table 49. Trunk cross sectional area of 36 varieties at Winfield from 2002 to 2006.

	Trunk cross sectional area (cm^2)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	74.58	99.7	123.42	137.7	164.8	abcde*
344	68.26	84.33	107.09	121.7	139.5	efghijk
705	47.51	65.4	84.98	103.8	124.7	hijklm
741	72.86	90.62	114.74	128.8	149.3	defghi
781	60.49	93.59	113.53	130.7	169.1	abcd
783	65.78	84.04	105.97	123.7	146.8	defghij
788	76	98.12	121.51	137.5	162.1	bcde
814	72.1	83.05	100.06	112.6	130.7	ghijklm
816	83.68	104.69	128.3	145.6	172.3	abcd
835	20.4	34.41	52.39	69.7	89.4	n
842	80.5	106.48	135.39	161.6	190.3	a
849	59.52	74.85	94.57	113.1	135.1	defghijklm
853	52.69	66.37	84.33	102	123.2	ijklm
856	73.07	95.85	122.89	145.5	172.5	abcd
1/40B	77.29	98.48	126.29	151.6	181.2	ab
2/12 Mc	63.31	81.78	105.3	121.7	145.8	defghij
2/18Mc	49.35	70.76	94.74	113.3	162.3	abcdef
2/48B	35.04	53.14	76.77	99.4	122.9	hijklm
2/5Mc	64.59	82.85	105.46	126.3	150	cdefgh
4/44Mc	63.35	84.98	111.08	142.2	176.5	abc
4/7Mc	53.09	68.38	86.77	107	128.9	ghijklm
A104	66.89	82.51	106.67	128.4	153.5	cdefg
A16	55.61	67.67	81.14	93.7	108.7	lmn
A199	45.52	58.39	73.71	87.9	106.9	mn
A203	57.4	76.17	97.87	112.8	144.2	defghijk
A268	73.59	92.22	112.96	130.8	154.8	bcdefg
A38	48	64.84	83.3	101.2	123.8	hijklm
A387	59.04	74.12	89.51	103.9	120.3	jklm
A4	37.07	49.65	65.55	81.2	105.7	mn
A417	62.69	85.06	102.83	120.3	141.2	efghijk
A422	70.05	89	110.2	125.5	148.6	defghi
A423	54	71.08	89.66	104.7	126.4	hijklm
A437	52.47	64.03	82.06	94.7	107.4	mn
Daddow	47.31	65.59	84.59	104.5	134.8	fghijkl
NG8	49.07	62.23	83.49	97.5	118.2	klm
Own Venture	63.1	83.61	112.55	132.5	170.6	abcd
LSD (P=0.05)						
Maximum	21.69	24.75	29.87	33.45	38.74	
Minimum	14.92	16.89	20.52	23.14	26.7	
Average	15.37	17.47	21.29	24.08	27.79	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Appendix 2. Hinkler Park macadamia regional variety trial data.

Table 50. Nut-in-shell yield of 27 macadamia varieties at Hinkler Park from 1999 to 2005.

	Nut-in-shell yield (kg/tree)								
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**1999-2005**	
246	0.02	1.82	4.49	8.19	7.48	10.30	12.02	45.03	abc
344	0.02	1.35	5.16	9.62	8.32	11.55	16.01	51.65	ab
741	0.02	1.43	5.68	7.53	7.26	10.54	11.38	44.31	abc
772	0.17	3.62	10.48	8.06	8.21	9.48	12.46	50.54	ab
781	0.02	0.80	3.43	7.72	8.08	10.66	15.03	46.07	abc
783	0.02	2.20	6.14	8.14	7.52	9.89	14.44	47.46	abc
788	0.04	3.79	6.63	8.54	8.16	9.81	11.51	48.22	abc
804	0.03	0.80	4.38	7.70	7.43	10.78	13.40	45.12	abc
814	0.03	4.33	6.51	7.70	7.26	10.34	12.42	47.14	abc
816	0.02	2.27	6.68	8.74	8.41	11.40	14.99	51.47	ab
837	0.04	1.80	4.83	7.45	7.64	9.71	11.93	44.38	abc
842	0.02	2.29	7.57	9.19	8.25	10.86	13.84	51.26	ab
849	0.07	1.39	8.14	8.28	7.61	10.32	8.88	45.60	abc
A104	0.03	3.04	6.22	7.63	7.30	9.53	11.61	45.04	abc
A16	0.08	2.70	6.45	7.95	8.07	9.34	11.18	45.97	abc
A199	0.02	3.37	7.08	8.59	7.78	9.12	11.35	47.10	abc
A203	0.16	3.94	8.24	9.04	7.66	10.75	14.58	52.25	a
A268	0.07	3.09	6.55	8.77	8.00	11.00	11.31	48.82	abc
A38	0.02	1.64	5.24	8.24	7.76	12.29	14.96	49.50	abc
A4	0.03	1.51	3.54	7.20	6.67	9.53	10.39	40.33	c
A422	0.02	1.91	6.67	8.10	7.70	9.25	11.29	45.29	abc
A423	0.02	1.06	5.04	8.35	7.38	10.19	11.59	44.62	abc
A426	0.03	1.93	4.92	7.96	8.34	9.40	10.39	44.61	abc
Daddow	0.02	0.99	4.29	9.49	8.89	11.57	14.22	50.33	ab
Heilscher	0.02	0.93	3.78	8.35	8.20	10.48	12.78	45.99	abc
NG8	0.29	2.75	4.37	7.79	6.72	9.36	10.63	42.58	bc
Own Venture	0.03	1.33	6.16	8.29	8.59	10.38	12.38	47.67	abc
LSD (P=0.05)									
Maximum	0.211	2.363	4.089	2.628	2.341	2.871	3.960	11.040	
Minimum	0.172	1.680	3.008	2.290	2.047	2.362	2.809	9.232	
Average	0.178	1.775	3.160	2.340	2.090	2.434	2.967	9.495	

* 1999-2005 numbers followed by the same letter are not significantly different (P = 0.05).

Table 51. Nut-in-shell yield per unit trunk cross sectional area of 27 macadamia varieties at Hinkler Park from 1999 to 2005.

	Nut-in-shell yield per unit trunk cross sectional area (kg/cm^2)					
	2002	**2003**	**2004**	**2005**	**1999-2005**	
246	0.08	0.07	0.07	0.07	0.27	efg*
344	0.10	0.07	0.08	0.09	0.31	cdefg
741	0.07	0.07	0.09	0.08	0.29	efg
772	0.07	0.07	0.07	0.08	0.32	bcdef
781	0.07	0.07	0.08	0.09	0.27	efg
783	0.08	0.07	0.07	0.09	0.30	defg
788	0.07	0.06	0.06	0.06	0.24	g
804	0.07	0.07	0.08	0.08	0.27	efg
814	0.08	0.07	0.10	0.11	0.41	ab
816	0.07	0.07	0.07	0.08	0.27	efg
837	0.06	0.07	0.07	0.08	0.26	efg
842	0.09	0.07	0.07	0.07	0.29	efg
849	0.10	0.07	0.09	0.07	0.34	abcde
A104	0.09	0.07	0.09	0.09	0.34	abcde
A16	0.10	0.09	0.09	0.10	0.38	abc
A199	0.12	0.09	0.09	0.10	0.41	a
A203	0.10	0.07	0.09	0.10	0.38	abcd
A268	0.11	0.08	0.09	0.08	0.37	abcd
A38	0.10	0.08	0.12	0.12	0.40	a
A4	0.08	0.07	0.08	0.08	0.28	efg
A422	0.09	0.08	0.07	0.08	0.31	cdefg
A423	0.10	0.07	0.08	0.08	0.29	efg
A426	0.09	0.08	0.08	0.08	0.32	bcdefg
Daddow	0.10	0.08	0.08	0.08	0.31	cdefg
Heilscher	0.07	0.07	0.07	0.07	0.24	fg
NG8	0.09	0.07	0.08	0.08	0.29	efg
Own Venture	0.08	0.08	0.08	0.07	0.29	efg
LSD (P=0.05)						
Maximum	0.03626	0.02488	0.03052	0.02874	0.1083	
Minimum	0.02697	0.02099	0.0225	0.02077	0.07586	
Average	0.02828	0.02155	0.02361	0.02187	0.08034	

* 1999-2005 numbers followed by the same letter are not significantly different (P = 0.05).

Table 52. Nut-in-shell yield per unit canopy area of 27 macadamia varieties at Hinkler Park from 2002 to 2005.

	Nut-in-shell yield per unit canopy area (kg/m^2)					
	2002	**2003**	**2004**	**2005**	**1999-2005**	
246	0.95	0.58	0.67	0.66	2.39	efg*
344	1.54	0.70	0.76	0.87	3.00	cdefg
741	0.92	0.67	0.83	0.82	3.01	efg
772	1.01	0.70	0.68	0.76	3.22	bcdef
781	0.83	0.60	0.65	0.76	2.36	efg
783	1.10	0.62	0.66	0.85	2.83	defg
788	0.94	0.58	0.59	0.62	2.58	g
804	0.86	0.57	0.70	0.72	2.30	efg
814	1.13	0.64	0.85	0.96	3.66	ab
816	0.98	0.63	0.73	0.79	2.85	efg
837	0.76	0.65	0.66	0.72	2.44	efg
842	1.34	0.69	0.72	0.73	2.86	efg
849	1.15	0.64	0.80	0.58	2.77	abcde
A104	1.24	0.65	0.79	0.90	3.34	abcde
A16	1.19	0.78	0.73	0.86	3.49	abc
A199	1.23	0.68	0.72	0.85	3.54	a
A203	1.33	0.64	0.81	0.94	3.60	abcd
A268	1.21	0.61	0.71	0.63	2.67	abcd
A38	1.08	0.60	0.83	0.90	3.13	a
A4	0.92	0.54	0.71	0.73	2.45	efg
A422	1.01	0.65	0.65	0.69	2.71	cdefg
A423	1.18	0.63	0.79	0.84	3.11	efg
A426	1.05	0.74	0.68	0.68	2.79	bcdefg
Daddow	1.18	0.68	0.72	0.73	2.69	cdefg
Heilscher	1.32	0.77	0.75	0.82	2.94	fg
NG8	1.46	0.64	0.80	0.83	3.08	efg
Own Venture	1.14	0.76	0.74	0.75	2.94	efg
LSD (P=0.05)						
Maximum	0.467	0.211	0.214	0.249	0.928	
Minimum	0.341	0.173	0.172	0.184	0.671	
Average	0.358	0.179	0.178	0.193	0.707	

* 1999 -2005 numbers followed by the same letter are not significantly different (P = 0.05).

Table 53. Sound kernel recovery of 27 macadamia varieties at Hinkler Park from 2001 to 2005.

	Sound kernel recovery (%)					
	2001	**2002**	**2003**	**2004**	**2005**	**Average**
246	34.2	31.6	30.8	26.8	36.6	32.0
344	31.2	33.7	22.3	17.3	38.6	28.6
741	34.4	25.6	28.8	28.0	39.3	31.2
772	39.1	36.5	33.9	25.5	35.2	34.1
781	38.1	38.0	36.6	29.1	38.8	36.1
783	37.4	40.0	33.2	28.5	40.9	36.0
788	43.1	39.6	35.7	37.2	43.4	39.8
804	44.1	35.6	24.1	24.9	39.6	33.7
814	35.1	30.2	16.8	22.4	41.2	29.1
816	48.3	36.8	25.4	30.1	45.0	37.1
837	39.7	38.9	26.3	30.8	42.6	35.7
842	37.0	39.0	38.0	20.7	40.1	35.0
849	41.9	39.5	37.1	18.4	44.0	36.2
A4	42.4	47.6	41.9	30.7	42.3	41.0
A16	43.2	40.9	38.6	38.7	42.5	40.8
A38	37.9	27.6	25.5	32.8	39.6	32.7
A104	44.1	40.5	35.6	43.1	43.0	41.3
A199	38.1	36.2	34.3	32.4	39.6	36.1
A203	36.5	36.5	28.7	27.6	38.0	33.5
A268	35.9	29.7	23.6	27.2	35.0	30.3
A422	38.6	38.8	32.6	16.0	40.9	33.4
NG8	40.4	34.3	31.3	31.4	41.3	35.7
A423	37.4	29.2	32.1	25.1	39.1	32.6
Daddow	34.6	37.1	35.3	28.0	36.5	34.3
Heilscher	39.8	40.4	37.6	37.2	44.9	40.0
Own Venture	35.2	36.2	21.9	26.7	39.0	31.8
A426	41.2	22.4	29.6	26.0	40.5	31.9
Average	38.8	35.6	31.0	28.2	40.3	34.8

Table 54. Total kernel recovery of 27 macadamia varieties at Hinkler Park from 2000 to 2005.

	Total kernel recovery (%)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**Average**
246	35.3	37.2	35.0	37.3	35.9	38.0	36.5
344	33.1	32.3	34.8	32.1	34.9	38.6	34.3
741	35.9	40.0	28.1	39.5	36.5	39.5	36.6
772	34.9	39.6	40.9	42.2	35.5	38.1	38.6
781	37.6	39.9	38.8	40.3	39.1	39.6	39.2
783	40.3	40.9	41.3	40.4	39.0	41.4	40.5
788	38.7	44.6	41.1	40.0	40.3	45.6	41.7
804	43.8	47.5	39.7	41.0	35.6	41.1	41.5
814	39.1	37.4	35.3	35.1	41.3	41.2	38.2
816	42.9	48.3	45.1	41.9	41.5	47.4	44.5
837	38.4	42.7	40.7	44.6	42.3	42.8	41.9
842	40.0	40.8	39.0	39.2	40.4	40.1	39.9
849	42.5	45.5	45.7	46.0	45.1	44.0	44.8
A4	45.5	45.8	49.1	47.3	45.5	42.3	45.9
A16	42.1	45.1	45.8	46.5	43.3	43.5	44.4
A38	38.2	40.5	36.6	36.3	41.8	40.3	38.9
A104	43.2	46.9	42.3	44.2	44.8	43.3	44.1
A199	38.4	39.2	39.2	39.2	35.9	40.4	38.7
A203	35.4	37.4	41.2	36.9	40.8	38.3	38.3
A268	38.2	37.9	37.7	37.6	37.7	38.1	37.9
A422	39.0	42.5	41.3	40.8	40.9	42.3	41.1
NG8	42.0	41.5	34.3	39.2	38.7	41.3	39.5
A423	37.4	40.9	42.2	42.3	41.0	41.5	40.9
Daddow	35.8	36.0	38.2	39.3	38.9	38.8	37.9
Heilscher	41.0	42.6	40.4	41.0	41.2	45.5	41.9
Own Venture	36.0	37.4	38.2	41.4	38.6	39.2	38.5
A426	42.0	44.1	41.5	43.3	43.0	42.1	42.7
Average	39.1	41.3	39.8	40.5	40.0	41.3	40.3

Table 55. Unsound kernel recovery of 27 macadamia varieties at Hinkler Park from 2001 to 2005.

	Unsound kernel recovery (%)					
	2001	**2002**	**2003**	**2004**	**2005**	**Average**
246	3.0	3.5	6.5	9.2	1.4	4.7
344	1.1	1.1	9.8	17.7	0.0	5.9
741	5.5	2.6	10.8	8.5	0.2	5.5
781	1.8	0.8	3.6	9.9	0.8	3.4
783	3.4	1.3	7.2	10.5	0.6	4.6
788	1.5	1.5	4.3	3.1	2.2	2.5
804	3.3	4.0	16.9	10.7	1.5	7.3
816	0.0	8.2	16.5	11.4	2.4	7.7
842	3.8	0.0	1.2	19.7	0.0	4.9
849	3.5	6.3	9.0	26.7	0.0	9.1
A16	2.0	4.9	7.9	4.6	1.0	4.1
A38	2.6	9.1	10.8	9.0	0.7	6.4
A104	2.8	1.8	8.6	1.6	0.3	3.0
A199	1.1	3.0	4.9	3.5	0.7	2.7
A203	0.9	4.6	8.3	13.2	0.2	5.4
A268	2.0	8.0	14.0	10.6	3.1	7.5
A422	3.8	2.4	8.2	24.8	1.4	8.1
Daddow	1.5	1.1	4.0	10.9	2.4	4.0
Heilscher	2.8	0.0	3.4	4.0	0.7	2.2
Own Venture	2.1	1.9	19.5	11.9	0.3	7.2
Average	2.4	3.3	8.8	11.1	1.0	5.3

Table 56. First grade kernel of 27 macadamia varieties at Hinkler Park from 1999 to 2005.

	First grade kernel (%)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**Average**
246	89.9	99.0	96.5	100.0	100.0	100.0	97.6
344	98.1	98.8	99.2	97.8	98.5	100.0	98.7
741	93.3	100.0	98.6	94.2	98.1	100.0	97.3
772	97.8			100.0	98.6	100.0	99.1
781	93.6	97.6	100.0	96.3	100.0	100.0	97.9
783	99.7	99.2	98.6	97.3	100.0	100.0	99.1
788			97.3	97.4	98.8	98.2	97.9
804	98.6	98.3	88.6	92.3	100.0	98.8	96.1
814	91.7	96.5	100.0	88.9	98.2	100.0	95.9
816	99.2			82.4	98.7	99.0	94.8
837	96.1	99.9	96.8	96.6	100.0	100.0	98.2
842	99.1	99.9	100.0	100.0	100.0	100.0	99.8
849	97.3	99.2		98.1	99.2	100.0	98.8
A4	99.2	99.8	98.9	97.4	100.0	100.0	99.2
A16	99.3	99.1		98.6	100.0	100.0	99.4
A38	99.0	98.1	92.3	100.0	100.0	100.0	98.2
A104	92.5	100.0	94.2	92.5	100.0	100.0	96.5
A199	98.5	98.9		100.0	100.0	99.0	99.3
A203	98.4	98.5	89.8	96.7	100.0	100.0	97.2
A268	95.8	99.3		93.1	97.4	100.0	97.1
A422	99.0	98.4	97.1	99.4	100.0	100.0	99.0
NG8	99.0	99.0	90.7	98.5	100.0	100.0	97.9
A423	100.0	97.4	100.0	100.0	100.0	100.0	99.6
Daddow	98.7	99.2	100.0	100.0	100.0	100.0	99.7
Heilscher	98.1	99.3	100.0	98.0	99.2	100.0	99.1
Own Venture	97.8	99.1	96.0	92.3	95.7	99.6	96.8
A426	97.5	99.9	100.0	96.4	100.0	100.0	99.0

Table 57. Whole kernels of 27 macadamia varieties at Hinkler Park from 2000 to 2005.

	Whole kernel (%)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**Average**
246	33.0	39.0	36.0	36.0	38.0	26.0	34.7
344	46.0	24.0	25.0	46.0	35.0	42.0	36.3
741	37.0	32.0	38.0	47.0	17.2	24.0	32.5
772	68.1			52.0	24.0	51.0	48.8
781	47.5	32.0	38.0	67.0	32.0	33.0	41.6
783	41.0	39.0	32.0	52.0	32.0	44.0	40.0
788			48.0	53.0	58.0	46.0	51.3
804	35.9	22.0	31.0	41.0	17.0	29.0	29.3
814	37.0	32.0	22.0	45.0	40.0	25.0	33.5
816	55.0			69.0	56.0	46.0	56.5
837	24.3	16.0	27.6	38.0	41.0	27.0	29.0
842	67.0	53.0	42.0	51.0	41.0	41.0	49.2
849	48.0	51.0		57.0	26.0	41.0	44.6
A4	30.0	25.0	46.0	37.0	35.0	25.0	33.0
A16	48.0	37.0		45.0	39.0	33.0	40.4
A38	54.0	66.0	59.0	67.0	44.0	61.0	58.5
A104	48.0	30.0	42.0	44.0	25.0	37.0	37.7
A199	51.0	46.0		56.1	41.0	38.0	46.4
A203	53.4	29.0	46.0	33.0	28.0	31.0	36.7
A268	42.3	39.0		58.0	43.0	27.0	41.9
A422	41.0	58.0	60.0	62.0	55.0	57.0	55.5
NG8	31.0	17.0	35.0	35.0	14.0	19.0	25.2
A423	49.3	64.0	50.0	52.0	43.0	50.0	51.4
Daddow	33.0	32.0	40.0	54.0	21.0	28.0	34.7
Heilscher	28.0	16.0	11.9	12.0	10.0	12.0	15.0
Own Venture	53.1	49.0	52.0	63.0	36.0	39.0	48.7
A426	42.0	60.0	39.0	46.0	42.0	38.0	44.5

Table 58. Mean nut mass of 27 macadamia varieties at Hinkler Park from 2000 to 2005.

	Mean nut-in-shell mass (g)					
	2000	**2002**	**2003**	**2004**	**2005**	**Average**
246	8.3	7.2	7.6	7.0	7.3	7.5
344	7.5	7.5	6.2	7.7	7.7	7.3
741	7.3	8.1	5.4	6.5	6.6	6.8
772	8.5		6.0	8.1	7.1	7.4
781	8.2	7.6	6.6	8.0	7.5	7.6
783	6.9	7.0	6.7	7.8	6.9	7.1
788		6.7	6.4	6.5	6.4	6.5
804	6.8	6.7	4.3	6.3	6.8	6.2
814	5.0	4.7	3.8	4.9	5.0	4.7
816	8.0		5.0	7.5	7.5	7.0
837	9.0	7.4	5.6	6.2	8.3	7.3
842	6.7	6.1	5.9	6.1	6.4	6.3
849	7.6		5.8	6.8	7.2	6.8
A4	8.1	5.7	5.5	7.6	7.6	6.9
A16	7.3		5.7	7.0	7.0	6.7
A38	7.3	5.2	4.6	6.7	7.1	6.2
A104	5.8	5.6	5.6	6.1	6.1	5.8
A199	6.5		5.0	6.8	6.8	6.3
A203	8.0	5.6	6.4	7.9	8.4	7.3
A268	8.3		6.2	8.6	9.0	8.0
A422	7.1	5.4	5.2	5.8	6.3	6.0
NG8	7.0	5.3	6.4	7.5	7.1	6.7
A423	7.9	5.7	5.3	6.3	5.8	6.2
Daddow	7.7	6.4	5.5	6.4	7.2	6.6
Heilscher	7.4	6.7	5.6	6.6	5.8	6.4
Own Venture	9.3	8.3	5.9	8.7	7.7	8.0
A426	6.1	5.8	5.7	6.4	7.3	6.2
Average	7.4	6.4	5.7	7.0	7.0	6.7

Table 59. Mean kernel mass of 27 macadamia varieties at Hinkler Park from 2000 to 2005.

	Mean kernel mass (g)						
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**Average**
246	2.9	2.8	2.5	2.8	2.5	2.8	2.7
344	2.5	2.7	2.6	2.0	2.7	3.0	2.6
741	2.6	2.4	2.3	2.1	2.4	2.6	2.4
772	3.0			2.5	2.9	2.7	2.8
781	3.1	3.2	2.9	2.7	3.1	3.0	3.0
783	2.8	2.9	2.9	2.7	3.1	2.9	2.9
788			2.7	2.5	2.6	2.9	2.7
804	3.0	2.6	2.7	1.8	2.3	2.8	2.5
814	1.9	1.7	1.7	1.3	2.0	2.1	1.8
816	3.4			2.1	3.1	3.6	3.0
837	3.5	3.6	3.0	2.5	2.6	3.6	3.1
842	2.7	2.5	2.4	2.3	2.5	2.6	2.5
849	3.2	3.1		2.7	3.1	3.2	3.1
A4	3.7	3.8	2.8	2.6	3.5	3.2	3.3
A16	3.1	2.6		2.7	3.0	3.0	2.9
A38	2.8	2.6	1.9	1.7	2.8	2.9	2.4
A104	2.5	2.9	2.4	2.5	2.7	2.6	2.6
A199	2.5	2.1		2.0	2.4	2.7	2.3
A203	2.8	3.3	2.3	2.4	3.2	3.2	2.9
A268	3.2	3.0		2.3	3.3	3.4	3.0
A422	2.8	2.6	2.2	2.1	2.4	2.7	2.4
NG8	2.9	3.0	1.8	2.5	2.9	2.9	2.7
A423	3.0	2.3	2.4	2.2	2.6	2.4	2.5
Daddow	2.8	2.7	2.4	2.2	2.5	2.8	2.6
Heilscher	3.0	2.6	2.7	2.3	2.7	2.7	2.7
Own Venture	3.3	3.1	3.2	2.5	3.4	3.0	3.1
A426	2.6	2.8	2.4	2.5	2.7	3.1	2.7

Table 60. Tree height of 27 macadamia varieties at Hinkler Park from 2002 to 2006.

	Tree height (m)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	4.21	4.703	4.88	5.511	5.857	bcde*
344	4.867	5.358	5.392	6.1	6.364	a
741	3.775	4.376	4.45	5.079	5.417	efghi
772	4.051	4.56	4.798	5.433	5.857	bcde
781	4.517	5.399	5.453	5.747	6.106	ab
783	4.114	4.744	4.716	5.374	5.57	defgh
788	4.305	4.887	4.818	5.335	5.781	bcdefg
804	4.023	4.394	4.772	5.287	5.87	abcdef
814	3.793	4.29	4.522	5.271	5.606	bcdefghi
816	4.602	5.051	5.371	5.806	6.048	abc
837	4.019	4.55	4.811	5.32	5.835	abcdefgh
842	4.125	4.622	5.002	5.433	5.895	abcd
849	3.86	4.315	4.47	5.236	5.475	defghi
A104	3.987	4.417	4.695	5.374	5.532	defghi
A16	3.33	3.885	3.999	4.687	5.063	i
A199	3.51	4.049	4.347	5.001	5.312	ghi
A203	3.616	4.11	4.45	5.079	5.475	defghi
A268	3.51	4.069	4.368	5.099	5.369	fghi
A38	4.093	4.601	4.654	5.177	5.599	cdefgh
A4	3.418	3.856	4.03	4.764	5.244	hi
A422	3.987	4.397	4.593	5.177	5.599	cdefgh
A423	4.146	4.765	4.9	5.413	5.895	abcd
A426	3.747	4.164	4.385	5.07	5.41	defghi
Daddow	4.082	4.56	4.654	5.177	5.608	cdefgh
Heilscher	4.327	4.704	4.825	5.576	5.699	bcdefgh
NG8	3.59	4.069	4.306	4.922	5.255	hi
Own Venture	3.976	4.438	4.531	5.06	5.427	defghi
LSD (P=0.05)						
Maximum	0.6629	0.7759	0.7124	0.6618	0.6685	
Minimum	0.4416	0.53	0.4857	0.462	0.4732	
Average	0.4715	0.5631	0.5164	0.4895	0.5003	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 61. Tree canopy diameter (N-S) of 27 macadamia varieties at Hinkler Park from 2002 to 2006.

	Tree canopy diameter, N-S, along the row (m)					
	2002	2003	2004	**2005**	**2006**	
246	3.431	3.891	4.092	4.263	4.555	abcde*
344	3.081	3.891	4.011	4.131	4.833	abc
741	2.787	3.461	3.702	3.498	3.889	ghij
772	3.232	3.825	3.881	4.037	4.463	abcdefgh
781	3.312	4.155	4.336	4.244	4.611	abcd
783	3.105	3.825	4.125	4.027	4.222	cdefghij
788	3.487	4.288	4.296	4.424	5	a
804	3.236	3.861	4.111	4.165	4.499	abcdefgh
814	2.862	3.491	3.616	3.436	3.676	ij
816	3.4	4.007	4.182	4.273	4.5	abcdefg
837	3.186	3.553	4.105	4.106	4.333	abcdefghij
842	3.153	3.742	3.938	4.216	4.537	abcdef
849	3.049	3.758	3.604	3.857	4.037	defghij
A104	2.731	3.444	3.661	3.555	3.833	hij
A16	2.882	3.576	3.872	3.602	3.907	fghij
A199	3.049	3.742	3.661	3.602	3.648	j
A203	3.185	3.775	3.783	3.952	4.166	defghij
A268	3.312	4.189	4.288	4.755	4.842	abc
A38	3.248	3.907	3.872	3.772	4.074	defghij
A4	2.907	3.71	3.832	3.777	4.272	bcdefghij
A422	3.113	3.626	3.864	3.904	4.24	cdefghij
A423	3.065	3.626	3.734	3.592	3.963	efghij
A426	3.172	3.691	3.842	3.789	4.068	defghij
Daddow	3.4	4.172	4.548	4.622	4.925	ab
Heilscher	2.964	3.611	3.92	3.777	4.386	abcdefghi
NG8	2.643	3.378	3.563	3.47	3.852	hij
Own Venture	3.081	3.725	3.881	3.97	4.352	bcdefghi
LSD (P=0.05)						
Maximum	0.6148	0.6488	0.6981	0.7973	0.8862	
Minimum	0.4725	0.4915	0.5315	0.5694	0.6393	
Average	0.4924	0.5134	0.555	0.6006	0.6732	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 62. Tree canopy diameter (E-W) of 27 macadamia varieties at Hinkler Park from 2002 to 2006.

	Tree canopy diameter, E-W, across the row (m)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	3.163	4.26	4.917	5.609	6.315	abcd*
344	2.941	4.099	5.048	5.665	6.315	abcd
741	2.926	3.795	4.405	5.073	5.56	fghij
772	3.074	3.974	4.516	5.221	5.68	efghij
781	3.37	4.492	5.218	5.924	6.533	a
783	3	4.028	4.706	5.406	6.057	abcdefg
788	3.348	4.581	5.329	5.748	6.553	a
804	2.979	4.4	5.139	5.798	6.301	abcde
814	2.758	3.685	4.212	4.893	5.508	fghij
816	3.385	4.492	4.998	5.702	6.474	ab
837	2.947	4.027	4.763	5.275	5.955	abcdefghi
842	3.082	4.278	5.138	5.711	6.384	abc
849	3.015	3.974	4.576	5.424	5.878	bcdefgh
A104	2.748	3.795	4.255	4.851	5.501	ghij
A16	2.822	3.599	3.994	4.675	5.282	hij
A199	3	3.849	4.164	4.768	5.084	j
A203	2.978	4.01	4.506	5.036	5.64	efghij
A268	2.919	4.028	4.706	5.045	6.057	abcdefg
A38	2.993	4.367	5.058	5.591	6.136	abcdef
A4	2.861	3.773	4.364	4.937	5.551	fghij
A422	3.074	4.028	4.536	5.387	6.156	abcdef
A423	2.978	3.956	4.355	4.971	5.501	ghij
A426	2.931	3.975	4.499	5.213	5.797	cdefghi
Daddow	3.282	4.331	4.676	5.415	6.096	abcdefg
Heilscher	2.817	3.726	4.531	5.248	5.731	defghi
NG8	2.615	3.438	3.914	4.731	5.223	ij
Own Venture	3	3.956	4.516	5.258	5.759	defghi
LSD (P=0.05)						
Maximum	0.5715	0.7184	0.7753	0.8482	0.8765	
Minimum	0.4501	0.5268	0.5352	0.6115	0.6081	
Average	0.4672	0.5534	0.5678	0.6442	0.6449	

*2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 63. Mean tree canopy diameter of 27 macadamia varieties at Hinkler Park from 2002 to 2006.

	Mean tree canopy diameter (m)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	3.3	4.077	4.521	4.977	5.462	bcd*
344	2.976	3.953	4.487	4.917	5.557	ab
741	2.853	3.616	4.029	4.248	4.692	fghij
772	3.153	3.9	4.193	4.631	5.077	bcdefgi
781	3.351	4.333	4.819	5.144	5.608	ab
783	3.051	3.926	4.436	4.73	5.139	bcdefg
788	3.44	4.502	4.98	5.408	6.056	a
804	3.103	4.132	4.63	5.05	5.417	abcde
814	2.797	3.571	3.866	4.066	4.508	ghij
816	3.402	4.254	4.615	5.034	5.514	ab
837	3.059	3.767	4.462	4.697	5.122	bcdefghi
842	3.118	4.006	4.536	5.008	5.488	abd
849	3.031	3.864	4.054	4.646	4.942	cefghi
A104	2.731	3.608	3.93	4.154	4.629	ghij
A16	2.845	3.581	3.93	4.08	4.557	hij
A199	3.023	3.793	3.885	4.133	4.307	j
A203	3.078	3.891	4.128	4.479	4.89	efghi
A268	3.098	4.072	4.503	4.924	5.491	abcd
A38	3.118	4.139	4.456	4.694	5.098	bcdefgi
A4	2.877	3.738	4.072	4.314	4.887	cefghi
A422	3.094	3.82	4.193	4.652	5.202	bcdef
A423	3.019	3.785	4.024	4.243	4.702	fghij
A426	3.046	3.824	4.167	4.486	4.913	defghi
Daddow	3.239	4.168	4.636	5.017	5.478	abcd
Heilscher	2.882	3.663	4.221	4.493	5.058	bcdefghi
NG8	2.616	3.395	3.701	4.038	4.494	hj
Own Venture	3.102	3.889	4.255	4.692	5.045	bcdefghi
LSD (P=0.05)						
Maximum	0.568	0.6499	0.675	0.7099	0.8027	
Minimum	0.4376	0.4787	0.468	0.4772	0.5423	
Average	0.4632	0.5114	0.5068	0.5194	0.5897	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 64. Projected effective canopy area of 27 macadamia varieties at Hinkler Park from 2002 to 2006.

	Projected effective canopy area (m^2)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	8.617	13.11	16.02	19.17	22.88	bcde*
344	7.066	12.38	15.6	18.46	23.89	abc
741	6.683	10.66	12.91	13.8	16.99	ghij
772	7.877	11.99	13.75	16.61	20.06	bcdefgi
781	8.98	14.95	18.2	20.24	24.09	ab
783	7.372	12.16	15.44	17.21	20.16	bcdefgi
788	9.475	16.3	19.45	22.87	28.62	a
804	7.785	13.54	16.94	19.56	22.57	bcdef
814	6.264	10.07	11.92	12.81	15.4	hij
816	9.229	14.3	16.65	19.54	23.22	bc
837	7.431	11.14	15.74	17.15	20.23	bcdefghi
842	7.709	12.61	15.87	19.31	23.06	bcd
849	7.308	11.87	12.79	16.59	18.67	efghi
A104	6.032	10.46	12.45	13.62	16.77	ghij
A16	6.454	10.1	12.19	12.95	16.05	hij
A199	7.241	11.3	11.86	13.17	14.23	j
A203	7.496	11.91	13.29	15.58	18.41	fghij
A268	7.494	13.19	15.9	18.86	23.49	bc
A38	7.678	13.54	15.31	16.59	19.5	cdefghi
A4	6.616	11	13.01	14.36	18.43	dfghij
A422	7.825	11.62	13.82	16.58	20.55	bcdefg
A423	7.233	11.26	12.65	13.77	16.9	ghij
A426	7.353	11.53	13.62	15.48	18.38	efghij
Daddow	8.329	13.82	16.97	19.69	23.34	bc
Heilscher	6.617	10.6	13.98	15.56	20.02	bcdefghi
NG8	5.526	9.14	10.86	12.62	15.62	hj
Own Venture	7.651	11.94	14.25	16.93	19.48	bcdefghi
LSD (P=0.05)						
Maximum	2.692	3.948	4.495	5.147	6.459	
Minimum	2.069	2.868	3.118	3.47	4.371	
Average	2.191	3.073	3.376	3.775	4.752	

*2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 65. Trunk girth of 36 varieties at Hinkler Park from 2002 to 2006.

	Trunk girth (mm)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	359.9	387.9	425.4	457.1	492.7	cdefg*
344	370.3	398.6	441.5	476.9	516.1	abcd
741	335	358.3	392.3	423.6	454	fghijk
772	369.6	388.9	421.6	455.8	500.1	bcdef
781	366.2	391	428.9	464.8	502.5	bcdef
783	350.8	377.3	419.2	448.6	483.6	defgh
788	403.9	434.4	479.1	520.8	559	a
804	358	381.1	414.3	447.5	479.2	defghij
814	310.9	328.6	358.9	377.7	413.5	jk
816	402	436	474	509.9	548.1	ab
837	345.2	372.2	402	438.3	476.4	cdefghij k
842	370.5	403.8	449.8	493.5	540.5	abc
849	329	348.9	381.3	407.4	446.2	ghijk
A104	313.4	331.2	360.6	398.1	433.4	hijk
A16	309.4	329.8	356.5	387.2	421.1	jk
A199	307.5	321.6	349.2	380	413.9	k
A203	344.7	367.9	399.3	433.9	473.6	defghi
A268	326.5	346.3	385.9	409.1	446.8	ghijk
A38	321.2	340.9	373.9	402.5	429.8	ijk
A4	306.3	326	367.6	392.7	440.6	ghijk
A422	328.6	347.5	379	418.1	462.1	efghijk
A423	331.8	352.1	391.6	428.1	463.6	efghijk
A426	329	350.2	377.7	405.9	440.3	ghijk
Daddow	375.7	401.4	430.5	466.5	508.6	abcde
Heilscher	383.5	406.5	461.7	493.1	544.9	abc
NG8	318.2	338.6	378	412.3	444.7	ghijk
Own Venture	359.1	381.5	417.1	459.4	502	bcdef
LSD (P=0.05)						
Maximum	64.83	67.58	70.24	71.19	76.53	
Minimum	46.2	46.84	47.64	47.35	51.02	
Average	48.74	49.65	50.68	50.54	54.43	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 66. Trunk cross sectional area of 27 macadamia varieties at Hinkler Park from 2002 to 2006.

	Trunk cross sectional area (cm^2)					
	2002	**2003**	**2004**	**2005**	**2006**	
246	103.96	120.6	144.8	167.1	194.4	efgh*
344	110.39	127.6	156.2	181.9	212.8	abcde
741	93.05	105.3	124.8	144.7	165.7	ghijk
772	110.1	121.5	142.5	166.3	200.4	cdefg
781	107.84	122.7	147.2	172.7	201.7	bcdefg
783	98.54	113.9	140.5	160.8	186.9	efghi
788	132.59	152.9	185.4	218.6	251.3	a
804	103.58	116.9	137.9	160.5	184.1	efghij
814	77.41	86.6	103.6	115.3	138.1	jk
816	131.09	153.7	180.8	208.6	240.6	ab
837	95.85	111.4	129.5	153.9	181.8	dfghijk
842	110.45	131	162.4	195.4	234.1	abcd
849	86.74	97.6	116.7	133	159.5	hijk
A104	79.66	89.1	105.5	128.2	151.6	ijk
A16	77.41	88	103	121.2	143.2	jk
A199	75.58	82.8	97.8	115.6	137.7	k
A203	95.21	108.3	127.4	150.3	179	efghij
A268	86.19	96.7	119.3	134.1	160.3	hijk
A38	82.9	93.4	112.3	130	148.7	ijk
A4	75.31	85.6	108.1	123.6	155.6	hijk
A422	87.1	97.1	115.1	139.7	170.6	fghijk
A423	87.89	99	122.5	146.3	171.6	fghijk
A426	86.44	97.9	113.9	131.6	155	hijk
Daddow	114.37	130.2	149.1	174.7	207.3	bcdef
Heilscher	119.76	134	173.2	196.5	241.2	abc
NG8	81.81	92.4	115.3	136.9	159.1	hijk
Own Venture	104.52	117.7	140.4	169.8	202.8	bcdefg
LSD (P=0.05)						
Maximum	35.35	39.49	45.4	49.93	59.09	
Minimum	24.76	27.04	30.54	33.05	39.33	
Average	26.2	28.72	32.53	35.3	41.97	

*2006 numbers followed by the same letter are not significantly different (P = 0.05).

Appendix 3. Forest Glen macadamia regional variety trial data.

Table 67. Nut-in-shell yield (kg/tree, kg/cm^2, kg/m^2) of 10 varieties at Forest Glen in 2002 to 2003, ranked by cumulative yield 1996-2003).

Nut-in-shell yield (kg/tree)

	1996	1997	1998	1999	2000	2001	2002	2003	1996-2003	
A29	1.64	10.10	13.88	17.94	21.78	21.85	11.92	5.56	107.03	a*
A38	5.12	10.84	11.93	17.76	20.03	21.25	11.23	5.24	105.32	a
A268	6.44	12.33	10.85	13.59	18.76	21.95	11.10	4.31	99.92	ab
A16	4.33	10.16	11.22	13.67	17.22	16.70	9.45	5.41	87.94	bc
344	2.95	5.30	11.89	15.39	13.26	19.49	11.04	4.23	83.75	c
A4	3.00	8.40	8.20	12.19	15.45	18.79	9.43	3.88	78.11	c
741	2.07	4.43	7.80	12.56	10.05	16.60	7.93	4.61	63.96	d
LSD (P=0.05)										
Maximum	2.156	2.222	2.633	3.536	3.726	3.446	2.192	1.486	13.750	
Minimum	1.921	1.944	2.339	3.158	3.276	3.086	1.975	1.368	12.070	
Average	2.017	2.057	2.459	3.312	3.460	3.233	2.064	1.416	12.750	

Nut-in-shell yield per unit trunk cross sectional area (kg/cm^2)

	2002		2003		1996-2003	
A16	0.069	a	0.038	a	0.625	a
A38	0.051	bc	0.024	bc	0.446	b
A268	0.050	bc	0.018	bc	0.422	bc
A203	0.054	b	0.020	bc	0.405	bc
772	0.055	b	0.027	b	0.403	bc
A4	0.048	bc	0.017	c	0.376	cd
A29	0.047	bc	0.022	bc	0.375	cd
344	0.050	bc	0.018	c	0.349	de
H2	0.049	bc	0.018	bc	0.331	de
741	0.040	c	0.022	bc	0.300	e
LSD (P=0.05)						
Maximum	0.0120		0.0105		0.0585	
Minimum	0.0108		0.0093		0.0510	
Average	0.0113		0.0098		0.0540	

Nut-in-shell yield per unit effective canopy area (kg/m^2)

	2002		2003		1996-2003	
A16	6.9	ab	3.1	a	49.4	a
A203	7.6	a	2.3	abc	46.7	ab
A38	6.6	ab	2.3	abc	43.1	abc
A268	6.7	ab	1.8	bc	41.1	bcd
772	6.9	ab	2.6	ab	40.8	bcde
A29	6.6	ab	2.2	abc	39.2	cdef
344	7.2	ab	1.9	bc	38.7	cdef
A4	6.6	ab	1.7	c	36.1	def
741	6.1	b	2.4	abc	34.0	ef
H2	7.0	ab	1.8	c	33.7	f
LSD (P=0.05)						
Maximum	1.25		0.90		7.42	
Minimum	1.16		0.81		6.55	
Average	1.19		0.85		6.90	

*numbers followed by the same letter are not significantly different (P = 0.05).

Table 68. Total kernel recovery (TKR), reject kernel and first grade kernel of 10 varieties at Forest Glen in 2002 to 2003, ranked by means.

Total kernel recovery (%)

	1996	1997	1998	1999	2000	2001	2002	2003	Mean
A4	39.94	43.99	44.29	44.19	47.61	44.6	37.5	38.9	42.64
A16	39.77	42.81	45.03	43.23	43.83	42.3	36.0	35.8	41.10
A38	35.71	37.50	38.75	39.07	38.76	36.2	36.0	33.2	36.90
A268	35.92	40.03	38.70	37.52	37.25	36.7	32.4	32.5	36.37
741	34.79	36.65	38.29	39.34	36.52	36.8	34.9	33.7	36.37
A29	30.88	37.44	39.75	40.35	40.14	36.1	33.8	32.2	36.32
H2	33.20	34.24	37.25	34.65	35.90	31.9	29.2	29.0	33.17
772	30.96	31.68	35.35	35.41	35.35	33.4	31.8	30.1	33.01
A203	31.85	32.51	34.86	32.58	33.00	33.5	31.5	32.3	32.76
344	30.36	32.57	34.53	34.16	33.32	32.0	30.8	32.2	32.49

Reject (unsound) kernel (%)

A268	6.42	0.29	1.39	0.00	0.88	3.1	10.4	5.0	3.43
A4	7.29	0.16	0.00	0.00	0.00	1.0	9.9	4.7	2.88
A16	3.93	0.50	2.54	0.00	0.03	1.7	8.6	4.3	2.71
A29	2.44	0.81	1.69	0.00	0.28	3.6	6.6	6.0	2.67
H2	2.15	1.51	0.82	0.00	0.00	1.0	8.8	5.7	2.49
A203	5.47	0.05	0.33	0.00	0.00	1.4	7.6	4.4	2.41
772	3.15	2.10	1.24	0.00	0.81	1.8	4.8	4.8	2.33
741	4.32	0.53	0.25	0.00	0.00	3.3	5.7	3.9	2.25
344	4.13	0.62	0.00	0.00	0.40	2.5	6.3	2.8	2.09
A38	2.24	0.13	0.66	0.00	0.21	3.1	5.1	4.5	2.00

First grade kernel (%)

A4	98.75	99.66	99.65	99.51	99.03	99.97	99.82	98.02	**99.30**
A38	96.58	94.24	99.06	99.16	99.57	100.00	99.79	98.59	**98.37**
741	96.65	98.51	97.59	97.70	97.31	99.78	99.54	97.31	**98.05**
H2	96.70	96.66	98.57	96.27	98.40	99.04	98.38	98.45	**97.81**
A16	97.50	96.82	96.64	97.47	97.82	99.41	97.84	96.83	**97.54**
772	98.09	96.47	98.34	98.67	94.55	97.30	99.32	97.44	**97.52**
A29	91.53	97.11	96.26	97.00	98.77	99.51	99.22	96.72	**97.01**
A268	94.83	97.76	97.41	94.40	91.42	99.12	99.26	97.92	**96.52**
A203	91.09	98.75	98.65	93.42	90.57	99.32	98.91	95.44	**95.77**
344	90.81	98.41	96.60	93.71	95.73	97.82	98.25	92.45	**95.47**

Table 69. Whole kernel of 10 varieties at Forest Glen in 1996 to 2003, ranked by means.

	Whole kernel (%)								
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**Mean**
H2	69.0	75	67	65.0	75.0	65.0	40.5	50.3	63
A38	58.0	62	63	62.5	64.0	42.0	43.0	44.3	55
A16	41.0	56	50	51.0	50.0	41.0	30.5	44.3	46
344	42.0	50	51	52.0	47.0	37.0	29.5	37.1	43
A203	39.0	41	38	48.5	62.0	40.0	29.6	35.6	42
772	44.9	42	42	42.0	50.0	41.0	28.4	36.6	41
A268	33.3	51	28	35.1	46.9	28.0	29.9	33.6	36
A4	30.0	45	30	33.0	45.0	33.0	23.5	36.3	34
741	16.0	41	35	36.0	37.0	31.0	22.0	33.3	31
A29	19.0	37	32	36.5	40.0	20.0	27.4	24.7	30

Table 70. Tree height of 10 varieties at Forest Glen from 2002 to 2006.

	Tree Height (m)			
	2002		**2003**	
344	7.3	a*	6.8	ab
741	7.2	a	6.8	ab
772	6.9	ab	6.9	ab
A16	6.4	b	6.7	ab
A203	6.7	ab	6.8	ab
A268	6.9	ab	6.6	b
A29	7.5	a	6.8	ab
A38	7.3	a	6.9	ab
A4	7.0	ab	6.7	ab
H2	7.3	a	7.0	a
LSD (P=0.05)				
Maximum	0.82		0.33	
Minimum	0.75		0.31	
Average	0.78		0.32	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 71. Canopy diameter and projected, effective canopy area of 10 varieties at Forest Glen from 2002 to 2006.

	Canopy diameter, N-S along the row (m)				Canopy diameter, E-W across the row (m)			
	2002		2003		2002		2003	
344	5.2	ab*	6.6	abc	3.8	b	4.3	a
741	4.8	bc	6.0	cd	3.7	b	4.3	a
772	4.8	bc	6.1	bcd	3.9	ab	4.3	a
A16	4.6	c	5.8	d	3.8	b	4.2	a
A203	4.8	bc	6.0	bcd	3.7	b	4.2	a
A268	5.2	ab	6.6	abc	4.1	ab	4.6	a
A29	5.5	a	7.0	a	4.2	a	4.7	a
A38	5.5	a	6.7	ab	4.0	ab	4.5	a
A4	5.0	abc	6.4	abcd	3.8	b	4.4	a
H2	5.0	bc	6.5	abcd	3.9	ab	4.6	a
LSD (P=0.05)								
Maximum	0.54		0.75		0.45		0.56	
Minimum	0.48		0.68		0.42		0.53	
Average	0.50		0.71		0.43		0.54	

	Mean canopy diameter (m)				Effective canopy area (m^2)			
	2002		2003		2002		2003	
344	4.5	bc	5.4	abc	15.2	bc	21.9	abc
741	4.2	c	5.1	bc	13.9	c	20.4	bc
772	4.4	bc	5.2	bc	14.9	bc	20.5	bc
A16	4.2	c	4.9	c	13.5	c	18.7	c
A203	4.2	c	5.1	bc	14.0	c	19.9	bc
A268	4.7	ab	5.6	ab	17.0	ab	24.3	ab
A29	4.9	a	5.9	a	19.1	a	26.6	a
A38	4.8	ab	5.6	ab	17.5	ab	24.0	ab
A4	4.4	bc	5.4	abc	14.9	bc	22.1	abc
H2	4.4	bc	5.6	ab	15.2	bc	24.2	ab
LSD (P=0.05)								
Maximum	0.44		0.59		3.12		5.10	
Minimum	0.39		0.53		2.78		4.59	
Average	0.41		0.56		2.92		4.79	

* 2006 numbers followed by the same letter are not significantly different (P = 0.05).

Table 72. Trunk girth and trunk cross sectional area of 10 varieties at Forest Glen from 2002 to 2006.

	Trunk girth (mm)				Trunk cross sectional area (cm^2)			
	2002		2003		2002		2003	
344	531.1	b*	547.9	b	225	bc	239	bc
741	490.0	bc	515.4	bc	193	bc	213	bcd
772	486.5	c	502.3	c	190	c	203	d
A16	408.7	d	428.2	d	135	d	148	e
A203	506.9	bc	524.8	bc	205	bc	220	bcd
A268	531.6	ab	546.7	b	226	b	238	bc
A29	577.6	a	596.1	a	267	a	284	a
A38	533.4	ab	547.6	b	227	abc	239	bcd
A4	495	bc	510.2	bc	196	bc	208	cd
H2	531.6	ab	551.7	ab	226	b	243	b
LSD (P=0.05)								
Maximum	49.56		47.69		39.8		39.8	
Minimum	43.3		41.61		34.8		34.7	
Average	45.81		44.06		36.8		36.8	

* 2006 girths followed by the same letter are not significantly different (P = 0.05).

Appendix 4. Nambucca macadamia regional variety trial data.

Table 73. Nut-in-shell yield (kg/tree) of 14 varieties at Nambucca in 1996 to 2003, ranked by cumulative yield 1996-2003).

	Nut-in-shell yield kg/tree)									
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**1996-2003**	
A29	0.476	4.257	5.891	19.72	21.48	18.91	29.32	20.86	123.32	a*
A38	1.189	4.08	8.979	18.38	16.53	16.13	19.21	16.7	103.08	b
246	0.766	2.645	4.86	14.62	21.29	17.8	21.49	17.12	101.02	b
A203	2.806	4.461	5.058	14.2	16.78	15.57	21.68	18.6	99.96	bc
A268	4.887	4.748	8.083	12.07	15.73	15.24	20.59	13.45	95.5	bcd
344	1.645	2.523	6.083	12.53	14.62	12.98	22.09	14.15	85.86	bcde
A4	1.746	4.333	5.151	12.09	13.81	15.43	17.58	12.04	82.54	cde
508	0.165	2.694	3.61	12.38	16.4	16.01	15.85	14.49	81.2	de
A323	1.441	4.506	8.29	11.02	14.31	13.74	15.23	12.05	80.71	de
A199	0.631	4.88	7.135	13.41	9.19	14.46	15.97	11.22	77.67	de
A16	1.007	4.073	7.613	11.7	12.25	9.87	16.8	12.07	74.55	e
A192	0.671	2.536	4.811	11.22	12.34	12.79	15.46	10.8	69.41	e
LSD (P<0.05)										
Minimum	1.267	2.184	2.37	4.561	4.613	4.195	5.739	3.998		
Maximum	1.354	2.361	2.855	7.679	4.924	4.412	6.101	10.04		
Average	1.28	2.21	2.502	5.023	4.658	4.226	5.791	5.119		

*Cumulative yield numbers followed by the same letter are not significantly different (P = 0.05).

Table 74. Nut-in-shell yield per unit projected canopy area (t/ha) of 12 varieties at Nambucca in 1996 to 2003, ranked by cumulative yield 1996-2003).

	Nut-in-shell yield per unit canopy area (t/ha)			
	2002	**2003**	**1996 2003**	
A38	0.18	0.14	0.82	a*
A203	0.18	0.14	0.80	a
A4	0.18	0.13	0.80	a
A29	0.18	0.13	0.80	a
A16	0.18	0.13	0.79	a
A199	0.18	0.12	0.79	a
A268	0.18	0.12	0.79	a
A323	0.17	0.12	0.79	a
A192	0.18	0.12	0.79	a
246	0.17	0.12	0.78	a
344	0.18	0.12	0.78	a
508	0.17	0.12	0.77	a
LSD (P<0.05)				
Minimum	0.026	0.034	0.122	
Maximum	0.026	0.034	0.123	
Average	0.026	0.034	0.122	

*Cumulative yield numbers followed by the same letter are not significantly different (P = 0.05).

Table 75. Total kernel recovery (%) of 14 varieties at Nambucca in 1996 to 2003, ranked by average.

	1997	1998	1999	2000	2001	2002	Average
A4	44.1	45.5	46.4	47.2	48.6	45.2	46.2
A16	39.3	41.6	41.3	42.7	41.7	43.4	41.7
Fernleigh Sp	37.5	39.4	40.8	42.2	45.7	41.6	41.2
Beaumont	40.4	40.7	39.6	40.2	42.6	40.7	40.7
A199	36.0	38.9	39.8	40.3	41.5	41.5	39.7
A29	35.0	37.5	39.3	40.1	41.5	39.5	38.8
A268	37.2	39.0	39.1	39.7	39.3	37.9	38.7
A192	35.5	37.0	37.8	40.0	39.7	42.2	38.7
A38	33.7	36.4	38.5	38.2	39.1	39.5	37.6
A323	33.0	38.4	36.3	39.9	38.0	39.0	37.4
246	33.2	34.7	36.3	38.3	38.6	38.7	36.6
344	32.5	34.4	35.3	37.6	35.1	38.9	35.6
508	33.1	32.6	32.8	37.3	37.2	37.7	35.1
A203	29.7	34.0	34.4	33.4	36.3	38.8	34.4
LSD (P<0.05)							
Minimum	1.879	1.71	2.226	1.954	2.128	2.835	
Maximum	3.609	1.965	3.454	2.482	2.29	3.015	
Average	2.544	1.748	2.432	2.053	2.151	2.86	

Table 76. Canopy diameter, tree height and projected, effective canopy area of varieties at Nambucca in 2002.

	Canopy diameter NS (m)	Canopy diameter EW (m)	Mean canopy diameter (m)
246	5.2	4.6	4.9
344	4.8	4.5	4.6
508	5.0	4.7	4.9
A16	4.5	4.2	4.3
A192	4.8	3.9	4.3
A199	4.7	4.1	4.3
A203	4.8	4.2	4.5
A268	5.0	4.2	4.6
A29	5.1	4.8	5.0
A323	4.7	4.0	4.3
A38	4.8	4.3	4.6
A4	4.7	4.3	4.5
LSD (P<0.05)	0.488	0.665	0.510

	Effective canopy area (m^2)	Height (m)
246	19.2	6.5
344	17.0	6.2
508	18.9	6.6
A16	14.5	5.6
A192	14.4	6.0
A199	14.7	5.9
A203	15.5	6.2
A268	16.6	5.8
A29	20.0	6.8
A323	14.7	5.8
A38	16.6	6.5
A4	15.9	6.0
LSD (P<0.05)	3.655	0.763

Appendix 5. Summary of Variety Characteristics.

Varieties with potential for the Bundaberg, south-east Queensland and central New South Wales regions are summarised.

HAES 246

Industry status: widely planted in the 1960's and 1970's; still some current plantings, particularly in NSW and SE Qld.
Yield: reliable, but not early bearing; best yields in NSW and SE Qld.
Quality: nuts 6.8g, moderate flecking, with open micropyle, kernels 2.0-2.7g, larger in NSW; 31%-37% kernel recovery (KR), <96% first grade kernel (G1K, float on tap water), ca. 45% wholes
Sensory quality: highly rated for flavour, texture and overall acceptability, colour slightly variable between sites
Flowering pattern: extended, heavy flowering
Nut drop pattern: mid-season (April – Aug)
Defects: pre-germination (on the tree and on the ground); basal kernel discolouration
Husk spot: highly susceptible
Tree features: medium to large spreading/rounded tree, moderately dense canopy, suitable only for wider tree spacings; susceptible to wind damage; tree produces much leaf litter that can cause problems with harvesting.
Grower's comments: kernel quality in Australia considered good, a heavy consistent cropper - cash cow for many farms, the basis of the early Australian industry, very average in southern Queensland) - not as good as in NSW, lower roasting quality, can leave on ground for longer periods than other varieties (less likely to germinate under wet conditions), heavy leaf fall can be a problem at harvest, susceptible to wind damage, good but variable yields, some concern about shelf life. It appears to have >36% KR closer to the coast.

HAES 344

Industry status: The most common variety in Australia; widely planted in the 1980's and early 1990's; no longer being widely planted.
Yield: not early bearing; best yield in central and SE Qld
Quality: nuts 6.9g, round, dull shell with moderate flecking; kernels 2.2g, larger in NSW; 32-35% KR; ca. 97.2% G1K, variable; ca. 35-46% wholes
Sensory quality: average flavour and overall acceptability. texture acceptable but less crunchy than other varieties. kernels tends to be darker (beige light brown and two-tone) than other varieties
Flowering pattern: mid-season flowering, medium in length; light flowering some years
Nut drop pattern: early-season nut drop (April – July), later in NSW (May –Aug/Sept)
Defects: lowest kernel recovery of recommended varieties; prone to nut borer attack
Husk spot: moderately tolerant
Tree features: medium-large, upright, dense, conical tree; dense foliage can result in poor spray penetration
Grower's comments: consistent performer, precocious, early nut fall, low kernel recovery a disadvantage, susceptible to macadamia nutborer - control difficult because of tight bunches, yield tends to be erratic in some environments, may need a higher standard of management, doesn't flower under (some) stress conditions, good roasting quality, favourable sensory feedback, susceptible to husk spot in a hot climate, more susceptible to excessive heat and vertical growth than other varieties. Apparent susceptibility to abnormal vertical growth (AVG) is a serious concern in the Bundaberg area.

HAES 741

Industry status: widely planted, particularly in Qld, from the late 1980's to the present
Yield: not early bearing; performs better as trees mature; best yield is in central and SE Qld
Quality: nuts 6.2g, variable size, some small, round and smooth; kernels 2.3g, full, slightly dull, larger in NSW; ca 36-38% KR, lower in north Qld; >97% G1K; ca. 36% wholes
Sensory quality: above average overall acceptability and flavour, slightly below average texture, attractive cream to beige kernels
Flowering pattern: condensed, late flowering, shy flowering in some areas in some seasons (dry autumn/winter)
Nut drop pattern: early: April - June

Defects: some basal discolouration of kernels
Husk spot: very susceptible, impact reduced by early nut drop
Tree features: medium-large, upright, moderate to open, turkey's neck, particularly when young, becoming more dense with age, performed well at northern sites (heat tolerant)
Grower's comments: reliable, hardy, wind-resistant, the most popular of the old varieties, does not crop well under 7-8 years, variable, low cropping in NSW, , performs well in Queensland, early nut fall a major advantage with many growers, appearance is ordinary, some basal discolouration.

HAES 788

Industry status: a new variety, with few plantings
Yield: reasonably precocious, performed well over a wide range of environments.
Quality: nuts 6.5g, attractive large, uniform white kernels 2.5-2.7g, consistently high SKR 32.0-39.8%, 94-98% G1K, ca 46-51% wholes
Sensory quality: not assessed
Flowering pattern: condensed, early- mid season flowering (limited information)
Nut drop pattern: early (90% dropped in June)
Husk spot: not assessed, no husk spot problems apparent
Tree features: large tree with spreading canopy
Grower's comments: 788 looks promising

HAES 814

Industry status: relatively new variety; minor plantings from mid- 1990's following performance in regional variety trials.
Yield: early bearing; high yields in NSW and central Qld.
Quality: nuts 4.4g, round; small kernels 1.8g, larger in NSW; 37-39% KR, lower in north Qld; 63-87% G1K, variable, higher in north Qld; ca. 34-37% wholes
Sensory quality: acceptable but generally low rating, flavour similar to 344, but slightly higher incidence of off-type flavours, kernel colour good, cream to off-white
Flowering pattern: short, late
Nut drop pattern: mid to late (May - August)
Defects: low first grade and whole kernel (with poor nutrition)
Husk spot: slightly susceptible
Tree features: small, upright, open canopy, large leaves
Grower's comments: very precocious, small tree suited for high density planting, prone to leaf mottling, may require high standard of nutrition, high to very high level of immaturity (up to 40% both in QLD and NSW), low first grade and high unsound kernel (may be acceptable in NSW), consistent size, may dehusk in the tree, small nuts may not be picked up by harvester, stresses readily. Not recommended.

HAES 816

Industry status: relatively new variety, very few plantings to date, mainly in NSW.
Yield: not early bearing; high yields in NSW and central Qld
Quality: nuts 6.9g, round, pale in colour; kernels ca. 2.9g but 3.4g at Clunes, round, uniform kernel; 42-45% KR, lower in north Qld; 96-98% G1K, lower in north Qld; ca. 53-58% wholes
Sensory quality: highest rating for texture, flavour and overall acceptability, kernel colour slightly variable
Flowering pattern: light, late
Nut drop pattern: early to mid-season (March – June)
Defects: none apparent
Husk spot: slightly susceptible
Tree features: medium to large, moderately upright, moderately dense, pale green leaves with no spines
Grower's comments: variable yield performance in different sites (caution – investigate performance locally), performs well in the Bundaberg area, roasting reasonable, slightly susceptible to insect damage (twig girdler and leafminer), may be slightly susceptible to canker (but less than A4), early to mid-season nut-fall may be an advantage but up to 10% sticktight has been observed in NSW, may require careful nutritional management

HAES 842

Industry status: relatively new variety; increased plantings from mid- 1990's following good performance in regional variety trials.
Yield: early bearing; high kernel yields in Qld and NSW; performs particularly well in central Qld; appears to be more tolerant of high temperatures than most other commercial varieties.
Quality: nuts 5.8g, even size, slightly flat and oval; kernels 2.1-2.5g, larger in NSW; 36-41% KR; 94-98% G1K, variable; ca. 50% wholes
Sensory quality: acceptable texture and flavour and overall acceptability, colour slightly variable but acceptable (cream, beige, light brown and two-tone)
Flowering pattern: heavy flowering over a long period
Nut drop pattern: extended, mid- to late-season (April – September)
Defects: up to 10% hang late, may pre-germinate
Husk spot: slightly susceptible
Tree features: medium-large, moderately upright tree; canopy open when young becoming more dense as the tree matures
Grower's comments: hardy, fairly precocious, good yields but not as good as 816 and 849 in NSW, seems suited to warmer areas, long, late nut fall a disadvantage, slight pre-germination, darker kernel colour (growers penalised), not enough planted in NSW to properly define

HV A4

Industry status: widely planted in the 1990's in Queensland and NSW.
Yield: very early bearing; best kernel yields in NSW
Quality: nuts 6.4g, thin shell, shiny golden brown colour; kernels 2.8-3.3g, larger in NSW; 42-47% KR; >97% G1K; ca 44% wholes.
Sensory quality: texture and flavour acceptable but below average (lowest rating of the new varieties), relatively bland flavour, attractive cream kernels.
Flowering pattern: very heavy, short, late flowering.
Nut drop pattern: mid-season (May-August)
Defects: dehuskers may need to be adjusted to avoid damage to the large nuts
Husk spot: only slightly susceptible
Tree features: medium size, spreading to rounded, open canopy; can be planted closer giving potentially higher yields per hectare; susceptible to wind damage in exposed sites; requires careful attention to nutritional management
Grower's comments: very precocious with large nuts of high kernel recovery, often get out of season flowering, young trees prone to canker in NSW, can decline at 8-9 years if not fertilised properly, performs better in southern areas and away from the coast (better than A16), need special nutrition and high standard of management, some concerns over flavour and roasting properties, large nut and thin shell, requires dehusker adjustment in some cases; characteristic raised crest may not be pre-germination; questions over the raw flavour but acceptable roasted and salted. Some processors prefer to keep A series varieties separate from Hawaiian varieties.

HV A16

Industry status: widely planted in the 1990's in Qld and NSW; still being planted.
Yield: early bearing; best kernel yield in Queensland
Quality: nuts 6.3g, thin shelled, oval; kernels 2.4-2.9g, larger in NSW, uniform and attractive; 39-42% KR; >97%G1K; ca. 44-51% wholes
Sensory quality: texture and colour good (above average), overall acceptability and flavour "acceptable", slightly bland
Flowering pattern: moderately intense, condensed, late flowering
Nut drop pattern: very late – May to November
Defects: late dropping (nuts hang on trees long after they are mature), prone to sticktights; dehuskers may need adjustment to avoid damaging nuts
Husk spot: moderate to highly susceptible, exacerbated by the late nut drop pattern
Tree features: small, moderate to dense canopy, upright, with willowy branches; can be planted closer, giving potentially higher yields per hectare

Grower's comments: hardy; suit high-density plantings; very late nut fall a major disadvantage to some growers; use ethryl as part of the management program; nut drop exacerbates susceptibility to husk spot; germination late in season north of Gympie; consider removing branches to improve air flow and light penetration in NSW; in future, may need to harvest separately; susceptible to stress affects; more discolouration after roasting, early NIS has off-flavours in May/June.

HV A29

Industry status: released to industry by Hidden Valley Plantations in 1991; relatively new variety
Yield: early bearing
Quality: nuts 6.2g, uniform; kernels 3.1g; 38% KR, 98% G1K, ca. 32% wholes
Sensory quality: not assessed
Flowering pattern: short, mid-season flowering
Nut drop pattern: mid-season (April – July)
Defects: periodic incidence of kernel discolouration
Husk spot: susceptible
Tree features: medium size, very upright tree; very vigorous; susceptible to wind damage in exposed sites; very open canopy means easier spray penetration
Grower's comments: looks very good in the south, may be an alternate bearer, average-good cropper, subject to discolouration, immaturity, some germination: very large kernel

HV A38

Industry status: released to industry by Hidden Valley Plantations in 1991; relatively new variety
Yield: early bearing
Quality: nuts ca 6.7g, uniform; kernels, ca. 2.7g, slightly flattened, cream; 37.5% KR; 98% G1K; ca. 41% wholes
Sensory quality: not assessed
Flowering pattern: short, mid-season flowering
Nut drop pattern: mid-season (April – August)
Defects: kernel discolouration, depending on season
Husk spot: susceptible
Tree features: medium size, very upright tree; very vigorous; needs early tree training and pruning to size; susceptible to wind damage in exposed sites; very open canopy means easier spray penetration
Grower's comments: good cultivar for close planting, some years performs inconsistently, most variable cultivar, susceptible to husk spot, stress and discolouration, high percentage of immaturity in some years, variable roasting, kernel quality doubtful for various reasons, high yield could justify planting. Should be treated with caution!

HV A203

Industry status: not widely planted.
Yield: early bearing
Quality: nuts 5.6g, variable kernel recovery, sometimes low, oval; kernels 2.1g, uniform and attractive; 33-34% KR; 89-97%G1K; ca. 43% wholes
Sensory quality: not assessed
Flowering pattern: moderately intense, condensed, late flowering
Nut drop pattern: early
Defects:
Husk spot: not assessed
Tree features: small to medium semi-compact to open, rounded tree canopy
Grower's comments: early days, good producer, very large kernel, mid 30's KR.

HV A268

Industry status: new variety, not widely planted
Yield: mid season
Quality: large nuts 8.2g, uniform; kernels 3.4g; 37-38% KR, 89-96% G1K, ca. 36% wholes
Sensory quality: not assessed
Flowering pattern: short, mid-season flowering

Nut drop pattern: mid-season (April – July)
Defects:
Husk spot: not assessed
Tree features: rounded, spreading, semi-compact to slightly open tree canopy.
Grower's comments: declines with age and may require more fertiliser than other varieties, good yields, very large kernel, mid-season nut fall, susceptible to husk spot

Daddow

Industry status: been around a long time but significant plantings only since mid- 1990's.
Yield: early bearing, high yields, particularly in Qld
Quality: nuts 6.4g, even, tea colour, heavily striped and a very prominent suture; kernels 2.4g, good kernel characteristics; 37-40% KR, lower in north Qld; 92-99% G1K, variable; ca. 42% wholes
Sensory quality: good overall acceptability, good kernel colour, acceptable but slightly below average texture and flavour
Flowering pattern: moderately heavy, mid- to late-flowering
Nut drop pattern: long, mid- to late-season nut drop, May - September
Defects: very dense foliage, long, late nut drop, slightly prone to nutborer
Husk spot: very susceptible
Tree features: medium size, slightly spreading, very dense canopy; prone to mottling of older leaves.
Grower's comments: no major defects, very hardy and reliable yield performance, suited to marginal conditions, late nut fall but acceptable, prone to leaf mottling, may have higher nutritional requirements, not stress-tolerant in poor soils. Like most late-dropping varieties, a considerable level of germination has been observed.