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SELECTION FOR YIELD PERFORMANCE WITHIN ELITE MACADAMIA GENOTYPES BASED ON A PRODUCTIVITY INDEX

C.W. Winks
Maroochy Horticultural Research Station
Department of Primary Industries
Nambour, Queensland, Australia

H.F.D. Bell and D.J.D. Bell
Hidden Valley Plantations
Beerwah, Queensland, Australia

ABSTRACT

The selection of elite genotypes in macadamia progeny has mainly been based on tree, nut, and kernel characterstics. The area of equal importance, that of yield performance, has largely been neglected because of the difficulty of making comparisons between progeny of different ages at different locations.

Silhouette area compared with yield has been identified as a valid method for relating yield to tree size in macadamia.

In this study, silhouette area, calculated by measuring the area of tree sketches with a planimeter, is compared with individual tree yield data for two seasons from nine selections of macadamia in a varietal comparison trial at Beerwah in southeast Queensland.

An index of productivity relating yield to silhouette area provided a useful method of identifying more fruitful genotypes in varietal comparison trials.

This technique is also used to identify more fruitful individuals in elite genotypes of various ages at Hidden Valley Plantations, Beerwah.

KEYWORDS

Tree silhouette area, varietal trial.

INTRODUCTION

Breeding and selection of genotypes adapted to Australian environments is a prime requirement in the Australian macadamia industry.

Well-adapted cultivars have the potential to overcome problems of poor yield performance evident in current commercial cultivars which are selected for high kernel quality and performance in a Hawaiian environment (Cull, 1978).

Emphasis in Australian selection work to date has been on nut and kernel characteristics (Bell, 1983; Winks, 1983). Several elite genotypes have been identified in progeny planted at Hidden Valley Plantations, Beerwah, in southeast Queensland. These progeny have been ranked according to their tree, nut, and kernel characteristics using a system of ratings and weighting for 27 characteristics.

The area of equal and vital importance to successful macadamia production, that of yield performance, has largely been neglected in progeny screening because of the difficulty in making comparisons between genotypes of different ages at different locations under varying levels of management.

Yield is highly correlated ($R = 0.8605$ and 0.8452) with silhouette area of trees within a cultivar over a range of tree age and size (Chapman *et al.*, 1985). Comparisons between nine genotypes in a varietal comparison trial have shown that varieties differ in productivity based on a productivity index which relates yield to silhouette area (Winks, 1985). Comparisons of yield with butt cross sectional area gave poor correlation.

In this paper additional comparisons are made to investigate further the relationship within and between cultivars in the Macadamia Varietal Trial using 1985 harvest data. Similar comparisons are made on the best 20 selections ranked according to tree nut and kernel characteristics in progeny at Hidden Valley Plantations.

METHODS

Studies were conducted on individual tree data from 54 trees (six trees each of nine varieties) for two harvest seasons (1984 and 1985) in a varietal comparison trial at Beerwah, southeast Queensland, planted in 1977.

Similar studies were conducted on data from individual trees of 20 elite genotypes in progeny at Hidden Valley Plantations, Beerwah.

Sketches of silhouette area were drawn with the aid of a viewing device (Bell and Bell, 1983). Two sketches were drawn of the widest and narrowest sides of each tree. The surface area of each sketch was measured using a

Table 1. Regression analysis; yield verses silhouette area, slope and intercept on Y axis, adjusted average Y. Productivity index (yield/silhouette area) macadamia varietal trial, Beerwah, southeast Queensland, 1984 data.

Variety	Yield per tree (kg)	Silhouette area canopy (m^2)	Correlation coef. (R) yield v. sil. area	Intercept Y axis (yield v. sil. area) (common slope)	Slope	Adjusted average Y	Productivity index yield/ sil. area
Mason 97	14.62	21.80	0.4065	1.1803	0.3476	12.60 ab	0.675 abc
Ikaika (333)	13.48	20.39	0.7764	0.9095	0.4619	12.33 ab	0.670 abc
Daddow	13.05	16.58	0.7755	2.8267	0.7422	14.25 a	0.790 a
Greber Hybrid	13.02	17.33	0.6874	2.3426	1.1966	13.76 ab	0.735 ab
Keauhou (246)	11.57	19.95	0.4828	-0.7363	0.3053	10.69 bc	0.606 abc
Probert	10.76	18.27	0.8617	-0.5050	0.8168	10.91 bc	0.571 bc
Own Choice	10.17	17.07	0.9288	-0.3490	0.6547	11.07 abc	0.594 bc
Keaau (660)	10.02	20.52	0.4930	-2.6367	0.4559	8.78 c	0.488 c
Armanasco	8.49	14.81	0.7362	-0.6431	0.7675	10.78 bc	0.572 bc
Pooled data	11.69	18.52	0.6228	0.9245	0.5810		0.606
L.S.D. (P = 0.05)	5.02	4.63				3.30	0.194
(P = 0.01)	6.88	6.17				5.13	0.259

Table 2. Regression analysis; yield verses silhouette area, slope and intercept on Y axis. Productivity index (yield/silhouette area) macadamia varietal trial, Beerwah, Southeast Queensland, 1985 data.

Variety	Yield per tree (kg)	Silhouette area canopy (m^2)	Correlation coef. (R) yield v. sil. area	Intercept Y axis (yield v. sil. area)	Slope	Productivity index yield/ sil. area
Mason 97	19.51	24.91	0.9449	-3.7906	0.9359	0.781 c
Ikaika (333)	19.00	24.04	0.9365	2.0201	0.7065	0.797 c
Daddow	25.53	19.29	0.9406	1.6294	1.2396	1.327 a
Greber Hybrid	16.29	21.59	-0.2648	21.7970	-0.2553	0.780 c
Keauhou (246)	19.76	24.38	0.5484	12.7460	0.2880	0.850 bc
Probert	20.20	20.35	0.9596	-1.6438	1.0739	0.976 b
Own Choice	18.20	19.33	0.6437	6.5872	0.6009	0.952 bc
Keaau (660)	17.96	22.69	0.7707	-1.0628	0.8391	0.792 c
Armanasco	16.45	19.03	0.2829	8.5426	0.4157	0.872 bc
Pooled data	19.21	21.73	0.4953	8.6479	0.4863	0.903
L.S.D. (P = 0.05)	6.23	5.40				0.176
(P = 0.01)	8.53	7.20				0.235

planimeter and mean silhouette area was converted to actual tree dimensions using the formula described by Chapman *et al.* (1985) where 1 cm^2 on the sketch equals 0.1347 m^2 on the tree.

Regression of yield of nut-in-shell (NIS) verses silhouette area was calculated for individual and pooled data and an index of productivity was calculated for each tree by dividing yield by silhouette area. These data were subjected to one way analysis of variance to compare indices.

RESULTS AND DISCUSSION

Regression analysis of 1984 data for yield verses silhouette area, analysed across varieties, showed slopes could be pooled whilst intercepts could be statistically pooled (Table 1).

Large data sets on the one variety have shown that yield is strongly correlated with silhouette area (R = 0.8605 and 0.8452 for two years' data) (Chapman *et al.*, 1985). Many of the data sets for individual varieties showed similar high correlations although they were limited to six trees of each variety (Tables 1 and 2). Negative correlation for cv. Grever Hybrid in 1985 was caused by low and erratic set in two trees. Correlation was high for the other four trees.

Measures of relative yield performance, adjusted average Y value from regression analysis, and the

calculated productivity index provide a method for comparing the variability in yield of trees of different sizes (Tables 1 and 2).

Most of the within variety variability in the trial could be attributed to the fact that the rootstocks used were seedlings. This cause of variability would not be present in seedling progeny. Reproductive maturity and site differences were the largest component of variability in progeny.

Although data from the varietal trial were limited to six trees of each variety, analysis of variance of the productivity index showed that statistically different groups ($P = 0.05$) were similar to the analysis of adjusted average values of Y from regression analysis (Table 1).

The productivity index of elite progeny ranged from 0.17 to 1.30 (Table 3) and this identified four genotypes with a productivity index similar to the best group in the varietal trial (Table 2).

Table 3. Yield, silhouette area, productivity index, of 20 elite genotypes Hidden Valley Plantations, Beerwah, southeast Queensland, 1985 data.

Selection	Yield kg/tree	Silhouette area canopy (m^2)	Productivity index
A16	20	15.36	1.30[1]
A4	17	24.27	0.70
A181	3.5	5.66	0.62
A232	5.5	6.6	0.83[1]
A88	8	7.28	1.10[1]
A29	20	18.85	1.06[1]
A51	9	16.83	0.53
A203	6.5	10.44	0.62
A92	3	8.19	0.37
A57	6.5	12.04	0.54
A58	6	16.27	0.37
A100	3	15.63	0.19
A200	6	11.57	0.52
A55	1	5.74	0.17
A63	6.5	18.02	0.36
A75	2	5.42	0.37
A126	6	14.3	0.42
A95	7.5	15.33	0.49
A189	4	12.41	0.32
A236	4	9.40	0.43

[1] Comparable to best groups in varietal trial.

The combination of high rank order as determined by selection criteria over a minimum of three seasons, and high productivity index (yield/silhouette area) indicate selections worthy of inclusion in regional variety testing (Table 3).

Assessment of yield potential of new genotypes in long term woody perennial crops like macadamia is difficult in practice within an acceptable time span. Differences in inherent tree shape, growth rate, and precocity make valid comparisons more difficult.

Ultimately it may be more realistic to assess yield potential by a measure of photosynthetic efficiency which can then be used to predict performance at different ages and densities.

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