Northern Territory Government

Information Booklet **IB2**

Results of Recent Trials of High-Value Hardwood Tree Species in the Northern Territory of Australia

by D.F. Reilly, R.M. Robertson, K. Neitzel, M.J. Clark and M.N. Hearnden

DEPARTMENT OF PRIMARY INDUSTRY, FISHERIES AND MINES
Crops, Forestry and Horticulture Division
GPO Box 3000 Darwin NT 0801 Tel: 08 8999 2357 Fax: 08 8999 2049 Email: horticulture@nt.gov.au Web: www.horticulture.nt.gov.au

Published 2005

Results of recent trials of high-value hardwood tree species in the Northern Territory of Australia

D.F. Reilly, R.M. Robertson, K. Neitzel, M.J. Clark and M.N. Hearnden

Northern Territory Government, Department of Primary Industry, Fisheries and Mines
PO Box 3000 Darwin, Northern Territory 0801 Australia

Key Words: Provenances, laterite, African mahogany, height increment, diameter increment

Summary

Exotic and native, high-value hardwood species were planted at sites in the NT over a three-year period from 1998-2001. The trials were established on private land from the Darwin rural area in the north of the Top End to Katherine, 300 km to the south. The best performing species (assessed in 2004) were African mahogany (*Khaya senegalensis* A. Juss), Teak (*Tectona grandis* Lin. F) and *Terminalia belerica* (Gaertner) Roxb. Generally, the best growth was in the Katherine region on the Tippera and the river levee soil types. The soil types that appeared less favourable for tree growth are the Podzolic and Laterite that exhibit poor drainage and inhibit root penetration. African mahogany showed the best growth across a number of sites and appeared more adaptable to site (soil) variability than some other species evaluated such as *Swietenia humilis* Zucc. and *T. grandis*. Another species planted in the second year of trials on only a few sites but also performing well was *Chukrasia tabularis* A.Juss. At some sites, demonstration areas of some species were also established to allow observations to be made on a wider range of species than just the trials allowed. Within the suite of species, *Pterocarpus macrocarpus* grew very well on the sites where it was planted.

Introduction

In the Northern Territory, climatic factors and deficiencies in soil nutrients have generally prescribed a low level of natural productivity associated with vegetation (Bristow 2003). The frequent occurrence of wild fires and the occasional cyclone are also major impediments to forestry plantation development. Despite these difficulties, and in view of the generally high cost of importing timber, some potential for plantation production was seen for the region. As early as the 1950s work was undertaken to determine site suitability and the testing of a wide range of tree species for their plantation potential (Bateman 1955).

More recently, developments in forestry in the NT have been in part due to initiatives of the NT Department of Business, Industry and Development (DBIRD) (formerly the Department of Primary Industry and Fisheries) and Greening Australia NT. The objectives have been to promote tree growing in traditional farming enterprises and to facilitate the interests of plantation-based companies seeking to establish themselves in the tropical north of Australia.

The 'Top End Regional Tropical Hardwood Forestry Project' (TERTHFP) was proposed, accepted and funded through the Natural Heritage Trust. A Farm Forestry co-ordinator was appointed in mid 1998. The aims included establishing high value, cabinet quality timber trees on small areas of already cleared land with rotation periods of 15-20 years or more and evaluating their performance.

Another aim of the project was to document and analyse previous trials where more than 200 introduced species were evaluated (Cracium 1973) and later assessed (Tozer *et al* 1983 and Robertson 2003). It was the project co-ordinator who realised the value of those older plantings and suggested their preservation and protection should become a priority. He used planting material (wildlings) from many of these older trials at Howard Springs for the establishment of TERTHFP trial sites in the first and second years of the project. African mahogany (*Khaya senegalensis*) was the major species assessed from the old planting sites at Howard Springs. It was recognised that many of the species were classified as high value timber trees and considered as endangered species in their native habitat, including African mahogany. In addition to African mahogany, 11 other species were selected for the trials and/or demonstrations. A complete inventory of the species included in one or more trials across the plantings of 1998/99 and 1999/00is given in Table 2.

Methodology

Nursery phase

Most of the plants were raised from seeds in "Plantek 35 Side Slot Trays" at DPIF and planted with Pottiputki planting tubes. Approximately 750 African Mahogany wildlings were obtained from the Howard Springs Forest Reserve. These and striplings of Pacific Mahogany (*S. humilis*) (20-30cm, diameter under 1cm) were also transplanted into the seedlings trays. Planting material of African Mahogany, Padauk (*Pterocarpus indicus*) and some Indian Mahogany (*Chukrasia velutina*) were extracted as wildlings from natural regeneration areas within the Howard Springs Reserve. These wildlings (20-40 cm, diameter at root collar >1cm) were planted directly into the site. Seed of *Terminalia belerica* was also collected from this area to produce seedlings for the trials.

Establishment phase

The first trial sites were established in the wet season of 1998/99 and covered a range of soil types in four distinct regions of the Top End on the NT, namely; Katherine, Douglas-Daly, Darwin rural and the Marrakai area east of Darwin.

Six trial sites were initiated or established between mid December 1998 and the January 1999. The sites assessed for this paper were Fred's Pass (Darwin rural), Parker and Walsh (Katherine). In association with CSIRO, an irrigated trial with *Chukrasia tabularis* and *C. velutina* (Indian Mahogany) represented by a total of 18 seedlot numbers was established on a 2 ha block in Berry Springs (Gunn *et al* 2004). At Fred's Pass an irrigation system was installed after planting. In most cases, the late start of the project limited adequate preparation of the sites eg. ploughing or ripping which should have been followed by a weed eradication program, spraying "Round Up". Teak (*Tectona grandis*) was planted at the Walsh trial (Katherine) in September/October 1999. The teak component of all the trials planted in the first year, (1998/1999) was actually planted in the following year of 1999/2000.

In the second year of the project, (1999/2000) another seven sites were established with the aim of having sites in each of the four sub-regions of the Top End of the NT. The make-up of the species for these sites was similar to that of the first year of planting. Efforts were made to include some native species in the trials and they included Cypress Pine (*Callitris intratropica* R.T. Baker & H.G. Smith) and Red Mahogany (*Eucalyptus pellita* F.v.M.) at some trial sites. The three sites planted in the second year of the project that were measured in 2004 were selected to cover the geographical range and the variation in soil types in the trial. These sites are Meehan (Katherine), Doherty, (east of Darwin) and Van Tilburg at Adelaide River (100 km south of Darwin).

All trials were planted in a randomised complete block design. On each site, 6 species were supposed to be trialled, each represented by 49-tree plots (7 rows x 7 trees) in 4 replications

(196 plants per species); a total of 1176 trees per site. Trees were spaced at 3m x3m. The initial plan was to establish the trials on a dryland basis. Only the trials in Katherine were to be irrigated, but because of the late planting (especially the first year) and the extreme climatic conditions that prevail in January and February, many of the trial sites were irrigated. The establishment of a cover crop by sowing legumes to suppress emerging weeds and fix soil nitrogen was planned and in some cases was actually implemented. The legumes used were *Cassia rotundifolia* Taub. or *Stylosanthes hamata* Pers. (seeded at 2-3kg/ha) applied with 100 kg/ha superphosphate (Neitzel, 2000).

In 2002 all sites were assessed. Some of the sites were in very poor condition due to a lack of management by the landowners, yet others planted in the same year were performing very well. Those sites that were considered in poor or unmanaged condition in 2002 are not presented in this paper. In addition to the sites mentioned above, the *K. senegalensis* component only at Kalano, Hickey and Duminski were measured and included in the analysis. Although the project continued for three years (1998/1999-2000/2001), this paper summarises the results of the trials established in the first two years only.

Initial Assessments and Observations

The first appraisal was undertaken in July 1999 when most sites had been established for about 6 months. It was the middle of the dry season when the unirrigated sites appeared less attractive than those receiving irrigation (Neitzel 2000). It was also noted that trees in the unirrigated sites clearly showed slower growth rates compared to the irrigated sites.

Although the assessment in July indicated that 6 of the 8 trial sites were performing adequately, there were problems with low rainfall following planting, water logging on one site and damage due to slashing weeds, and from birds and fire. Weeds were the major problem limiting growth of the trees, most likely due to the lack of site preparation and adequate weed control prior to planting. The initial measures showed that overall, *Khaya senegalensis, Pterocarpus indicus, Terminalia belerica* and *Swietenia humilis* had the best growth, with many individuals over 2 metres tall.

The second assessment was done in mid-2002 when all sites established during the three-year project were measured for height and diameter. All 49 trees in plots were measured. However, for the comparison with 2004 data (25 tree net plots only measured) the data for external rows measured in 2002 were omitted.

In 2004, a third assessment was undertaken on most sites that were established in the first two years of the project. At this measure only the 25 tree net plots were measured. A detailed assessment was undertaken on stem form, stem straightness score (see below), forking and bole length.

Criteria for assessing Straightness Score

Score	Description of criteria
6	Straight (no defects)
5	Slight defects (would not affect recovery)
4	Moderate defects (would affect recovery by up to 10%)
3	Significant defects (would affect recovery by up to 25%)
2	Poor straightness (but some recovery possible)
1	Useless (nil recovery possible)

The final year of trials were planted using a different layout with one main species per site and other secondary species planted with it. The layouts were so different, that confidence in their comparison would have been reduced with sites established in the first two years. Also, the sites regarded as badly managed with little or no weed control or slashing after the 2002 assessment were not measured again. A list of the sites measured, their characteristics and the species are shown in Table 1.

Statistical Analysis

Data for survival, tree height, DBH, bole length and straightness scores collected in 2004 and the mean annual increments in height, DBH and bole length were analysed for differences between species at each growing site and for differences between growing sites for each species, using nested analysis of variance models (Neter et al. 1996). All data was standardised and expressed as mean annual increments to enable comparison between sites planted in different years and to enable comparison between Teak and other species. Data for survival were arcsine-squareroot transformed where necessary. In most tests, scores for straightness did not require transforming but where necessary, a Box-Cox transformation was applied (Sokal and Rohlf 1995). All variables were tested at the 0.05 level of significance. For post-hoc analyses, Tukey's HSD tests for unequal numbers were used to determine significant pair-wise differences within factors and generate homogenous groups.

Results

Table 1 shows the details of each site, indicating year of establishment, climate and soils data with taxon information across the sites and degree of maintenance inputs by the landholders. The emphasis of this assessment is on the variation between sites (their characteristics) and the effect on tree growth rather than comparisons between taxa across different sites. The inventory of species planted at each site is shown in Table 2. Different provenances were tested in various trials in the regions, therefore they are not exactly equivalent in terms of genetic resources tested. The mean values of the measured traits of species within sites are shown in Table 3. The ranking to compare species between sites is shown at Table 4.

The height and diameter growth of some species were significantly better than others at some sites and not others (Table 4). *Terminalia belerica* was significantly better for height ($p < 0.0001$) and diameter ($p = 0.0026$) at Parker (Tippera) than at Fred's Pass (laterite) or Walsh (river levee).

K. senegalensis (Table 3) performed best on all sites (established both 1998/1999 and 1999/2000) for both height and diameter with the exception of Fred's Pass where *K. senegalensis* height has been suppressed, possibly by repeated browsing by possums to growing tips. *K. senegalensis* is significantly better than *Swietenia humilis* ($p = 0.002$) and *Tectona grandis* ($p = 0.002$) for DBH growth on the same site (Figure 1*). Pterocarpus indicus* was planted as a trial species only at Fred's Pass and was not included in the overall analysis, but at the most recent measure it ranked first for height growth (9.52m) compared to *T. grandis* and *S. humilis* (8.0m) and second (12.1cm) to *K. senegalensis* (12.5cm) for diameter

K. senegalensis had the best height growth at Walsh compared to other sites established in 1998/99, being significantly better than Fred's Pass and Duminski, ($p<0.001$) but not with Parker. *K. senegalensis* at Fred's Pass had better diameter growth compared with other sites and was similar to Parker and Walsh. All these three sites were better than Duminski ($p<0.0001$) (Figure 2). In the second year of establishment, *K. senegalensis* had the best height growth at Meehan (Tippera) ($p< 0.05$) and the diameter growth at Hickey (Tippera) ($p < 0.05$), (Table 4 and Figures 4 and 5).

By standardising growth to a mean annual increment and comparing the species across all sites in the two years of establishment (Table 3), Meehan, south of Katherine on Tippera soils had the best growth for height and bole increment, was second for diameter increment. The site with best diameter increment for *K. senegalensis* was Hickey, also on Tippera soils near Katherine. The MAI for height, diameter and bole length in *K. senegalensis* across all sites can be seen at Figure 6 and the MAI for height growth for all species across all sites is shown in Figure 7. In Table 5 the performance of each species' characteristics compared with that of *K. senegalensis* are tabled and a score relative to the performance for each trait is given. From that table it can be seen that only one other species, *C. tabularis* has the same MAI for dbhob, all others are inferior for this trait. For height MAI, only three species are superior to *K.*

senegalensis, whereas for bole and straightness score, all species with the exception of *C. odorata* are superior. In Table 6, the performance is relative to six sites chosen to compare the combined traits for three species across the six sites. In this case the performance is ranked in comparison to the Meehan site. For the two traits, height and diameter only Walsh is equal to Meehan for height MAI and all are inferior to Meehan for diameter MAI. For the two traits addressing form of the trees, Walsh and Doherty are equal and better for bole length respectively and all sites except Van Tilburg have superior straightness scores to Meehan.

Tectona grandis (Figures 8 and 9), planted in the same year (1999/2000) at all sites had the best incremental growth for height and diameter at Walsh than all other sites. Another site that has recorded good growth for Teak diameter is Fred's Pass on a laterite site and should be less favourable for teak. It should be noted that only two replicates for *T. grandis* were measured at Fred's Pass in 2004, and the site is extremely well tended with regular mulching and irrigation of the trees nearly 5 years after establishment. The other laterite site where *T. grandis* was planted was at Doherty and the results indicate the poor growth in height, diameter and bole increment. The MAI for height, diameter and bole length in *T. grandis* across all sites can be seen at Figure 10 and the MAI for height growth for all species across all sites is shown in Figure 11. It should also be noted that Meehan, the other site rated 'excellent' for site maintenance (Table 1) also has the best incremental growth for height and diameter (Table 4) for a range of species from 2002 to 2004 compared to all other sites.

C. odorata consistently ranked poorly. On three of the four sites where it was planted it ranked last and on the fourth site, Walsh, it was grouped in the lowest ranking for all traits.

Assessments for bole length (in metres) and straightness score (SS from 1 to 6) were measured for the first time in 2004 (Table 3). Differences existed between species on the same sites and differences occurred between sites for the same species. When comparing species across sites for both years of establishment, Walsh had the best SS for *K. senegalensis* while Meehan had the best bole length for the same species (Figures 12 and 13). Also Walsh had the best bole length and SS for *T. grandis,* (Figures 14 and 15) and *S. humilis*, while Parker had the best bole length for *T. belerica* and Parker and Walsh were equal best for SS in *T. belerica*. When comparing the species within sites, *T. belerica* was the best for both bole and SS at Parker, Fred's Pass and best for bole length at Walsh (Table 3).

For sites established in 1999/2000, the results are still inconsistent for bole length and SS. At Doherty, *K. senegalensis* ranked best for bole length and *E. pellita* ranked best for SS (Table 3). At Meehan, *Chukrasia spp.* ranked best for bole length and SS. At Van Tilburg *S. humilis* ranked best for SS while *T. grandis* was best for bole length. Comparing species across sites within this group (1999/2000), Kalano, generally rated poor for site performance and site maintenance (Table 1) had the second best SS for *K. senegalensis* (Figure 13) and ranked third to Meehan for bole length in *K. senegalensis* (Figure 12). Doherty appeared inferior for both traits across all species in the comparison with the exception of *K. senegalensis* bole length where it ranked third. The bole length MAI for all species at all sites measured can be seen at Figure 16.

Discussion

Across sites, significant differences in the height and diameter increments within species were obvious. A large number of trees within species were assessed over a number of years across all the sites but the number of soil types tested was low. Despite these limitations, the unsuitability of some soil types is evident for the growth of high value tropical hardwoods in the Top End of the Northern Territory. Conversely, we have found other soil types, within the climatic constraints of the region, to be very productive for particular species and provenances.

The range of species planted over the three years of the trials was diverse. The choice of species to be analysed in this exercise was reduced to those that were common to most sites

planted in the first two years of trial establishment. The species analysed were*; Khaya senegalensis, Tectona grandis, Terminalia belerica, Swietenia humilis, S. macrophylla* and *Cedrela odorata* of which *K. senegalensis* was performing best overall over the two years of establishment. On some sites that were judged to be in poor condition in 2002, it was decided to measure only *K. senegalensis* so that there was at least data for one species across the maximum number of sites planted in the first two years of the trials. *K. senegalensis* was the only species measured at Duminski, Kalano and Hickey. Duminski and Kalano had the poorest performance overall for their respective years of establishment, (although Kalano ranked high for bole increment).

The sites where *K. senegalensis* has appeared to fail, classified as 'Poor' in Table 1 were Duminski (established 1998/1999) and Kalano (established 1999/2000). The compacted Podzolic soils at Duminski (without irrigation) have indicated poor growth, and the traditionally owned site at Kalano near Katherine on Tippera soil where maintenance has been minimal and experienced a fire in 2002, has given poor results in 2004.

The comparison of species across sites, regardless of the year of planting, based on incremental growth per year is given in Table 4 and ranks each species across sites. The standardised results in Table 4 allow comparisons between sites planted in different years and for *T. grandis* that was all planted in the single year of 1999/00 to be compared with other species. The sites in Katherine planted on Tippera soils; Parker, Meehan, Kalano, Hickey and the site on river levee soilsWalsh, consistently rank in the top groups for all traits across all species, with the notable exception of Fred's Pass where *K. senegalensis* height increment, was affected by browsing possums, as mentioned previously.

Overall, the best site for bole and straightness traits with the most number of species ranking first or second in the assessment was Walsh on river levee soils in the Katherine region. On a similar site (soil type), Van Tilburg near Adelaide River (planted 1999/2000), the ranking for these traits across species was generally low, especially for *T. grandis* and *K. senegalensis.*

For the main species assessed as indicated in Figure 7, the three species performing best, *K. senegalensis, T. grandis* and *S. humilis* have fairly similar growth at most sites. Meehan appears best (mostly) or equal to the other sites for survival and growth (ht and dbhob). This reflected in Table 6. Similarly, the Meehan site is bettered for bole length by Doherty only, and for straightness by Walsh only. These results suggest the superiority of the Meehan site (soil type) for best tree growth compared to other soil types. The better growth at this site (even when compared to other sites on same soil type) can be partially explained by the special care afforded by the landholder. Additional applications of fertiliser to the site (often left over after fertilising his mango block) could explain the superior performance at this site. The better results for Doherty (Bole) and Walsh (Straightness score) in comparison to Meehan cannot be explained.

In addition to the species discussed above, other species not analysed here have been performing well, namely *Chukrasia velutina, C. tabularis, Pterocarpus macrocarpus* and *P. indicus. C. velutina* was planted on a number of sites, but appeared to be performing best at Meehan near Katherine. Of the four replicates measured at that site, all were growing well with very good form and straightness scores. The mean value for height was 8.16m and the mean DBH was 11.58cm. This compares very well with *K. senegalensis* on the same site with a mean height of 8.3m and a mean DBH of 11.1cm.

P. macrocarpus and *P. indicus* were planted as demonstration species at both Parker and Walsh where DBH was measured on the net plot of 25 trees and height was scored as predominant height. At Parker, *P. macrocarpus* had a mean height of 8.4m and mean DBH of 10.72cm, and *P. indicus* had a mean height of 11.46m and mean DBH of 12.5cm. At Walsh, *P. macrocarpus* had a mean height of 12.87m and mean DBH of 13.53cm, and *P. indicus* had a mean height of 10.02m and a mean DBH of 11.92cm. At Fred's Pass *P. indicus* was growing well as indicated in the 'Results' section (above) and has persisted well with survival at 91% at age 5.5 years. It and *P. macrocarpus* were planted at other sites in the first year of

establishment, at a river levee site on the Daly River where they were the only surviving species after the area experienced a flood in 1998/99 and in the Marakai region on a poorly drained podzolic soil type. *P. macrocarpus* did not persist on the podzolic soil type.

Further consideration should be given to these species to determine optimum provenances and silviculture.

Damage due to insect attack, including giant termites (*Mastotermes darwiniensis*) was generally low across the sites. Termite damage to *T. grandis* and *E. pellita* was observed at Hickey on the Tippera soil and also at Parker on the same soil type to *T. grandis* in the trial and *E. pellita* in the demonstration area adjacent to the trial. In the Darwin region, trials established at Humphris and Duminski (Table 2) on grey podzolics, damage from insects was observed in *E. pellita* and leaf yellowing in the species was also noticed at Duminski, maybe due to poor drainage. Where *E. pellita* was planted, especially in the second year, many of the seedlings were damaged during planting as the seedlings were difficult to remove from the trays in which they were propagated. It has also become apparent that Eucalypts planted in this series of trials and subsequent trials in the Northern Territory are prone to attack by giant termites. In contrast, tree species within the family Meliaceae that are included in these trials: *C. odorata, Chukrasia spp., Khaya spp*. and *Swietenia spp.* on numerous soil types have experienced very little damage due to termites.

No incidence of damage associated with shoot tip borer *Hypsipyla robusta* which is a major pest of *Meliaceae,* has been observed in this series of trials. Recently the pest has been recorded in the Darwin region as is indicated in a paper to this workshop (Gunn *et a*,).

Conclusion

The results of the assessments indicate that *K. senegalensis* was the best performing species for height and diameter growth on all sites where it was planted. Other species were better for bole length and Straightness Score than *K. senegalensis* on most sites. This suggests that the planting material used for the trials was sourced (as striplings) from tree stands with poor form. Most examples of *K. senegalensis* growing in the Northern Territory exhibit similar growth habits. Therefore, for this species to be considered as a potential commercial high value hardwood species, improvement to form must be undertaken via selection or a tree improvement program.

The species has many favourable silvicultural characteristics in plantings in northern Australia or east-central Queensland trials including:

a) when well-established, it tolerates mild fire, drought, termites, fairly strong winds and flooding

b) plantation grown timber is good and could replace many tropical species currently logged unsustainably

c) the timber of 38 plantation grown, select, rotation-age trees from the NT breeding population are being evaluated for relative recoveries, properties, drying requirements and user application in a joint project between NT DBIRD – QDPI&F – RIRDC.[this is an activity, not a characteristic, recast in the light of matt's paper and cite same]

d) the species has a high growth rate, good logs (>50cm) are obtainable in rotations of 30 years or less

e) it is responsive to fertiliser, irrigation and pruning

f) *K. senegalensis* has been in the northern Australia for more than 40 years and is known to survive and grow into very large trees.

Further work to refine pruning, thinning and responses to fertiliser application need to be undertaken to provide more accurate information to growers to better manage plantations of this potentially commercial species. Better understanding of these management aspects

together with knowledge gained from the 'joint venture timber study' and the improved genetic material resulting from the 'tree improvement program' currently in its infancy with NT DBIRD, as indicated in a paper to this workshop by Nikles *et al*., will provide growers with improved plant material, silvicultural information and processing procedures for the cultivation and value adding of this species in northern Australia.

Optimum growth for the desirable species as outlined above occurs predominantly on the soils in the Katherine region, namely Tippera and river levee soil types. The river levee at Adelaide river (Van Tilburg) also showed good growth in *K. senegalensis* for both height and diameter. The laterite soil type, has shown encouraging results for height and diameter growth in *K. senegalensis* and *T. gra*ndis at Doherty and Fred's Pass respectively.

The major soil types in the areas identified for agricultural production including forestry and horticulture, in the Katherine/Daly basin are similar to those discussed above. It would not be unexpected for the more traditional enterprises of horticulture and agriculture to be allocated the superior land units (in terms of soil types) and for any forestry enterprise to struggle with the remaining inferior soils with the inherent problems as described above. This type of land allocation will see forestry activities in the Northern Territory condemned on the basis of non-commercial returns due to poor matching of species to sites and not allowing potential species to express their full potential. The tree improvement program, as mentioned above and indicated in a paper to this workshop by Nikles *et al* will serve to address the research deficiencies for an important species on the horizon for Australia's 'dry tropics'

Acknowledgments

The authors of this paper would like to thank all the Landholders who generously made available areas of their properties to establish the 24 sites from 1998/99 – 2000/01. Also to the person that made it all happen in his role as Farm Forestry Co-ordinator, and for his documentation with site layouts and trial designs, Mr Kurt Neitzel. The initiation of the project concept was by Mike Clark of Greening Australia who played a major role in its inception and organisation. Others who were also involved with this project on the steering committee were Greg Wills (NTF&TPN) and Peter Brocklehurst of NT Dept. of Infrastructure and Planning.

Thanks to all who assisted with the measuring of the trial sites including Vicki Simlesa, Nick Hartley, Jim Stuart and Kevin Flockhart.

A special thank you goes to Dr Garth Nikles for his continued support of Forestry development in the Northern Territory and his expert knowledge in the collection and analysis of data during the assessments of the trials.

References

Aldrick, J.M. and Robinson, C.S. 1972. Report on the land units of the Katherine-Douglas area, NT. Series No. 1. Land Conservation Unit, (CCNT)

Bateman, W. 1955. Forestry in the Northern Territory. F. & T. B. Leaflet No. 72

Bristow, M. 2003. Review of Agroforestry in Tropical Savanna Regions of Northern Australia. A report for the RIRDC/Land & Water Australia/FWPRDC, Joint Venture Agroforestry Program.

Cracium, G. 1973. Species Testing Results – Hardwoods. Position paper No3, Northern Territory Administration Forestry Branch

Lucas, S.J. 1980. A soil Survey of Part of the Coastal Plains Research Station NT. Report LC 80/3. Land Conservation Unit, (CCNT)

Neitzel, K. , Haines, M. W., and Robertson, R.M. 1995. Assessment of Established Woodlots in the Berry Springs and Howard Springs area. Internal report for the Conservation Commission of the Northern Territory and NT Agroforest.

Neitzel, K. 2000. Half-time for the NHT Farm Forestry Project in the NT. (Unpublished)

Neter J, Kutner MH, Nachtsheim CJ, Wasserman W. 1996. *Applied Linear Statistical Models*. Fourth Edition. Irwin, Chicago.

Robertson, R. M. 2003. Measurement details of some CSIRO trials established in the Northern Territory at Howard Springs, Humpty Doo, Gunn Point and Melville Island sites from 1969 to 1979. Northern Territory Department of Business, Industry and Resource Development, Internal report, Darwin.

Sokal RR, Rohlf FJ. 1995. *Biometry. The Principles and Practice of Statistics in Biological Research*. Third Edition. Freeman, New York.

Tozer, S. and Robertson, R.M. 1983. The introduction of Timber Producing Species into the Higher Rainfall Zone of the Northern Territory of Australia. Internal report for Conservation Commission of the NT (CCNT).

Table 1. Site description and source of planting material for NHT TERTHFP properties in the Northern Territory. Soil descriptions from Aldrick and Robinson (1972) and Lucas (1980).

Site	Soil Description	Species planted & Seed source	Maintenance of site	Year of Planting
Parker (Kath) Lat. $14^0$35.00' Long. $132^0$17.00' MAR 971mm Mean Average temp (C^0) 33.7	Tippera- Massive red earths with a porous profile and are well drained. Typically, dark reddish brown or dusky red fine sandy clay loam or clay loam, very hard, limestone derived. Gn2. 11*	*K. senegalensis* – HS striplings, D417 Senegal (1) *T. grandis* – Saragoza, El Salvador *S. humilis* – Striplings, Honduras *C. odorata* – DPI Qld 5525 *T. belerica* – HS Seed *S. macrophylla* – ATSC (2)	Good	1998/99 1999/00 1998/99 1998/99 1998/99 1998/99
Walsh (Kath) Lat. $14^0$27.00' Long. $132^0$17.00' MAR 976mm Mean Average temp (C^0) 34.2	River levee –Massive red earths formed by fine textured alluvial deposits along river flats, usually poorly drained. Derived from calcareous sediments or on shales. Gn2.11*	*K. senegalensis* –HS striplings, D417 Senegal (1) *T. grandis* – Rio Lindo, Honduras *S. humilis* – Striplings, Honduras *C. odorata* – DPI Qld 5525 *T. belerica* – HS Seed *S. macrophylla* – ATSC (2)	Very Good	1998/99 1999/00 1998/99 1998/99 1998/99 1998/99
Fred's Pass (Dwn Rural) Lat. $12^0$32.00' Long. 131^0.0215' MAR 1713mm Mean Average temp (C^0) 31.9	Laterite – Derived from lithosol (tenosol) or detrital laterite. Usually dark greyish loamy sand with a surface veneer of about 10% gravel, increasing with depth, moderately well drained. Uc*	*K. senegalensis* – HS striplings, D417 Senegal (1) *T. grandis* – La Cumbre, Honduras *S. humilis* – Striplings, Honduras *C. odorata* – DPI Qld 5525 *T. belerica* – HS seed *Pterocarpus indicus* – Striplings Howard Springs	Excellent	1998/99 1999/00 1998/99 1998/99 1998/99 1998/99
Duminski (Dwn) Lat. $12^0$33.47' Long.$131^0$00.42' MAR 1713mm Mean Average temp (C^0) 331.9	Podzolic- comprises the worst drained soils in the Top End. A gradual textured grey/brown profile can be texture contrast with an A2 horizon and a heavy textured yellowish subsoil. Gn2. 64*	*K. senegalensis* – HS striplings , D417 Senegal (1) *S. humilis* – Striplings, Honduras *T. belerica* – HS seed *E. pellita* – ATSC 19718 *Chukrasia velutina* – HS striplings *Castanospermum australe* – 10324	Very Good (Not Irrigated)	1998/99 1998/99 1998/99 1998/99 1998/99 1998/99

Doherty (Marrakai) Lat. $12^0$45.00' Long. $131^0$28.50' MAR 1325mm Mean Average temp (C^0) 33.1	Laterite - Derived from lithosol (tenosols) or detrital laterite. Usually dark greyish loamy sand with a surface veneer of about 10% gravel, increasing with depth, moderately well drained. Gravel distribution through the profile is variable Uc*	*K. senegalensis* – HS striplings , D417 Senegal [(1)] *T. grandis* – La Cumbre, Honduras *S. humilis* – Choluteca, Honduras *C. odorata* – DPI Qld 5525 *E. pellita* – ATSC 19719 *C. tabularis* – Unknown	Very Good	1999/00 1999/00 1999/00 1999/00 1999/00 1999/00
Meehan (Kath) Lat. $14^0$36.10' Long. $132^0$29.30' MAR 971mm Mean Average temp (C^0) 33.7	Tippera - Massive red earths with a porous profile and are well drained. Typically, dark reddish brown or dusky red fine sandy clay loam or clay loam, very hard, limestone derived. Gn2. 11*	*K. Senegalensis* – HS striplings , D417 Senegal [(1)] *T. grandis* – Rio-Lindo, Honduras *S. humilis* – Choluteca, Honduras *S. macrophylla* – Tela, Honduras *C. odorata* – QDPI 5525 *Chukrasia tabularis* – mix of 20100 & 20032	Excellent	1999/00 1999/00 1999/00 1999/00 1999/00 1999/00
Van Tilburg (Adel R) Lat.$13^0$13.10' Long. $131^0$08.00' MAR 1303mm Mean Average temp (C^0) 31.9	River levee – Massive yellow earths with a porous profile and are well drained. Typically, dark reddish brown or dusky red fine sandy clay loam or clay loam, very hard, limestone derived. Gn2. 65,66*	*K. senegalensis* – HS striplings , D417 Senegal [(1)] *T. grandis* Unknown *E. pellita* – ATSC 19718 *Chukrasia tabularis* - Unknown *C. odorata* – QDPI 5525 *S. macrophylla* – Tela, Honduras	Poor-Good	1999/00 1999/00 1999/00 1999/00 1999/00 1999/00
Hickey (Kath) Lat.$14^0$31.20' Long. $132^0$13.00' MAR 976mm Mean Average temp (C^0) 34.2	Tippera – (Tindall family) Massive red earths loam to clay loam, impeded drainage. Typically, dark reddish brown or dusky red fine sandy clay loam or clay loam, very hard, limestone derived. Gn2. 11*	*K. senegalensis* – Hs striplings , D417 Senegal [(1)] *T. grandis* – Unknown *S. humilis* – Choluteca, Honduras *E. pellita* – ATSC 19719 *Canarium australiamum* Local seed – Katherine *Callitris intratropica* – Local	Poor	1999/00 1999/00 1999/00 1999/00 1999/00 1999/00

Kalano (Kath) Aboriginal site Lat.14^{0}28.00' Long. 132^{0}15.06' MAR 976mm Mean Average temp (C^0) 34.2	Tippera - - Massive earths with a porous profile and are well drained. Typically, dark reddish brown or dusky red fine sandy clay loam or clay loam, very hard, limestone derived. Gn2. 11*	*K. senegalensis* – HS striplings , D417 Senegal [(1)] *S. humilis* – Choluteca, Honduras *T. grandis* – La Cumbre, Honduras *Enterolobium cyclocarpum*, Honduras *E. pellita* – ATSC 19719 *C. odorata* – QDPI 5525	Poor (Fire 2002)	1999/00 1999/00 1999/00 1999/00 1999/00 1999/00

(1) Striplings collected from EP 370 Howard Springs (D417 Senegal)

(2) Unclear which seed source was used (either seed lot 20097, 19861 or 19918 from ATSC).

(*) Northcote key soil profile descriptions

Table 2. Inventory of species **represented** in various trials by year of planting. The trials of columns 2-6 are in Katherine region, of column 7 the Daly river, of column 8 Adelaide river 100 km south of Darwin, columns 9 & 10 in the Marrakai region and 11 – 15 in the Darwin region. See Appendix 1 for details of the trial sites.

Species	Parker		Walsh		Meehan		Hickey		Kalano		Salzgeber		VanTilberg (Dry & Irrig)		Doherty		Humphris		Wills		Hammett		Hay man		Freds Pass		Duminski	
	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00	99	00
1	X		X			X		X		X	X			X		X	X									X		
2	X		X			X		X		X	X			X		X						X		X		X		
3	X		X			X								X						X				X				
4											X														X			
5											X						X											
6	X		X			X				X				X		X	X					X		X	X			
7	X		X								X														X		X	
8		X		X		X		X		X				X		X				X				X		X		
9						X		X		X				X		X	X			X				X			X	
10																	X										X	
11						X					X			X		X				X		X		X				X
12								X												X		X						
13										X										X		X						
14								X																				
15														X														

99 - Planted in the wet season 1998/1999

00 – Planted in the wet season 1999/2000

X – Species measured and included in this report in Tables 3 and 4.

Species represented

1 *Khaya senegalensis* (African mahogany)
2 *Swietenia humilis* (Pacific mahogany)
3 *S.macrophylla* King. (Big-leaved mahogany)
4 *Pterocarpus indicus* Wild. (Padauk)
5 *P. macrocarpus* Kurz. (Burmese Rosewood)
6 *Cedrela odorata* P Browne (West Indian Cedar)
7 *Terminalia belerica*
8 *Tectona grandis* Lin (Teak)
9 *Eucalyptus pellita* F Muell. (Red mahogany)
10 *Castanospermun australe* A. Cunn. (Black bean)
11 *Chukrasia tabularis (*Indian mahogany)
12 *Callitris intratropica* (Cypress Pine)
13 *Enterolobium cyclocarpum* (Elephant ear)
14 *Canarium australianum* (White beech)
15 *Elaeocarpus grandis* (Quandong)

Table 3. Mean values for growth and form of species assessed in 2004 at sites in the Northern Territory established in the NHT TERTHFP in 1998/99 & 1999/00

Site, Species	Survival (percent)	Height (m)	Height (MAI) (m)	DBH (m)	DBH (MAI) (m)	Bole Length (m)	Bole Length (MAI) (m)	Straightness Score
Doherty								
E.pellita	52 (6.7) b	8.2 (0.31) a	1.8 (0.07) a	9.3 (0.39) b	2.1 (0.09) b	7.2 (0.43) b	1.6 (0.1) a	3.5 (0.11) a
K.senegalensis	95 (5) a	7.7 (0.1) a	1.7 (0.02) a	10.7 (0.17) a	2.4 (0.04) a	3.8 (0.17) a	0.9 (0.04) c	2.9 (0.06) c
Chukrasia	53 (5.7) b	6.6 (0.16) b	1.5 (0.03) b	8.9 (0.26) bc	2 (0.06) b,c	5.3 (0.22) c	1.2 (0.05) b	3.2 (0.09) ab
T.grandis	95 (1.9) a	6.2 (0.09) b	1.4 (0.02) b	8 (0.12) cd	1.8 (0.03) c,d	3.6 (0.12) a	0.8 (0.03) c	2.9 (0.05) bc
S.humilis	76 (8.6) ab	6.2 (0.11) b	1.4 (0.03) b	7.3 (0.18) d	1.6 (0.04) d	3.7 (0.16) a	0.8 (0.04) c	3.1 (0.06) bc
Fred's Pass								
S.humilis	76 (10.7) a	8 (0.15) a	1.5 (0.03) b	10.6 (0.32) a	1.9 (0.06) b,c	3.4 (0.17) c	0.6 (0.03) b	3.3 (0.08) b
T.grandis	68 (-) a	8 (0.25) a	1.8 (0.05) a	9.9 (0.37) a	2.2 (0.08) a,b	4.9 (0.31) ab	1.1 (0.07) a	3.2 (0.12) ab
T.belerica	93 (3) a	7.6 (0.22) a	1.4 (0.04) b	9.9 (0.24) a	1.8 (0.04) c	5.3 (0.24) a	1 (0.04) a	3.6 (0.1) a
K.senegalensis	83 (7.7) a	6.7 (0.11) b	1.2 (0.02) c	12.5 (0.26) b	2.3 (0.05) a	3.2 (0.1) c	0.6 (0.02) b	3 (0.07) b
C.odorata	60 (9.1) a	5.9 (0.22) c	1.1 (0.04) d	8.1 (0.34) c	1.5 (0.06) d	4 (0.21) bc	0.7 (0.04) b	3.1 (0.09) b
Meehan								
K.senegalensis	97 (1.9) ab	8.3 (0.11) a	1.8 (0.02) a	11.1 (0.16) a	2.5 (0.04) a	4.5 (0.16) c	1 (0.04) c	2.9 (0.08) c
Chukrasia	89 (1.9) bc	8.2 (0.1) ab	1.8 (0.02) a,b	11.6 (0.18) a	2.6 (0.04) a	6.8 (0.16) a	1.5 (0.04) a	3.9 (0.08) a
T.grandis	99 (1.0) a	7.8 (0.09) b	1.7 (0.02) b	9.6 (0.14) b	2.1 (0.03) b	4.5 (0.2) c	1 (0.04) c	3.3 (0.06) b
S.humilis	89.3 (4.8) abc	7.2 (0.09) c	1.6 (0.02) c	8.5 (0.12) c	1.9 (0.03) c	5 (0.21) bc	1.1 (0.05) b,c	3 (0.07) bc
S.macrophylla	75 (7.2) c	6.7 (0.11) d	1.5 (0.02) d	8.3 (0.11) c	1.8 (0.03) c	5.2 (0.16) b	1.2 (0.04) b	3.1 (0.05) bc

Table 3. (cont.)

Parker								
T.belerica	96 (-) a	9.1 (0.14) a	1.7 (0.03) a,b	11.2 (0.17) ab	2 (0.03) a,b	6.7 (0.31) a	1.2 (0.06) a	3.5 (0.09) a
K.senegalensis	100 (-) a	9.1 (0.12) ab	1.6 (0.02) a,b	11.9 (0.16) a	2.2 (0.03) a	4 (0.13) c	0.7 (0.02) b	3 (0.06) bc
S.humilis	78 (7.0) ab	8.5 (0.14) b	1.5 (0.03) b	10.5 (0.17) bc	1.9 (0.03) b,c	3.7 (0.17) c	0.7 (0.03) b	3.2 (0.08) a.b
T.grandis	89.3 (2.7) ab	7.7 (0.16) c	1.7 (0.04) a	9.6 (0.23) de	2.1 (0.05) a	5.3 (0.29) b	1.2 (0.06) a	3.1 (0.09) abc
S.macrophylla	56 (12.0) b	7.6 (0.25) c	1.4 (0.05) c	8.6 (0.27) e	1.6 (0.05) d	4.7 (0.25) bc	0.9 (0.05) b	3.4 (0.1) ab
C.odorata	59 (17.1) b	6.7 (0.2) d	1.2 (0.04) d	9.8 (0.35) cd	1.8 (0.06) c	4.6 (0.24) bc	0.8 (0.04) b	2.8 (0.12) c
Van Tilberg (dryland)								
K.senegalensis	93.3 (3.5) a	7.5 (0.08) a	1.7 (0.02) a	10.9 (0.12) a	2.4 (0.03) a	3.1 (0.09) c	0.7 (0.02) c	2.9 (0.05) b
E.pellita	61 (4.4) a	7.2 (0.24) a	1.6 (0.05) a	8.3 (0.28) b	1.8 (0.06) b	5.3 (0.31) a	1.2 (0.07) a	3.2 (0.09) a
S.humilis	70 (13.9) a	6 (0.1) b	1.3 (0.02) b	7.8 (0.17) b	1.7 (0.04) b	3.8 (0.15) b	0.8 (0.03) b	3.3 (0.06) a
Van Tilberg (irrigated)								
K.senegalensis	100 (-) a	7.5 (0.13) a	1.7 (0.03) a	10.5 (0.23) a	2.3 (0.05) a	3.6 (0.19) b	0.8 (0.04) b	2.7 (0.07) b
T.grandis	96 (2.8) ab	7.1 (0.09) a	1.6 (0.02) a	8.6 (0.12) b	1.9 (0.03) b	4.5 (0.2) a	1 (0.05) a	2.9 (0.07) b
S.humilis	83 (5.3) bc	6.3 (0.14) b	1.4 (0.03) b	7.6 (0.2) c	1.7 (0.04) c	4.4 (0.21) ab	1 (0.05) a,b	3.2 (0.06) a
C.odorata	50 (13.1) c	5.2 (0.16) c	1.2 (0.04) c	6.7 (0.27) d	1.5 (0.06) d	3.8 (0.23) ab	0.8 (0.05) a,b	2.9 (0.06) b
Walsh								
K.senegalensis	100 (-) a	9.5 (0.14) a	1.8 (0.03) a	11.7 (0.28) a	2.1 (0.05) a,b	3.6 (0.13) c	0.7 (0.02) c	3.3 (0.08) bc
S.humilis	99 (1.0) a	8.5 (0.11) b	1.5 (0.02) b	10.7 (0.16) ab	1.9 (0.03) b,c	4 (0.16) bc	0.7 (0.03) b,c	3.5 (0.09) b
T.grandis	88 (3.7) ab	8.2 (0.14) b	1.8 (0.03) a	9.6 (0.25) c	2.1 (0.06) a	6.7 (0.25) a	1.5 (0.06) a	4.4 (0.11) a
C.odorata	40 (6.1) d	7.6 (0.41) bc	1.4 (0.07) b,c	11.2 (0.73) ab	2 (0.13) a,b,c	5.1 (0.38) abc	0.9 (0.07) b,c	2.9 (0.13) c
S.macrophylla	53 (12.8) cd	7.1 (0.17) c	1.3 (0.03) c	8.7 (0.24) c	1.6 (0.04) d	4.3 (0.2) bc	0.8 (0.04) b,c	3.1 (0.1) bc
T.belerica	80 (5.9) bc	7.1 (0.15) c	1.3 (0.03) c	9.8 (0.2) bc	1.8 (0.04) c,d	5 (0.59) b	0.9 (0.11) b	3.4 (0.1) bc

Table 4. Species compared across sites for traits measured. (See table 3 for mean values). Groups with the same letter are not significantly different.

Species	Survival	group	Height (MAI)	group	DBH (MAI)	group	Bole (MAI)	group
C.odorata	Freds Pass	a	Walsh	a	Walsh	a	Walsh	a
	Parker	a	Parker	b	Parker	a	Parker	a
	Van Tilberg (irrigated)	a	Van Tilberg (irrigated)	b,c	Van Tilberg (irrigated)	b	Van Tilberg (irrigated)	a
	Walsh	a	Freds Pass	c	Freds Pass	b	Freds Pass	a
K.senegalensis	Van Tilberg (irrigated)	a	Meehan	a	Hickey	a	Meehan	a
	Walsh	a	Walsh	a,b	Meehan	b	Kalano	a,b
	Parker	a	Doherty	b,c	Van Tilberg (dryland)	b,c	Doherty	b
	Doherty	a,b	Van Tilberg (dryland)	b,c	Doherty	b,c	Van Tilberg (irrigated)	b,c
	Meehan	a,b	Van Tilberg (irrigated)	b,c	Van Tilberg (irrigated)	b,c,d	Parker	c,d
	Van Tilberg (dryland)	a,b	Hickey	b,c	Fred Pass	c,d	Hickey	c,d,e
	Duminski	a,b	Parker	c	Parker	d	Van Tilberg (dryland)	c,d,e
	Freds Pass	a,b	Kalano	d	Walsh	d	Walsh	c,d,e
	Hickey	b	Freds Pass	e	Kalano	e	Duminski	d,e
	Kalano	b	Duminski	f	Duminski	f	Freds Pass	e
S.humilis	Walsh	a	Meehan	a	Walsh	a	Meehan	a
	Meehan	a	Parker	a,b	Freds Pass	a	Van Tilberg (irrigated)	a,b
	Van Tilberg (irrigated)	a	Walsh	a,b	Parker	a	Van Tilberg (dryland)	b,c
	Freds Pass	a	Freds Pass	b,c	Meehan	a	Doherty	c
	Doherty	a	Van Tilberg (irrigated)	c,d	Van Tilberg (dryland)	b	Walsh	c,d
	Parker	a	Doherty	c,d	Van Tilberg (irrigated)	b	Parker	d
	Van Tilberg (dryland)	a	Van Tilberg (dryland)	d	Doherty	b	Freds Pass	d
S.macrophylla	Meehan	a	Meehan	a	Meehan	a	Meehan	a
	Parker	a	Parker	b	Walsh	b	Parker	b
	Walsh	a	Walsh	b	Parker	b	Walsh	b
T.belerica	Parker	a	Parker	a	Parker	a	Parker	a
	Freds Pass	a	Freds Pass	b	Freds Pass	b	Freds Pass	b
	Walsh	a	Walsh	b	Walsh	b	Walsh	b
T.grandis	Meehan	a	Walsh	a	Freds Pass	a	Walsh	a
	Van Tilberg (irrigated)	a,b	Freds Pass	a	Walsh	a	Parker	b
	Doherty	a,b	Meehan	a	Parker	a	Freds Pass	b,c
	Parker	a,b,c	Parker	a	Meehan	a	Van Tilberg (irrigated)	b
	Walsh	b,c	Van Tilberg (irrigated)	b	Van Tilberg (irrigated)	b	Meehan	b
	Freds Pass	c	Doherty	c	Doherty	b	Doherty	c

Table 5. Performance relative to *K senegalensis* (Ks) of eight species for several traits across a variable number of sites. For Ks the actual trait values are shown.

Species (no. of sites)	Survival (%)	Relativity to *K.senegalensis* (%)				Overall no. of traits > Ks[1]
		Height (MAI m)	Dbhob (MAI cm)	Bole (MAI m)	Straight-ness score	
K.senegalensis *(6)*	95.5	1.5	2.3	0.8	2.96	
T. grandis *(6)*	89	**111**	88.4	**137.5**	**111.5**	3
S. humilis *(6)*	81.6	96.7	78.3	101.8	**109.1**	2
C. odorata *(4)*	52.3	81.7	73.9	100	98.8	0
T. belerica *(3)*	89.7	97.3	81.2	**129.2**	**118.2**	2
S. macrophylla *(3)*	61.3	93.3	72.5	**120.8**	**108.1**	2
C. tabularis *(2)*	71	**110**	100	**168.8**	**120**	3
P.macrocarpus *(2)*[2]	**98**	NA[3]	96	NA	NA	1
P. indicus *(1)*	91	**113.3**	95.7	**412.5**	**111.4**	3

[1] Counts in this column derive from the highlighting that indicates those species – trait values clearly exceeding the inferred '100%' value for *Ks.* Note that 'Survival' has been included in the counts, giving a total of 5 comparison traits.

[2] Species represented by a single plot at each site.

[3] NA – not assessed.

Table 6. Performance relative to Meehan of three species (*K senegalensis, T grandis* and *S humilis*) for several traits, across five other sites. For Meehan the actual trait values are shown.

Sites (region) [1]	Survival (%)	Relativity to Meehan (%)				Overall No. of traits > Meehan [2]
		Height (MAI m)	Dbhob (MAI cm)	Bole (MAI m)	Straight-ness score	
Meehan (K)	95.1	1.7	2.2	1.0	3.1	
Parker (K)	89.1	94.1	95.5	90	100	0
Walsh (K)	95.7	100	90.9	100	**119.4**	1
Doherty (M)	88.7	88.2	81.8	**121**	103.2	1
Van Tilberg (AR)	93	94.1	90.9	90	93.5	0
Freds Pass (D)	75.7	88.2	95.5	80	103.2	0

[1] Regions: K – Katherine; M – Marakai (50 km SE of Darwin); AR – Adelaide R (100 km south of Darwin);

D – Darwin area

[2] Counts in this column derive from the within cell markings that indicate those sites – trait values clearly less (underscored) or clearly greater (**bolded**) than the inferred '100%' value for Meehan. Note that 'Survival' has been included in the counts, giving a total of 5 comparison traits.

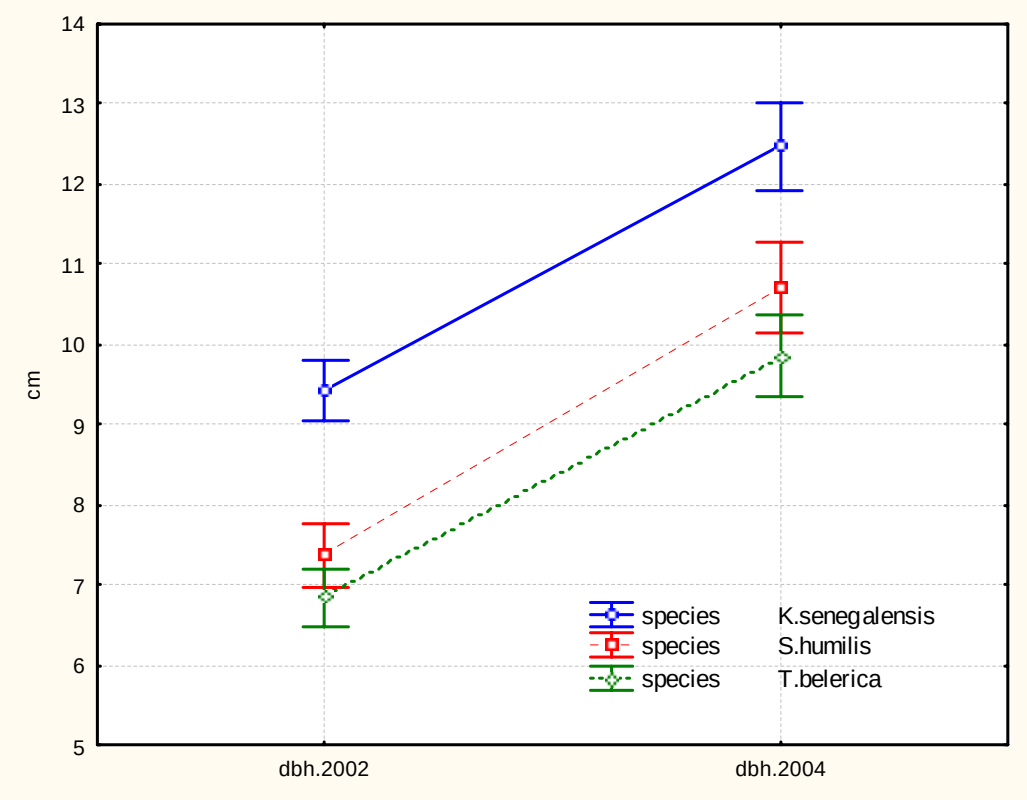

Figure 1. Shows the DBH growth at Fred's Pass for three species established in 1998/99.

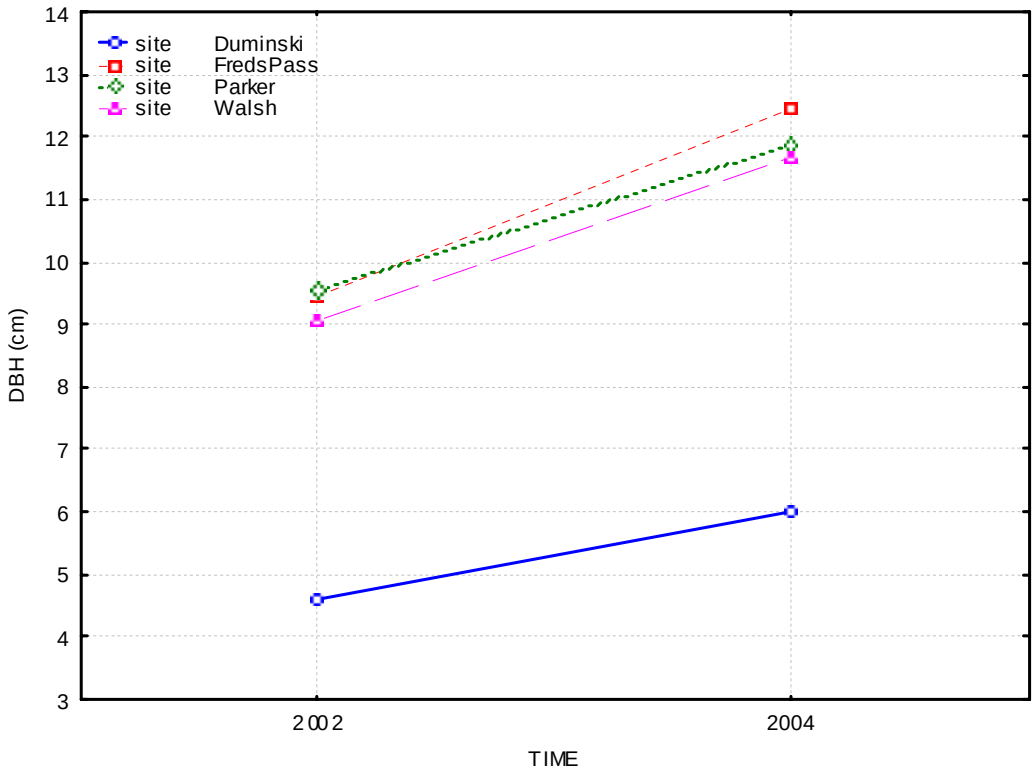

Figure 2. Indicates the incremental growth for DBH of *K. senegalensis* across 4 sites planted in 1998/99.

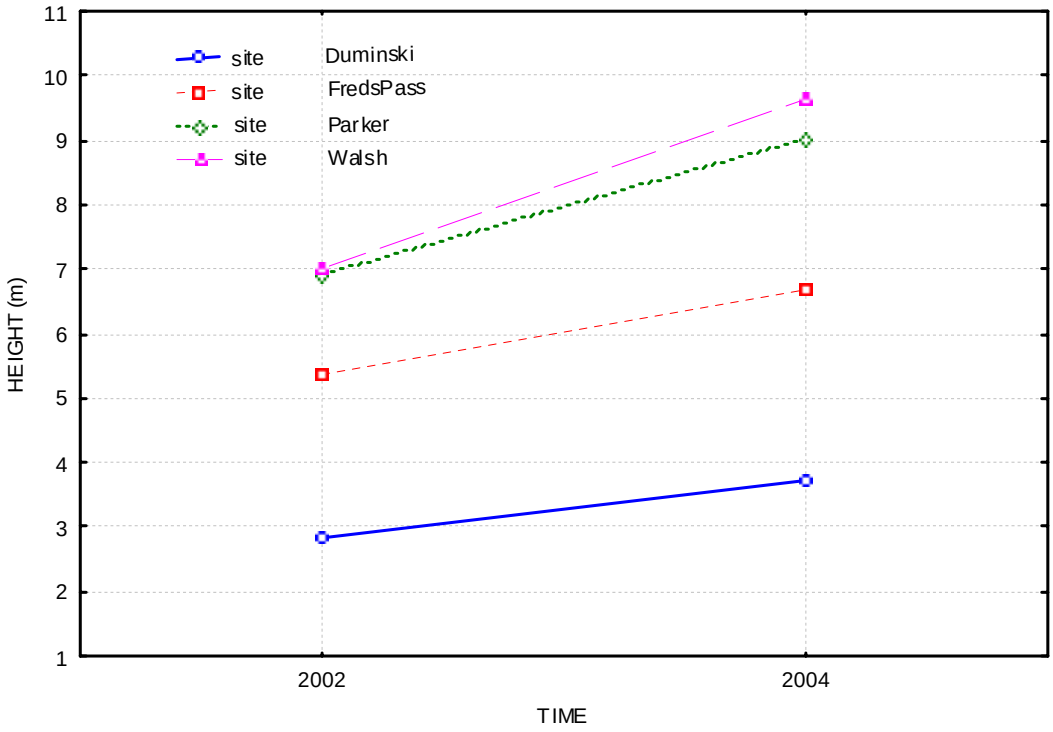

Figure 3. Indicates the incremental height growth for *K. senegalensis* across 4 sites established in 1998/99.

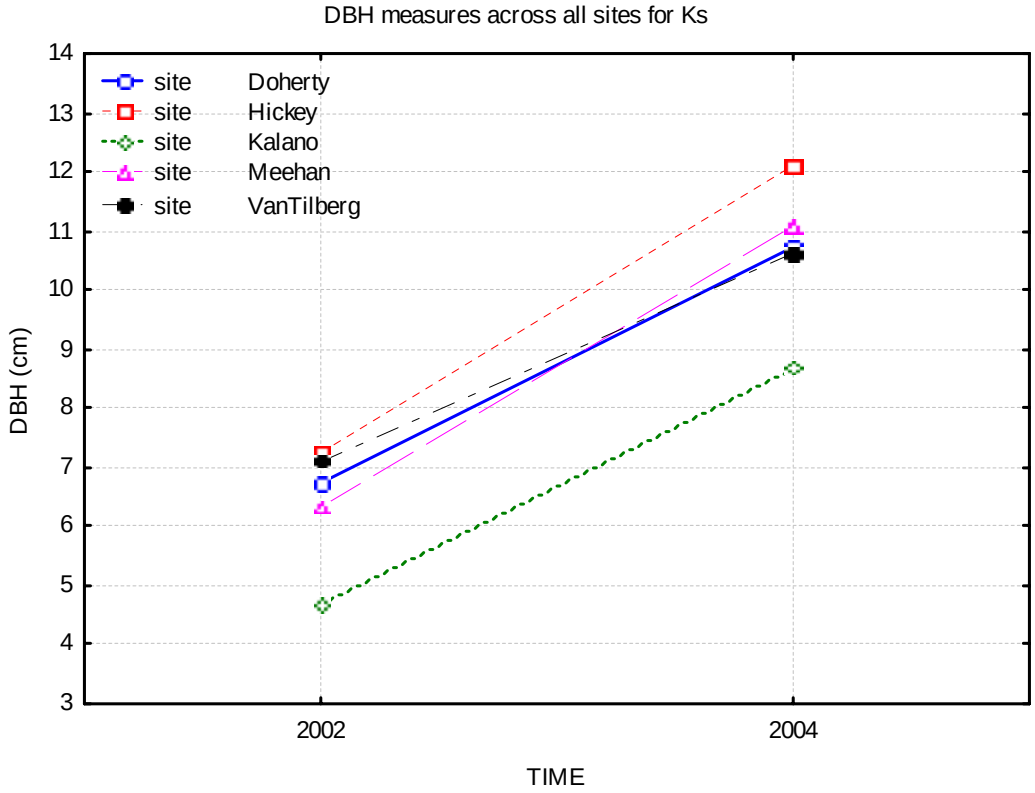

Figure 4. Shows the poor performance of *K. senegalensis* at the Kalano site for DBH growth compared with other sites established in 1999/00.

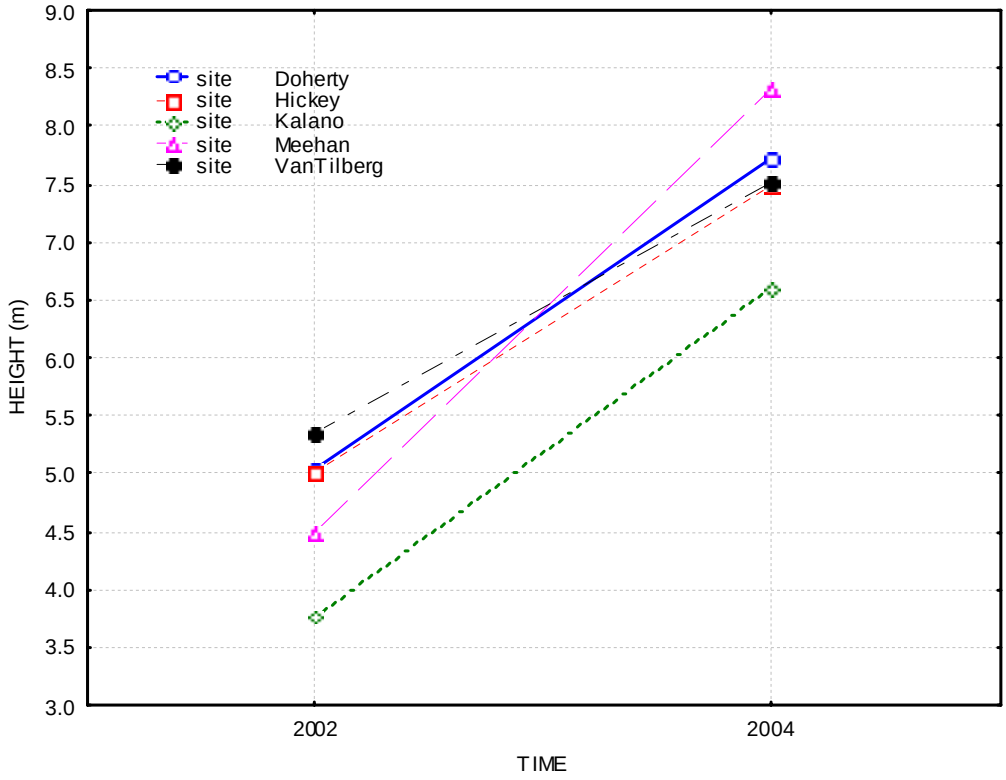

Figure 5. Shows the poor height growth for *K. senegalensis* at the Kalano site compared to the other sites established in 1999/00.

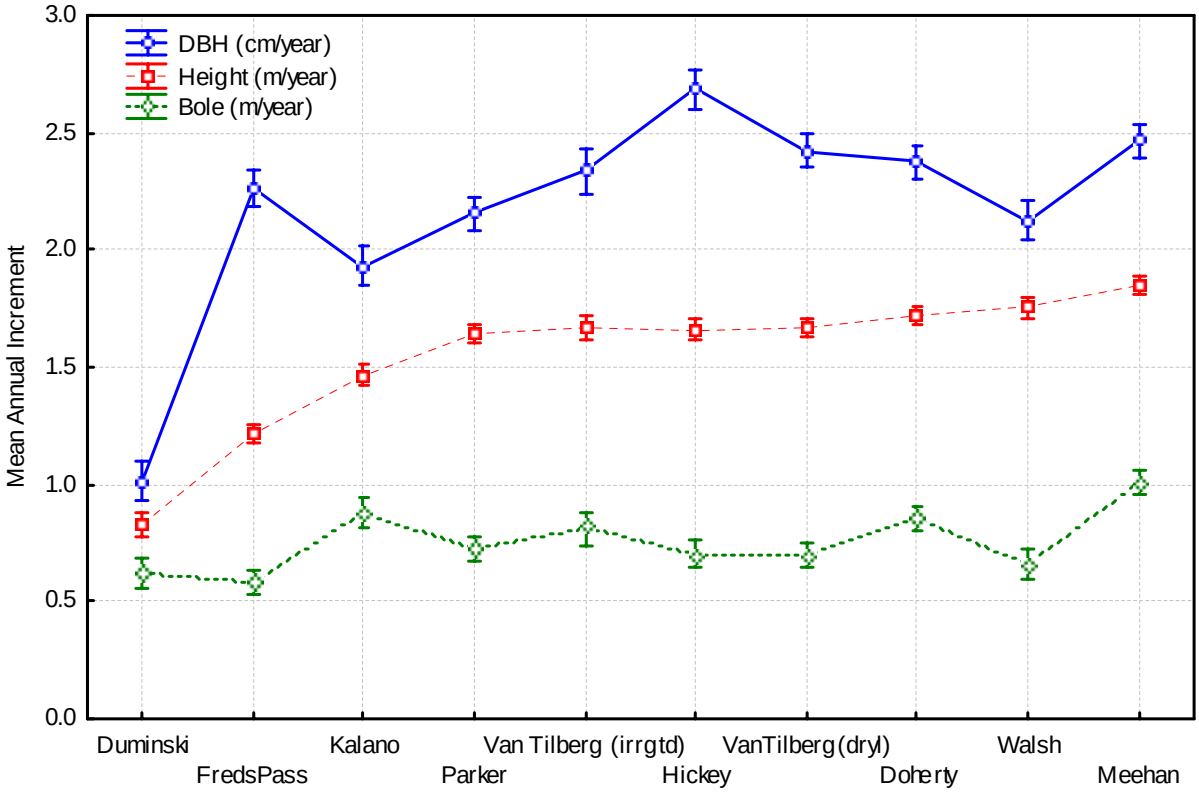

Figure 6. Shows the incremental increases (MAI) for height, diameter and bole length for *K. senegalensis* at all sites established in both 1998/99 and 1999/00.

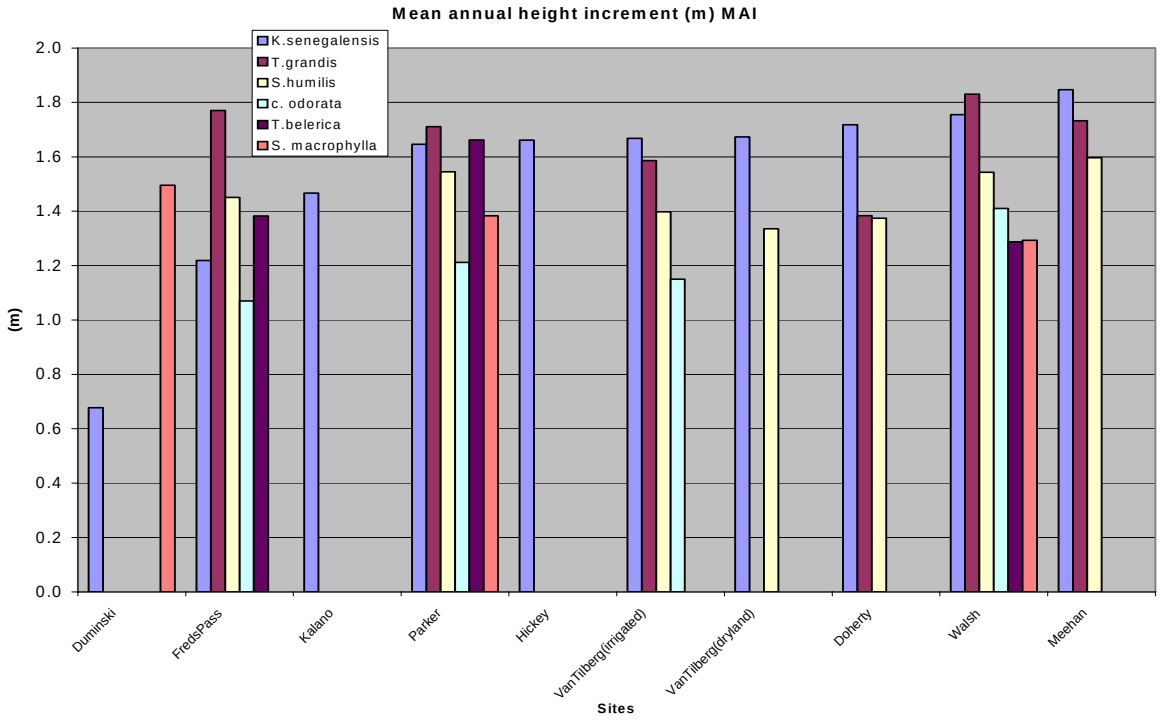

Figure 7. Shows the incremental height growth per year for all species across all sites reported in this paper.

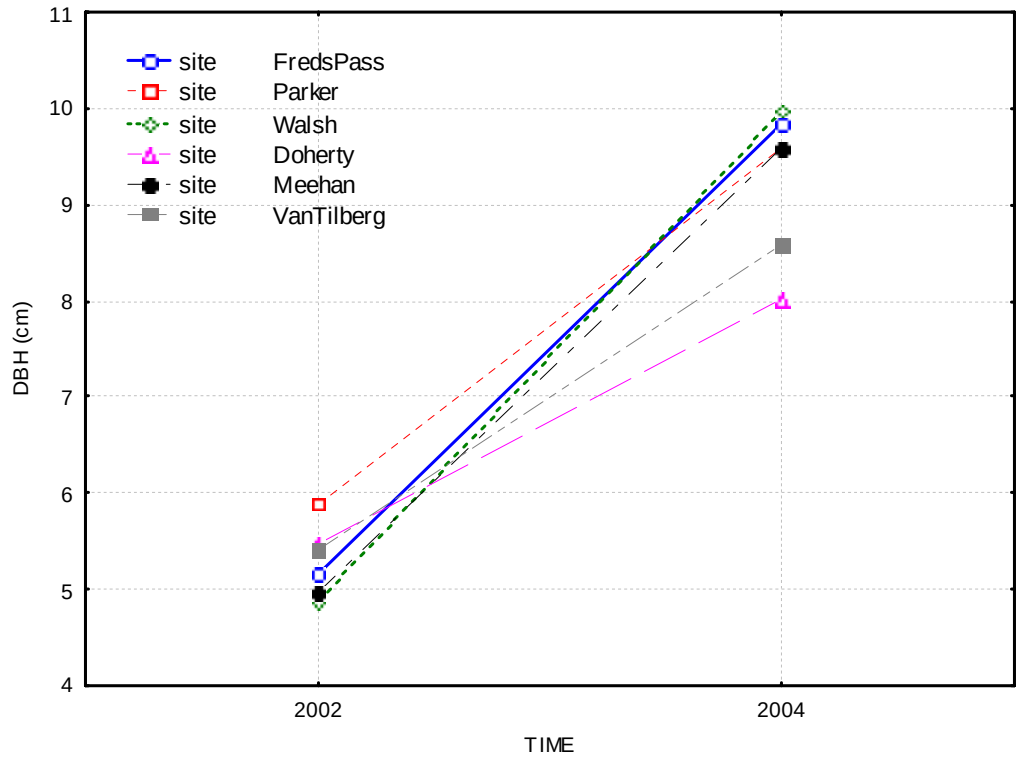

Figure 8. Illustrates the very good growth in DBH for Teak at a number of sites established in 1999/00 including Walsh, Meehan and Fred's Pass

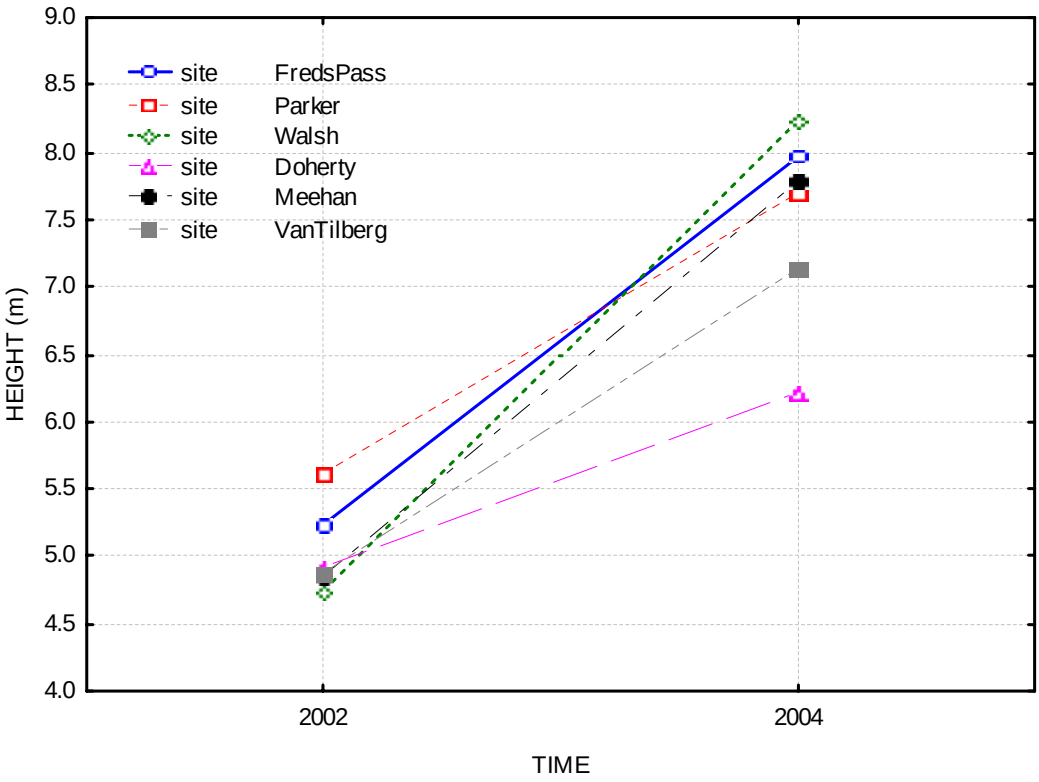

Figure 9. Illustrates the incremental height growth for Teak at all sites established in 1999/00, indicating the best growth at the Walsh site.

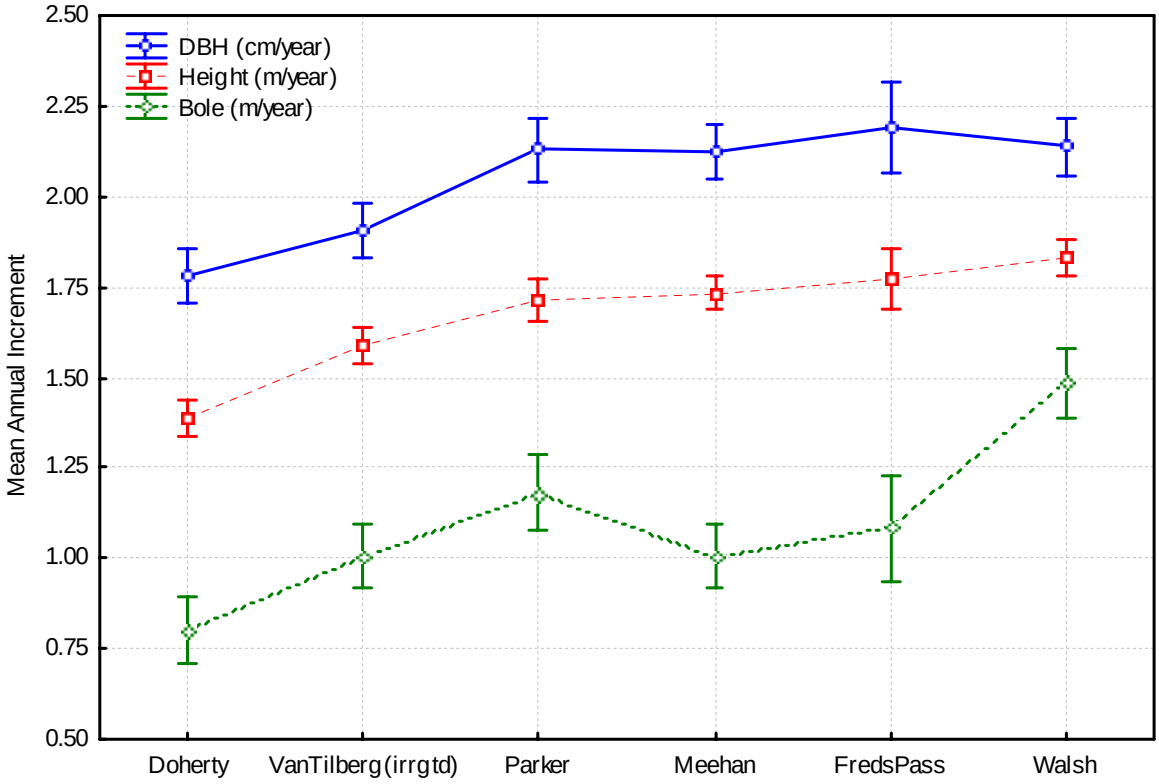

Figure 10. Shows the incremental increases (MAI) for height, diameter and bole length for *T. grandis* at all sites established 1999/00.

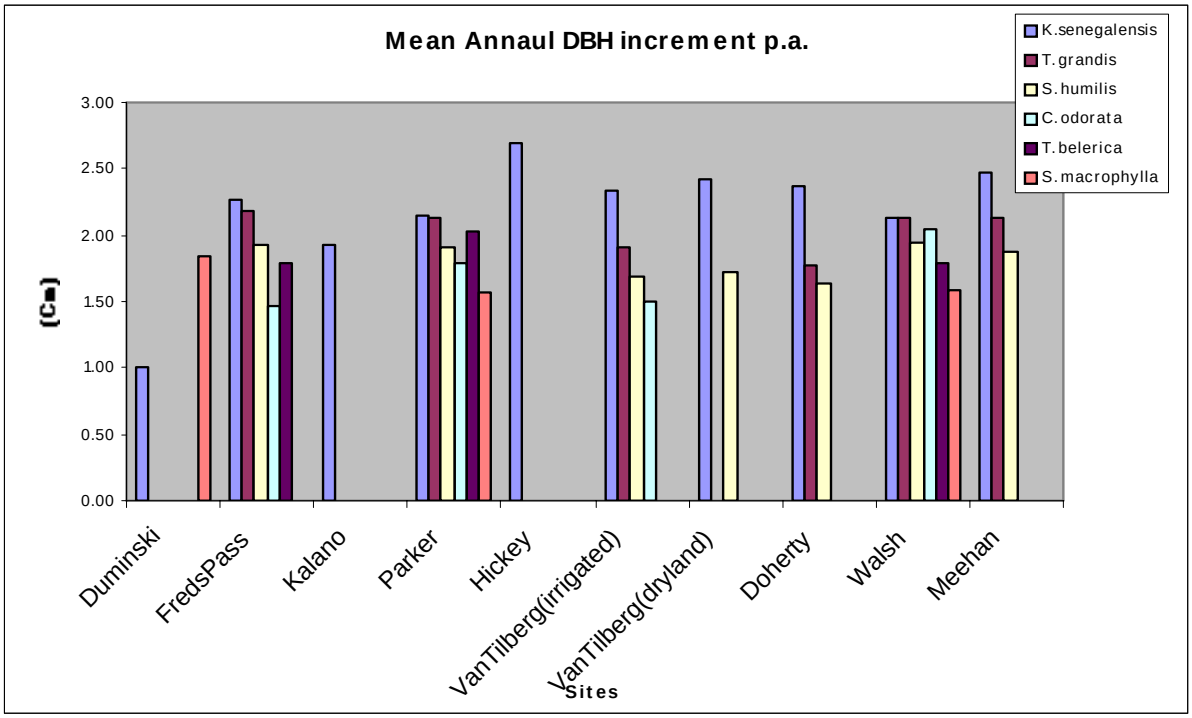

Figure 11. Shows the incremental diameter growth for all species across all sites reported on in this paper.

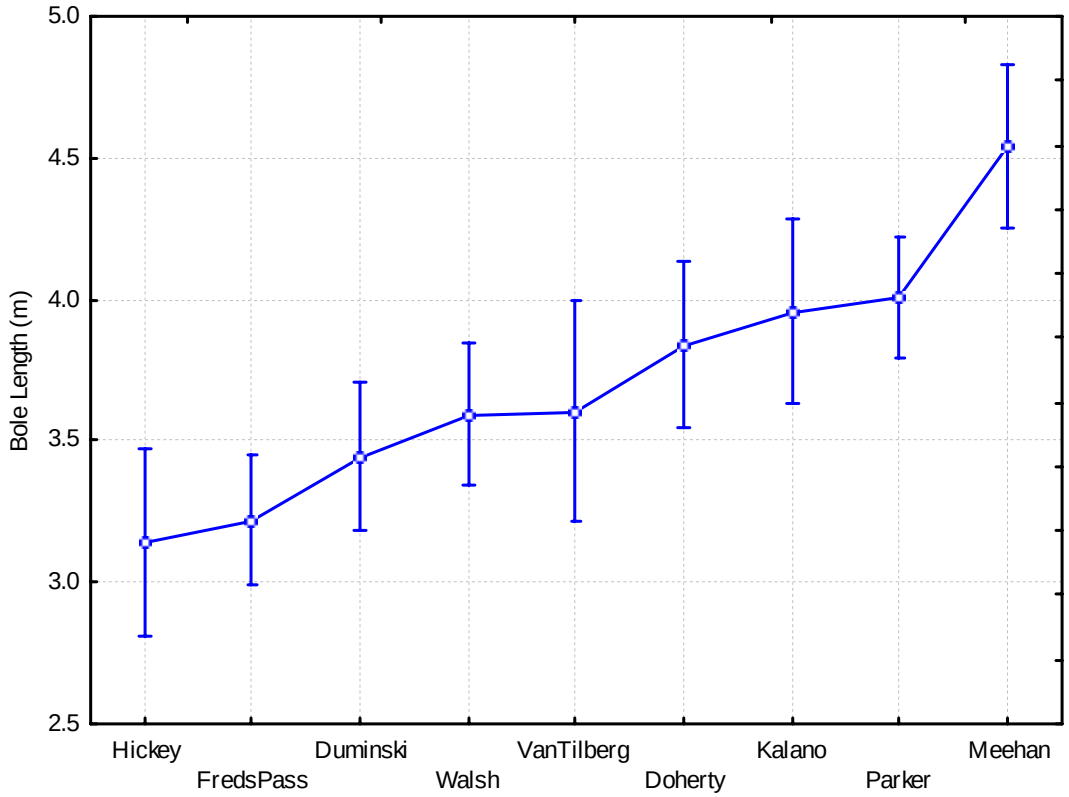

Figure 12. Illustrates the differences in bole length for *K. senegalensis* across sites over 2 years of establishment, 1998/99 and 1999/00.

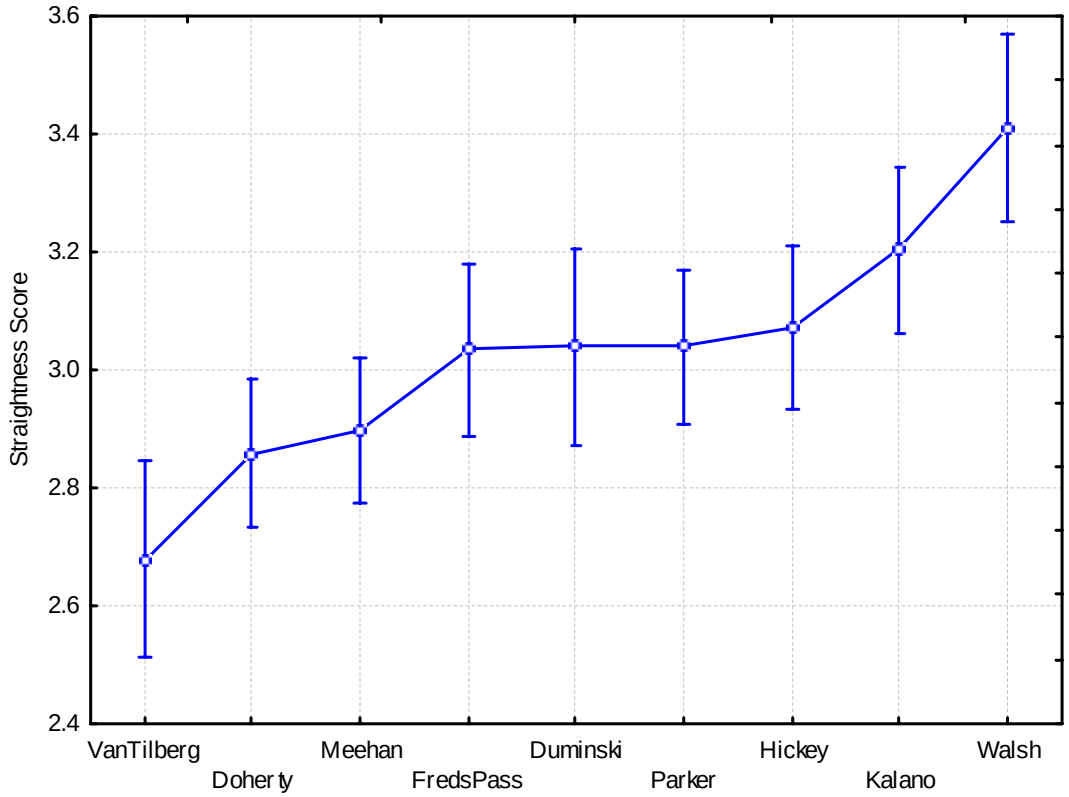

Figure 13. Illustrates the Straightness score assessment for K. senegalensis across all sites measured over 2 years of establishment 1998/99 and 1999/00.

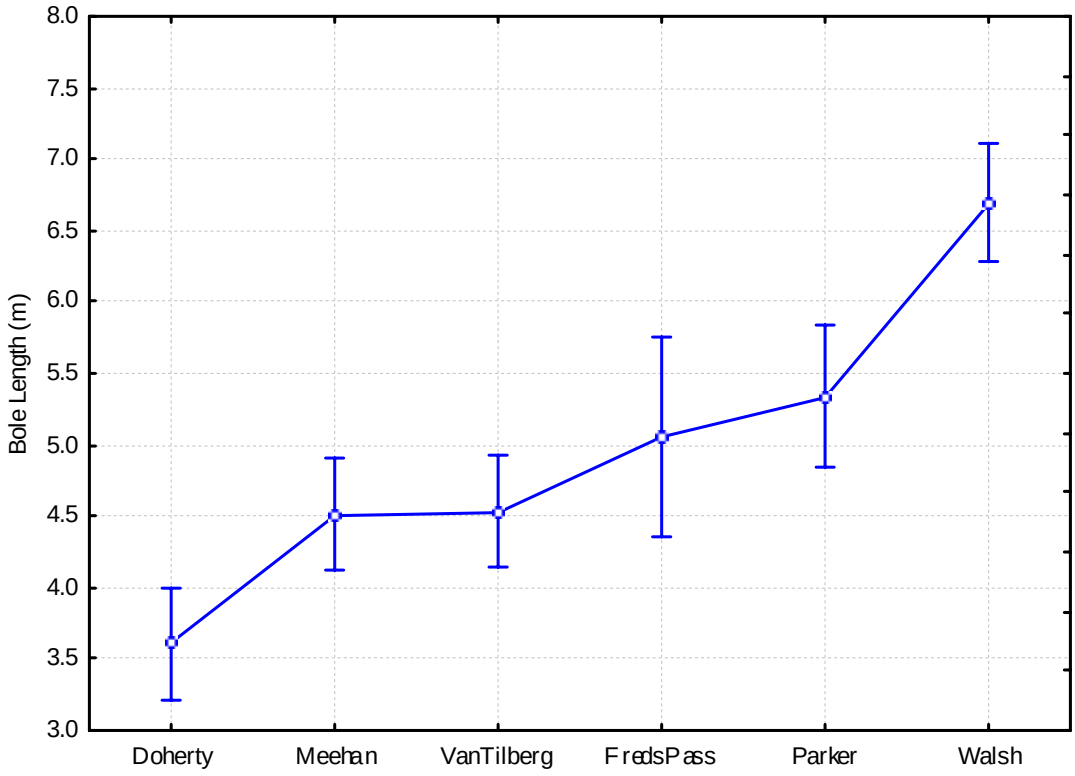

Figure 14. Illustrates the bole length for Teak across sites established in 1999/00.

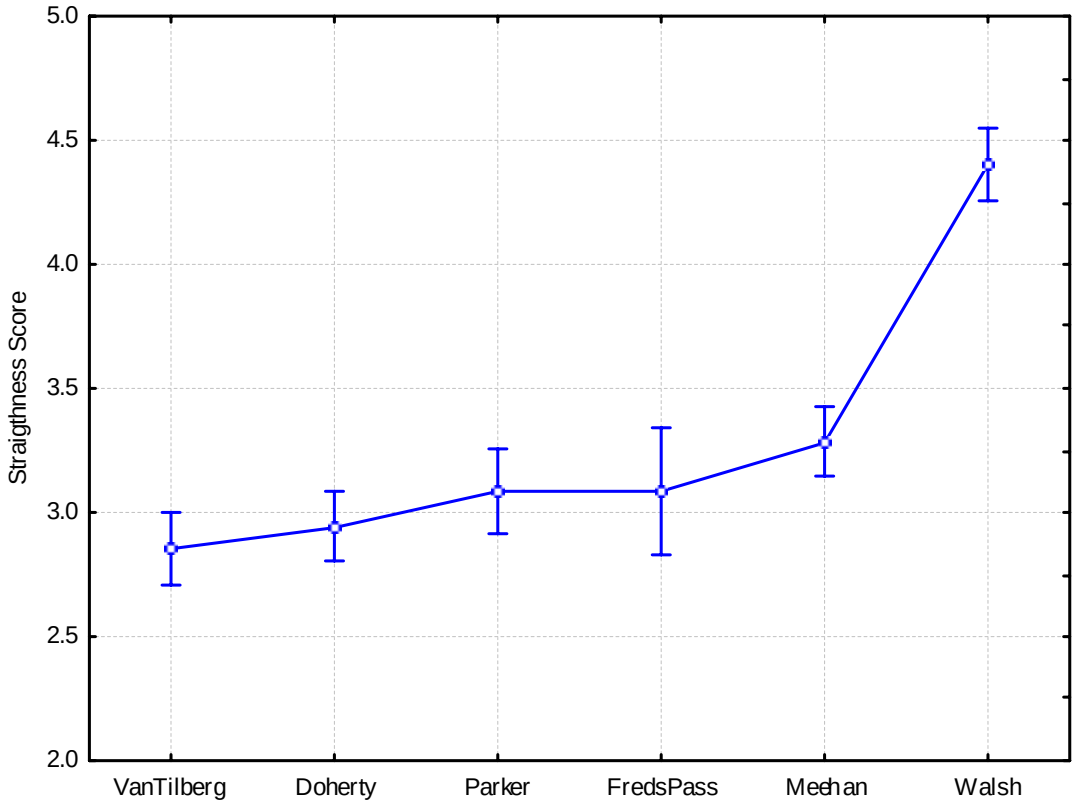

Figure 15. Shows the assessment for Straightness score for Teak across sites established in 1999/00 and indicates the superior performance of the species at the Walsh site near Katherine.

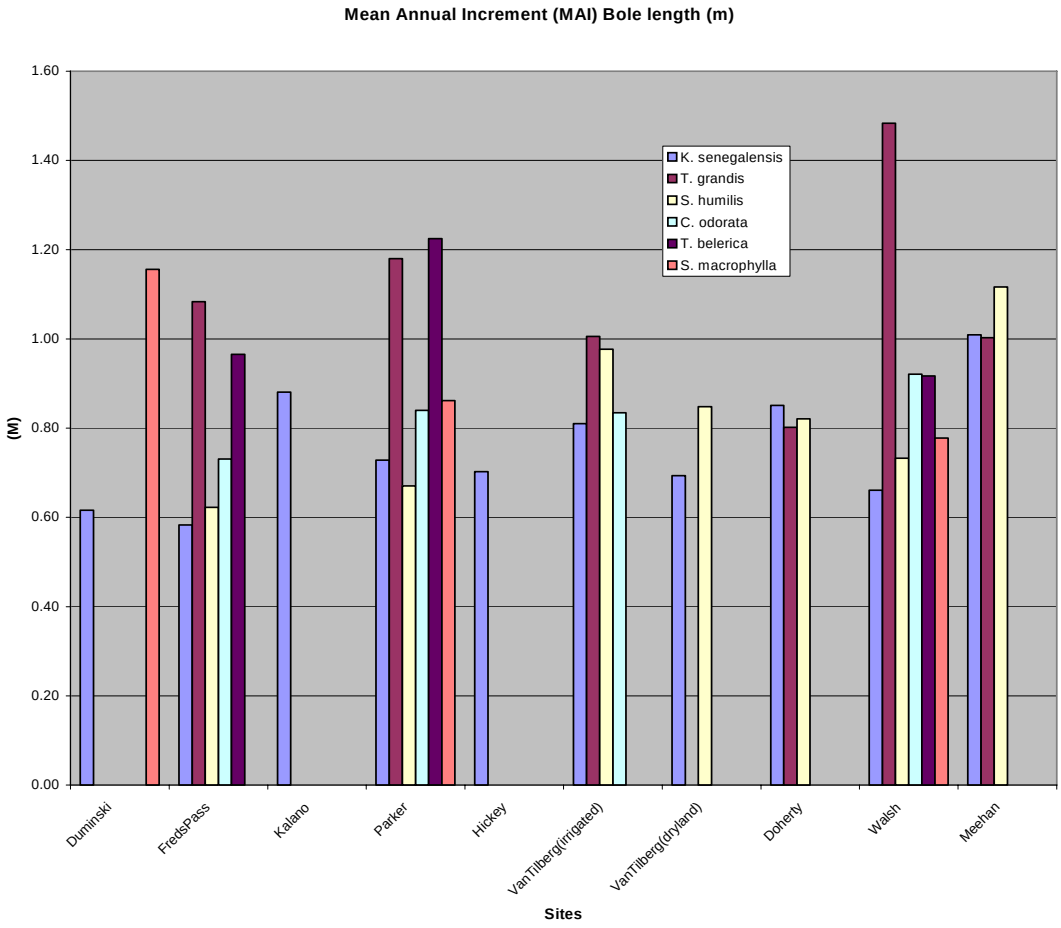

Figure 16. Shows the incremental bole length growth for all species across all sites where measured.