# Evaluation of International Provenance Trials of *Casuarina equisetifolia*

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# Foreword

*Casuarina equisetifolia* is widely grown throughout the tropics. It is a multi-purpose species, providing a range of products and services, from fuelwood to shelter and erosion control.

Australian species often form an important component of agroforestry in developing countries and wider use of this resource can bring assured benefits, especially in the more difficult situations of water stress and other environmental extremes, or where nitrogen accretion, tree fodder production and soil stabilisation are critical.

Some *Casuarina* species grow (often rapidly) over a wide range of sites, including arid and saline areas, many yield excellent firewood and some can be vegetatively propagated. ACIAR has supported projects to identify *Casuarina* species with potential for fuelwood, agroforestry and soil conservation.

The results published in this report have been collected from trials over many years. They reveal a considerable amount of genetic variation between provenances and provide important information for people interested in agroforestry and fuelwood production in the tropics and subtropics.

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Peter Core
Director
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# Contents

# Preface

*Casuarina equisetifolia* is one of the most extensively planted exotic species in a large number of tropical and subtropical areas. It is a true multipurpose species, providing a range of services and products for industrial and local end users. It is of considerable importance for agroforestry systems and reclamation of unstable coastal ecosystems. Its wood has many uses but is renowned for fuel.

Following a recommendation of the Food and Agriculture Organization of the United Nations' (FAO's) Panel of Experts on Forest Gene Resources, range-wide provenance seed collection and provenance trials were coordinated by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Tree Seed Centre. With 37 collaborators from 26 countries involved, it is among the largest international efforts in evaluation of provenance variation within a species. Apart from contributions from collaborating countries, the Australian Agency for International Development (AusAID) and the Australian Centre for International Agricultural Research (ACIAR) provided core funding for most of the activities.

The results of this international collaboration are synthesised in this technical report. It is hoped that the information on provenance performance is useful for all those concerned with the planting of *C. equisetifolia*.

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# Summary

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Tree Seed Centre (ATSC) coordinated a series of 38 international provenance trials of *Casuarina equisetifolia* subsp. *equisetifolia* which was established during 1992–1994 in 20 countries involving 60 seed sources of natural provenances and land races. The origins of these seed sources are categorised into five broad regions, namely:

1. natural distribution in Australia and the Pacific
2. natural distribution in Southeast Asia
3. locations of introductions in Asia
4. locations of introductions in Africa
5. locations of introductions in Central America.

These provenance trials were assessed for 14 growth and morphological characteristics:

- growth
  - height
  - diameter
- stem form
  - axis persistence
  - stem straightness
- branching habit (permanent branches)
  - density
  - thickness
  - angle
  - length
- branching habit (deciduous branchlets)
  - length
  - thickness
- health
  - stem damage
  - foliage damage
- reproduction
  - flowering
  - fruiting.

The collected data were forwarded to the ATSC for processing and after initial perusal of their quality, data from 25 trials were selected for analysis of individual trials and site-by-provenance interaction. Multiple regression analysis was performed to investigate the influence of environmental factors (i.e. latitude, longitude, altitude and rainfall) on provenance behaviour. In addition, a principal component analysis was conducted to determine if there was any pattern in the variation.

The results reveal a considerable amount of genetic variation among provenances and land races of *C. equisetifolia*. There was evidence of a site-by-provenance interaction although it was not as large as what would be expected from a large and diverse number of seed sources. In general, much of the variation between provenances could be better explained by country or provenance-region effects. This was further strengthened by the results obtained from the principal component analysis which revealed a separation between natural provenances from Southeast Asia and Australia/Pacific, and a separation between introduced populations from Asia and Africa.

Based on results at country and regional levels, the following general trends were apparent:

- Natural provenances from Southeast Asia and land races from Asia were generally more vigorous, while natural provenances from the Australia/Pacific region grew slowest. However, a few individual seedlots from Australia/Pacific and Africa were also fast-growing.
- Most seed sources had good axis persistence (i.e. good length of bole) but trees from planted-stand seed sources scored better in terms of stem straightness. The better stem form among the introduced populations could be attributed to recurrent selection of trees of good form in plantations for seed collection.
- Although there were differences in the branching habit among seed sources of *C. equisetifolia*, in general trees were densely branched with horizontally angled branches. These characteristics, together with the fine needle-like branchlets, underline the suitability of its planting for windbreaks in coastal areas.
- Although there was little evidence of any provenance variation in flowering, populations introduced to Asia and Africa appeared to flower more intensively than those from other regions, especially those from the natural distribution range in Australia/Pacific and Southeast Asia.

# 1 Introduction

There are two subspecies of *Casuarina equisetifolia* (L): subsp. *incana* and subsp. *equisetifolia* (Wilson and Johnson 1989). The former is typically a small tree or large shrub, 6–10 m tall, that grows exclusively in Vanuatu and along the coast of Queensland and northern New South Wales in Australia. The latter is a small to large tree (8–35 m tall) that has a wide natural distribution in subtropical and tropical coastlines from northern Queensland and the Northern Territory in Australia, throughout southern Thailand, Malaysia (Peninsular Malaysia, Sabah and Sarawak), the Philippines, Indonesia, Melanesia and Polynesia (see Figure 1). *Casuarina equisetifolia*, in particular subsp. *equisetifolia*, has been introduced into a large number of countries, and is now a common feature of the coastal landscape of most tropical and warm subtropical countries, where it is often naturalised. This report is mainly concerned with subsp. *equisetifolia*, and the following refers to that taxon only.

In its natural range, *C. equisetifolia* is commonly confined to a narrow strip adjacent to sandy coasts, usually from sea level to 100 m above sea level. It is found on sand dunes, in sand alongside estuaries behind foredunes and gentle slopes near the sea. It may be found at the leading edge of dune vegetation, subject to salt spray and inundation with sea water at extremely high tides. Soils are invariably well drained and rather coarse textured, principally sands of 2 m or more in depth. It tolerates both calcareous and slightly alkaline soils and is intolerant of waterlogging.

Within its natural range, the climate is hot humid to subhumid, with no frosts and rainfall between 700 mm and 4000 mm per annum. In most regions, there is a distinct dry season period of 6–8 months, although towards the equator in Southeast Asia and within part of the species' range in Australia, this seasonality decreases and annual rainfall can be as high as 3500 mm.

The form of *C. equisetifolia* in wild populations is very variable, from crooked low-branching trees on exposed seashores to straight-stemmed forest trees in more sheltered situations. The crown is finely branched, with furrowed, needle-like, greyish-green branchlets bearing minute, reduced, teeth-like leaves in whorls of 7–8 per node. Branchlets, 15–38 cm long and <1.0–1.5 mm in diameter, are formed by numerous segments of article each 5–8 mm long. Trees are predominantly dioecious (male and female flowers occurring on separate trees) with a small percentage being monoecious (single-sex male and female flowers on the same tree). Male inflorescences occur on simple, terminal, elongated spikes, 7–40 mm long, borne in whorls with 7–11.5 whorls per cm of spike. Female flowers are cone-shaped, ellipsoid, 5–10 mm long, and borne on lateral woody branches. Fruiting bodies (cones) are 10–24 mm long and 9–13 mm in diameter. The winged seed (samara) is dull brown, 6–8 mm long.

*Casuarina equisetifolia* is a nitrogen-fixing tree of considerable social, economic and environmental importance in tropical/subtropical littoral zones of Asia, the Pacific, Africa and Central America. It is commonly used in agroforestry systems, for soil stabilisation and reclamation, and in coastal protection and rehabilitation (Figure 2). The wood is dense, and makes very good fuelwood and charcoal as well as timber for general construction. It is one of the most extensively introduced tree species outside its natural range, especially into southern China, India, Vietnam,

East, West and North Africa, Central and South America, the Caribbean and many Middle Eastern countries. Some of the early introductions, such as those to India and Vietnam, date back more than a century (Kondas 1983; Ha and Le 1996). There are 300,000 ha of *C. equisetifolia* plantations in southern China (Zhong and Bai 1996), 500,000 ha in India (M. Paramathma 1998, pers. comm.) and 120,000 ha in Vietnam (Ha and Le 1996). The genetic background of the planting material is generally unknown. Marked variation in growth and branching habit between different populations has been observed (Pinyopusarerk and House 1993).

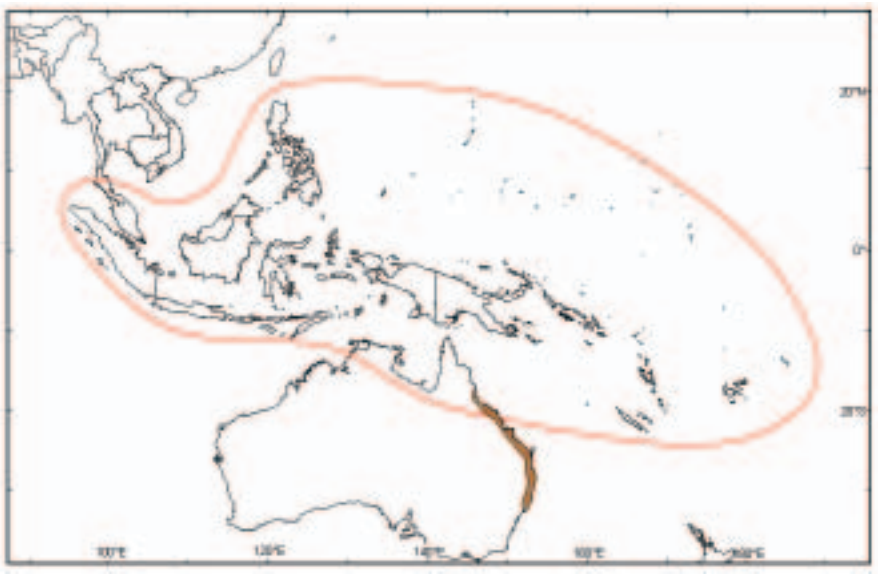

**Figure 1.** Natural distribution of *Casuarina equisetifolia* subsp. *equisetifolia* (red line) and subsp. *incana* (brown shading).

*Casuarina equisetifolia* has been given among the highest priorities with regard to genetic sampling and assessment by the Food and Agriculture Organization of the United Nations' (FAO's) Panel of Experts on Forest Gene Resources. The Second International Casuarina Workshop held in Cairo, Egypt, in January 1990 recommended an international collaborative effort be made to undertake a comprehensive collection of seed from the full range of both natural and derived occurrence (El-Lakany et al. 1991). Following that recommendation, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) Australian Tree Seed Centre (ATSC) coordinated a range-wide provenance seed collection during 1991–1993, focusing on the subspecies *equisetifolia*, with financial support from the Australian International Development Assistance Bureau (AIDAB), now the Australian Agency for International Development (AusAID). More than 30 forest departments and research institutions in Asia, the Pacific, Central America and Africa assisted in the collections. Following the collections, seed was distributed for establishment of replicated trials in the tropical zone of many countries. Field establishment followed a common guideline (Pinyopusarerk and Chandler 1992), while an assessment

manual was provided for field measurements (Pinyopusarerk et al. 1995). Apart from height and diameter, other characteristics such as stem form, branching habit, health and reproduction were included in the measurements. Early results of a small number of these trials were reported at the Third International Casuarina Workshop held in Vietnam in 1996 (Pinyopusarerk et al. 1996). While growth differed from site to site following prevailing local environment conditions, there were clear differences between provenances in most of the growth parameters measured. There were also differences in the provenance ranking, indicating possible provenance and environment interaction.

**Figure 2.** Coastal planting of *Casuarina equisetifolia* in southern Thailand.

While results have been reported for some of the individual trials by collaborators, the ATSC has used data from selected trials to determine the magnitude of site-by-provenance interaction. This report discusses overall patterns of provenance performance in individual trials and an overall analysis across sites of selected trials.

# 2 Seed Collection and Distribution

## 2.1 Seed collection

The aim of the collection was to obtain a broad representation of the species from throughout the species' natural occurrence and locations of introductions. During 1991–1993, a total of 67 seedlots were collected in 21 countries both within and outside the species' natural distribution range. Most seedlots included seed from 10 or more parent trees, but some had less because of the small population size.

The origins of these seedlots can be categorised into five broad regions:

1. natural distribution in Australia and the Pacific (15 seedlots)
2. natural distribution in Southeast Asia (16 seedlots)
3. locations of introductions in Asia (18 seedlots)
4. locations of introductions in Africa (15 seedlots)
5. locations of introductions in Central America (3 seedlots).

The locations of these collections are shown in Figure 3, and details of the provenance origins are given in Table 1. Note that two seedlots from Vanuatu and Tonga are designated as numbers 12 and 12a. The main reason is to keep the provenance numbers in line with those used in an early report of a trial planted in northern Australia (Pinyopusarerk and Williams 2000).

All seed from the collections was sent to the CSIRO Australian Tree Seed Centre in Canberra for registration, storage, viability testing and subsequent dispatch to collaborators for trial establishment.

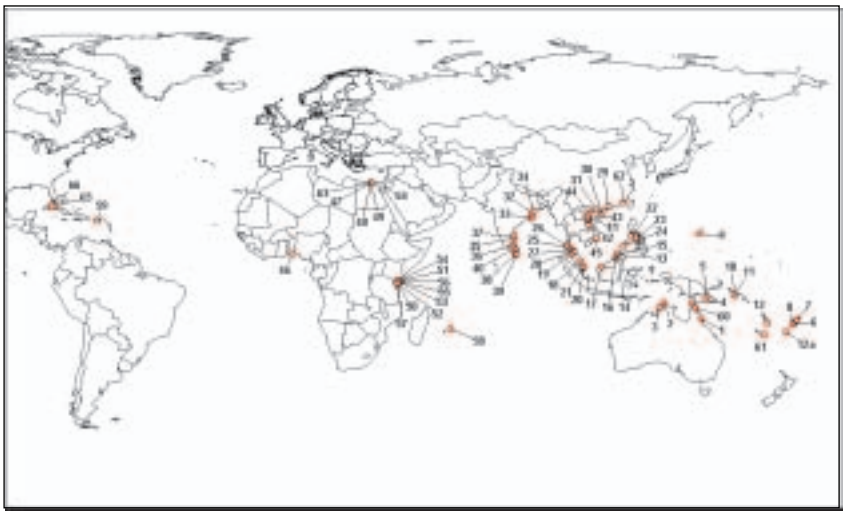

**Figure 3.** Locations of seed collections of *Casuarina equisetifolia.*

**Table 1.** Results of international seed collection of *Casuarina equisetifolia*.

| Prov. no. | CSIRO seedlot no. | Provenance name | Country | Latitude (° ') | Longitude (° ') | Altitude (m) | Rainfall (mm) | No. of parents |
|---|---|---|---|---|---|---|---|---|
| 1 | 15958 | Wangetti Beach, Queensland | Australia | 16 41 S | 145 34 E | 30 | 3100 | 36 |
| 2 | 16166 | Danger Point, Northern Territory | Australia | 11 07 S | 132 20 E | 10 | 1300 | 5 |
| 3 | 18008 | Darwin, Northern Territory | Australia | 12 25 S | 130 50 E | 20 | 1500 | 11 |
| 4 | 18378 | Prince of Wales Island, Northern Territory | Australia | 10 45 S | 142 08 E | 1 | 1500 | 10 |
| 5 | 18153 | Ela Beach | Papua New Guinea | 9 05 S | 147 17 E | 10 | 1100 | 5 |
| 6 | 18270 | Baravi, Viti Levu | Fiji | 18 11 S | 177 35 E | 106 | 2200 | 10 |
| 7 | 18271 | Wainunu, Vanua Levu | Fiji | 16 50 S | 178 49 E | 30 | 2300 | 10 |
| 8 | 18272 | Sigatoka, Viti Levu | Fiji | 18 10 S | 177 29 E | 24 | 2400 | 10 |
| 9 | 18121 | Mariana Island | Guam | 13 20 N | 144 40 E | 2 | 2400 | – |
| 10 | 18402 | Kolombangara | Solomon Islands | 8 07 S | 157 08 E | 2 | 3500 | 11 |
| 11 | 18403 | Gizo | Solomon Islands | 8 07 S | 156 54 E | 2 | 3500 | 10 |
| 12 | 18312 | Efate | Vanuatu | 17 45 S | 168 18 E | 30 | 2400 | 4 |
| 12a | 18040 | Onetaka | Tonga | 21 04 S | 175 04 E | 1 | 1800 | 10 |
| 13 | 18157 | Pantai Moyog, Kota Kinabalu, Sabah | Malaysia | 5 55 N | 116 05 E | 2 | 2600 | 2 |
| 14 | 18158 | Tanjung Aru, Kota Kinabalu, Sabah | Malaysia | 5 55 N | 116 05 E | 2 | 2600 | 2 |
| 15 | 18160 | Pantai Dalit, Tuaran, Sabah | Malaysia | 6 12 N | 116 12 E | 5 | 2600 | 3 |
| 16 | 18161 | Pantai Menintaman, Sabah | Malaysia | 5 02 N | 115 32 E | 40 | 2600 | 3 |
| 17 | 18244 | Bako National Park, Sarawak | Malaysia | 1 44 N | 110 30 E | 50 | 4000 | 4 |
| 18 | 18348 | Kuantan, Pahang | Malaysia | 3 48 N | 103 20 E | 30 | 2900 | 11 |
| 19 | 18374 | Langkawi Island, Kedah | Malaysia | 6 19 N | 99 51 E | 30 | 2600 | 10 |
| 20 | 18375 | Desaru, Johor | Malaysia | 1 30 N | 104 17 E | 15 | 2600 | 4 |
| 21 | 18376 | Tanjong Balau, Johor | Malaysia | 1 36 N | 104 16 E | 15 | 2600 | 4 |

**Table 1.** (cont'd) Results of international seed collection of *Casuarina equisetifolia*.

| Prov. no. | CSIRO seedlot no. | Provenance name | Country | Latitude (° ') | Longitude (° ') | Altitude (m) | Rainfall (mm) | No. of parents |
|---|---|---|---|---|---|---|---|---|
| 22 | 18117 | San Jose, Mindoro | Philippines | 12 25 N | 121 03 E | 20 | 2100 | 10 |
| 23 | 18154 | Aklan, Panay Island | Philippines | 11 55 N | 122 23 E | 30 | 2000 | 10 |
| 24 | 18357 | Narra, Palawan | Philippines | 9 19 N | 118 29 E | 10 | 2500 | 10 |
| 25 | 18296 | Ban Bangsak, Phangnga | Thailand | 8 46 N | 98 16 E | 5 | 4000 | 18 |
| 26 | 18297 | Ban Kamphuam, Ranong | Thailand | 9 21 N | 98 27 E | 10 | 3000 | 18 |
| 27 | 18298 | Had Chaomai, Trang | Thailand | 7 33 N | 100 37 E | 2 | 1600 | 21 |
| 28 | 18299 | Had Samira, Songkhla | Thailand | 7 09 N | 100 37 E | 2 | 1900 | 8 |
| 29 | 18267 | Yanjing, Guangdong | China | 23 00 N | 113 03 E | 4 | 1500 | 12 |
| 30 | 18268 | Daodong, Hainan | China | 19 58 N | 110 59 E | 10 | 1700 | 20 |
| 31 | 18586 | Beihai, Guangxi | China | 21 35 N | 109 00 E | 2 | 1500 | 11 |
| 32 | 18013 | Kujang, Cuttack, Orissa | India | 20 12 N | 86 38 E | 7 | 1400 | 10 |
| 33 | 18014 | Haingara, Balukhand, Orissa | India | 18 50 N | 85 53 E | 10 | 1400 | 12 |
| 34 | 18015 | Chandipur, Balasore, Orissa | India | 21 30 N | 86 54 E | 2 | 1600 | 10 |
| 35 | 18118 | South Arcot, Tamil Nadu | India | 11 42 N | 79 44 E | 40 | 1400 | 10 |
| 36 | 18119 | Rameswaram, Tamil Nadu | India | 9 15 N | 79 20 E | 5 | 900 | 13 |
| 37 | 18120 | Chengai Anna, Tamil Nadu | India | 12 36 N | 79 48 E | 50 | 1200 | 10 |
| 38 | 18286 | Weligama | Sri Lanka | 6 00 N | 80 16 E | 10 | 1500 | – |
| 39 | 18287 | Hambantota | Sri Lanka | 6 08 N | 81 07 E | 16 | 1000 | – |
| 40 | 18288 | Madagama | Sri Lanka | 8 06 N | 80 15 E | 80 | 1200 | – |
| 41 | 18085 | Cua Loc, Nghi Loc, Nghe An | Vietnam | 18 24 N | 105 48 E | 5 | 1900 | 5 |
| 42 | 18086 | Non Nuoc, Da Nang | Vietnam | 16 06 N | 106 20 E | 2 | 1900 | 8 |
| 43 | 18127 | Thach Lien, Ha Thinh | Vietnam | 18 44 N | 105 45 E | 2 | 2600 | 8 |
| 44 | 18128 | Hai Thinh, Ha Nam Ninh | Vietnam | 20 22 N | 106 21 E | 2 | 2000 | 8 |

**Table 1.** (cont'd) Results of international seed collection of *Casuarina equisetifolia*.

| Prov. no. | CSIRO seedlot no. | Provenance name | Country | Latitude (° ') | Longitude (° ') | Altitude (m) | Rainfall (mm) | No. of parents |
|---|---|---|---|---|---|---|---|---|
| 45 | 18152 | Ninh Chu, Ninh Thuan | Vietnam | 11 33 N | 108 59 E | 2 | 700 | 9 |
| 46 | 18355 | Cotonou | Benin | 6 24 N | 2 31 E | 8 | 1300 | 15 |
| 47 | 18122 | Montazah | Egypt | 31 16 N | 30 05 E | 13 | 200 | 10 |
| 48 | 18125 | Maa'mora | Egypt | 31 13 N | 29 55 E | 15 | 200 | 9 |
| 49 | 18126 | Agamy | Egypt | 31 13 N | 29 45 E | 9 | 200 | 10 |
| 50 | 18134 | Kenyatta Beach | Kenya | 4 00 S | 39 00 E | 10 | 1000 | 10 |
| 51 | 18135 | Malindi | Kenya | 3 15 S | 40 09 E | 7 | 900 | 10 |
| 52 | 18136 | Diani | Kenya | 4 17 S | 39 35 E | 10 | 1000 | 10 |
| 53 | 18137 | Watamu | Kenya | 3 19 S | 39 17 E | 12 | 900 | 10 |
| 54 | 18141 | Robinson Island | Kenya | 2 58 S | 40 10 E | 2 | 1000 | 7 |
| 55 | 18142 | Kilifi | Kenya | 3 38 S | 39 51 E | 20 | 1000 | 10 |
| 56 | 18143 | Gede | Kenya | 3 20 S | 40 01 E | 15 | 900 | 12 |
| 57 | 18144 | Baobab | Kenya | 4 00 S | 39 06 E | 25 | 1000 | 25 |
| 58 | 18565 | Isle d'Ambre | Mauritus | 20 03 S | 57 39 E | 2 | 1700 | 4 |
| 59 | 18752 | Rio Piedres | Puerto Rico | 18 00 N | 66 00 W | 20 | 1800 | – |
| 60 | 18345 | Chili Beach, Queensland | Australia | 12 39 S | 143 25 E | 1 | 1400 | 11 |
| 61 | 18383 | Isle of Pines | New Caledonia | 22 06 S | 167 05 E | 2 | 3000 | 2 |
| 62 | 18269 | Xiamen, Fujian | China | 24 24 N | 118 06 E | 50 | 1500 | 16 |
| 63 | 18123 | Victoria College | Egypt | 31 13 N | 29 55 E | – | 200 | 4 |
| 64 | 18124 | Alda Beach | Egypt | 31 16 N | 30 05 E | – | 200 | 10 |
| 65 | 19553 | Villa Clara | Cuba | 23 00 N | 80 30 W | 60 | 1500 | 12 |
| 66 | 19554 | Matanzas | Cuba | 23 04 N | 81 35 W | 20 | 1600 | – |

Note: Provenance numbers 60–66 were not included in the international provenance trials.

## 2.2 Seed distribution

Although 67 seedlots was collected, only 60 were distributed for planting in this series of trials. The 60 seedlots that were planted were numbered from 1 to 59 including 12a, as shown in Table 1. Numbers 60 to 66 were not included in these trials because they were either obtained late or had insufficient seed. A few seedlots were found to have very low viability.

The distribution of seed commenced in 1992, with the majority of the distribution taking place in 1993. Invitations to participate in the internationally coordinated trials were sent to all organisations which had assisted in the seed collection as well as those who were active in casuarina research and development. By the end of 1994, more than 40 subsets of the seed were dispatched to 37 forestry agencies in 26 countries. Most recipients obtained a common set of 28 seedlots representing the main geographical origins of the seed. The largest subset of 59 seedlots was supplied to a collaborator in northern Australia.

# 3 Trial Establishment

The first series of field trials was established in 1992, followed by the majority of trials in 1993 and some additional trials in 1994. Guidelines for establishment, maintenance and initial measurement were provided to collaborators to ensure standardisation across many trial collaborators and countries. For the majority of these trials, randomised complete block designs were used with four replicates, plot size of 25–36 trees, and planting distance of 2 2 m. In a few cases, latinised row–column designs were used.

Despite a generous quantity of seed for each provenance being dispatched to trial collaborators, varying skills in nursery operations resulted in some seedlots having too few seedlings for planting in some trials. In some cases, some provenances were either not represented in all four replicates or not planted at all. The majority of the trials reported were represented by more than 20 seed sources from all provenance regions.

Collaborators were requested to provide the following information for each trial:

- contact details
- location
- soil and climate
- management history
- trial layout.

By 1995, up to 38 trials in 20 countries were confirmed established. Some of these trials were, however, discontinued after only one or two growing seasons due to poor survival or damage by fire.

**Figure 4.** Locations of provenance trials included in this report.

**Table 2.** Geographical details of international provenance trials of *Casuarina equisetifolia.*

| Trial no. | Trial location | Soil details | Mean annual rainfall (mm) | Mean annual temp (°C) | Latitude (° ') | Longitude (° ') | Altitude (m) |
|---|---|---|---|---|---|---|---|
| IPT-01 | Weipa, Australia | Loam, pH 6–7 | 2000 | 28 | 12 36 S | 141 50 E | 6 |
| IPT-02 | Ratchaburi, Thailand | Sandy, pH 5 | 1100 | 29 | 13 20 N | 99 29 E | 160 |
| IPT-03 | Lad Krathing, Thailand | Light clay, pH 4.5-6 | 1300 | 28 | 13 42 N | 101 06 E | 80 |
| IPT-04 | Yangxi, China | Sand to loamy sand, pH 6–7.5 | 2290 | 23 | 21 48 N | 111 41 E | 1 |
| IPT-05 | Dongshan, China | Deep sand to loamy sand pH 5.8 | 950 | 21 | 23 40 N | 117 28 E | 4 |
| IPT-06 | Syh-hu, Taiwan | Sandy, pH 6–7.5 | 1010 | 23 | 23 40 N | 120 08 E | 10 |
| IPT-07 | Balukhanda, Orissa, India | Deep sand to loamy sand, pH 6–7.5 | 1420 | 33 | 19 53 N | 85 53 E | 10 |
| IPT-08 | Neyveli, Tamil Nadu, India | Deep loam, pH 6.5 | 1000 | 33 | 11 30 N | 79 30 E | 300 |
| IPT-09 | Beraliyakanda, Sri Lanka | Red gravel, pH 4.5–6 | 2200 | 30 | 06 16 N | 80 09 E | 60 |
| IPT-10 | Nghe An, Vietnam | Loamy sand, pH 4.5–6 | 1940 | 24 | 18 44 N | 105 45 E | 2 |
| IPT-11 | Sam Son, Vietnam | Loamy sand, pH 4.5–6 | 2540 | 26 | 15 36 N | 108 30 E | 2 |
| IPT-12 | Gede, Kenya | Loamy sand, pH 6–7 | 940 | 28 | 03 15 S | 39 35 E | 55 |
| IPT-13 | La Soledad, Honduras | Deep sandy loam, pH 7.2 | 880 | 25 | 14 27 N | 87 42 W | 640 |
| IPT-14 | Santa Rosa, Honduras | Deep loamy sand, pH 5.2 | 2500 | 26 | 13 10 N | 87 10 W | 100 |
| IPT-15 | Madang, PNG | Loamy sands, pH 6–7.5 | 3220 | 30 | 05 01 S | 145 59 E | 5 |
| IPT-16 | Kuiburi, Thailand | Sandy loam, pH 7.3 | 1180 | 27 | 12 05 N | 99 36 E | 30 |
| IPT-17 | Takuapa, Thailand | Loamy sand, pH 4.5–6 | 3600 | 27 | 08 46 N | 98 16 E | 15 |
| IPT-18 | Sai Thong, Thailand | Sandy, pH 6–7.5 | 1500 | 27 | 11 25 N | 99 27 E | 50 |
| IPT-19 | Lakkihalli, Karnataka, India | Sandy loam to clay loam, pH 5.3 | 700 | 26 | 13 12 N | 76 24 E | 930 |
| IPT-20 | Pondicherry, India | Deep clay loam, pH 5.9 | 1500 | 27 | 11 59 N | 79 50 E | 300 |
| IPT-21 | Tandojam, Pakistan | Clay, pH >7.5 | 200 | 30 | 25 24N | 68 31 E | 28 |
| IPT-22 | Pothukulama, Sri Lanka | Very deep sandy loam, pH 6–7.5 | 1250 | 30 | 07 42 N | 79 55 E | 27 |
| IPT-23 | Ratmalagara, Sri Lanka | Sandy, pH 6–7.5 | 1630 | 32 | 07 31 N | 79 54 E | 2 |
| IPT-24 | South Tahrir, Egypt | Coarse sand with calcareous outcrops | <50 (irrigated) | 27 | 30 30 N | 29 30 E | 50 |
| IPT-25 | Muthundu, Malawi | Deep sand, pH 7 | 1000 | 24 | 14 29 S | 35 15 E | 600 |

The physical and climatic conditions of these trials varied greatly, with altitude ranging from 1 m to more than 900 m, and mean annual rainfall as low as <50 mm (a site requiring irrigation) to as high as 3600 mm. Table 2 provides information on locality, climate and soil conditions of 25 trials established in 13 countries which have been included in this report. The locations of these provenance trials are indicated in Figure 4.

# 4 Selection of Traits for Assessment

The earlier guidelines on trial establishment advised collaborators on measurement of height and diameter growth only. Observations of the progress in some trials revealed obvious differences among provenances in both growth and several morphological characteristics. Subsequently, an assessment procedure was developed to include, apart from height and stem diameter, a number of qualitative traits such as stem form and branching habit (Pinyopusarerk et al. 1995). Classification and scoring techniques were applied to characteristics which could not be measured quantitatively. This assessment as a whole summarises the quality of individual trees. A data-recording form was constructed so that the data could be transferred to a computer, processed and analysed.

The following summarises the assessment procedure for the 14 growth traits measured.

## 4.1 Quantitative traits

Height and diameter at breast height were the only two quantitative traits included in the assessment.

***Height*** (***Ht***) referred to the total tree height. If there was more than one stem per tree, only the tallest was measured. Height was measured to the nearest 0.1 m.

***Diameter at breast height (Dbh)*** was defined as the stem diameter taken at 1.3 m from ground level and was measured to the nearest 0.1 cm.

For forking trees or trees with multiple leaders, *Dbh* was measured on all stems 1.3 m above ground level. A branching leader was considered a stem if its diameter was equal to or greater than half of the diameter of the principal leader at the same height. The diameter, equivalent to that of a single stem with the same cross-sectional area, was calculated using the formula:

$$Dbh = (d_1^2 + d_2^2 + \ldots + d_n^2)^{1/2} \quad (1)$$

where $d_1$, $d_2$,…,$d_n$ were the diameters of the stems measured at 1.3 m above ground level.

## 4.2 Qualitative traits

These were characteristics where quantitative measurements were either not possible or too time-consuming to make. The variability of such characteristics was recorded by visual classification. The number of classes varied between characteristics, depending on the extent of variation within each characteristic. Twelve qualitative characteristics were assessed, reflecting stem form, branching habit, health and reproduction.

### 4.2.1 Stem form

***Axis persistence (Axpst)***. This characteristic explained the ability of the tree to retain its primary stem axis. From a utilisation point of view, the longer the main axis, the higher the quality of the resulting log.

Axis persistence was categorised into six classes. The total height of the tree was divided into four equal parts (Figure 5). The length of the unbroken axis was scored according to the quarter section to which it could be followed. In addition, classes at the beginning and the end of the scale respectively were incorporated. The score in each class was as follows:

1 = double or multiple stems from ground level
2 = axis loses persistence in the first (lowest) quarter of the tree
3 = axis loses persistence in the second quarter of the tree
4 = axis loses persistence in the third quarter of the tree
5 = axis loses persistence in the fourth quarter of the tree
6 = complete persistence.

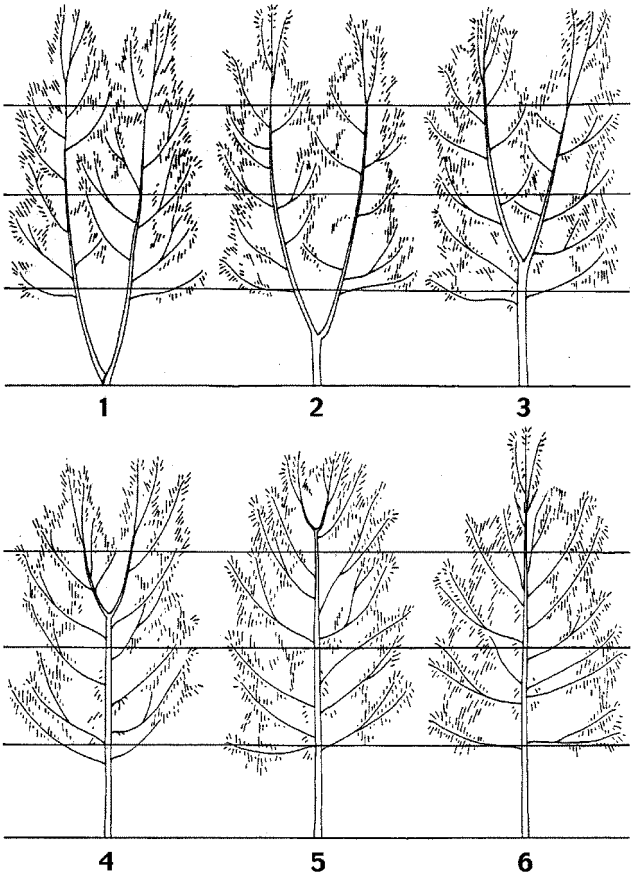


**Figure 5.** Guidelines for recording axis persistence.

***Stem straightness (Strst)***. This characteristic was recorded only for the trees that scored 4–6 in axis persistence. In scoring this characteristic, we first looked at whether the stem was vertical and then the number of bends, if any. A stem was considered not vertical if its main axis deviated from the imaginary vertical line; the deviation might be at any point between the first and third quarters of total height. The deviation or bend at the tip of the stem was ignored. There were six classes as follows:

1 = not vertical with more than two bends
2 = roughly vertical with more than two bends
3 = not vertical with one to two bends
4 = roughly vertical with one to two bends
5 = roughly vertical and straight
6 = completely vertical and straight.

### 4.2.2 Branching habit

Two types of branches were assessed, permanent branches and deciduous branchlets. Permanent branches referred to first-order branches that originated from the main stem, while deciduous branchlets were the needle-like foliage that originated from either the first- or second-order branches.

*Permanent branches* were scored for four characteristics.

***Density (Denpb)***, four classes:
1 = very high — regular branching with internode length around 15 cm
2 = high — irregular branching with internode length mainly around 15 cm
3 = low — irregular branching with internode length mainly around 30 cm
4 = very low — sparse branching with internode length generally >30 cm.

***Thickness (Thkpb)***, four classes:
1 = very heavy — more than three branches, diameter > one-third of adjacent stem
2 = heavy — one to three branches, diameter > one-third of adjacent stem
3 = light — branch diameter up to one-third of adjacent stem
4 = very light — branch diameter < one-quarter of adjacent stem and uniform.

***Angle (Angpb)***, two classes:
1 = branch angle <60° (upright)
2 = branch angle >60° (horizontal).

***Length (Lenpb)***, two classes:
1 = long — generally > one-quarter of total height
2 = short — generally < one-quarter of total height.

*Deciduous branchlets* were scored according to two characteristics.

***Length (Lendb)***, two classes:
1 = long — generally >15 cm
2 = short — generally <15 cm.

***Thickness (Thkdb)***, two classes (a template was provided to trial collaborators for this characteristic):

1 = coarse
2 = fine.

### 4.2.3 Health

Stem and foliage were simply assessed as healthy or unhealthy. Damage was normally caused either by insects or diseases. We excluded damage caused by machinery or fire.

***Stem damage (Stmhe)***, two classes:
1 = yes
2 = no.

***Foliage damage (Folhe)***, two classes:
1 = yes
2 = no.

### 4.2.4 Reproduction

The presence of flowers, and sex expression and fruiting bodies (cones), were recorded as follows:

***Flowering (Flwre)***, two classes:
1 = yes
2 = no.

***Fruiting (Frtre)***, two classes:
1 = yes
2 = no.

## 4.3 Trial assessment

Collaborators were responsible for measurement of field trials following the guidelines provided by ATSC. Trial data were forwarded to ATSC for processing and statistical analysis. Of 38 trials established, 28 were fully assessed according to the assessment procedure described above. The remaining trials were assessed on height and diameter growth only.

Not all the trials assessed are reported here. Some were excluded due to incomplete data collection or discrepancies between layout and field data which could not be clarified.

The age at which the assessments were carried out varied between trials. The youngest of the trials reported here was 12 months and the oldest was 48 months. This prevents direct comparison between trials on some traits, such as height and diameter growth, but it does not affect evaluation of provenance differences or site-by-provenance interaction.

# 5 Data Analysis

## 5.1 Data processing

Data processing was a lengthy process. Some collaborators supplied data in the recording sheets which needed to be transferred into Microsoft Excel files. After receiving the data, our first task was to check the data to ensure that they corresponded to the planting layout. Very often, data were supplied without a planting layout or the supplied data did not match the layout. In these situations, it was necessary to ask collaborators to send layouts or clarify the discrepancies.

All data sets were transferred into Microsoft Excel file format in either of the following two structures, depending on the experimental design employed in the planting:

- data structure for trials established using randomised block designs
  *Replicate – Plot No. – Tree No. – CSIRO Seedlot No. – Variates*
- data structure for trials established using latinised row–column designs
  *Replicate – Row – Column – Tree No. – CSIRO Seedlot No. – Variates.*

The CSIRO-developed computer software, DataPlus (Williams et al. 2000), was then used to process experimental data and generate plot means, variances and counts (for automatic calculation of survival percentage) for analysis of the data by the statistical package GenStat (GenStat 2002). The use of DataPlus for data processing also ensured that incorrect treatment allocation and outlying values for variates outside of pre-specified data ranges were detected before we proceeded to the statistical analysis.

Following the screening and processing of the trial data, there were 14 trials from nine countries for which we had both quantitative and qualitative data. Data on height (*Ht*) for an extra 11 trials and on diameter at breast height (*Dbh*) for seven trials from seven countries were also available for analysis. In total, data from 25 trials (see details in Table 2) were analysed for this report.

## 5.2 Individual sites

Simple analysis of variance was used for the trials laid out as randomised complete block designs. In this analysis, the plot mean from each site was modelled as consisting of an overall mean, a component for the particular replicate the plot is in, a component for the particular provenance which is on the plot, and a residual or remainder term, i.e.

(plot mean) = (overall mean) + (replicate effect) + (provenance effect) + (residual)

or symbolically

$$Y_{ij} = \quad + \ _i + \ _j + \ _{ij} \qquad (1)$$

where the $Y_{ij}$ ($i$ = 1,2,...,$r$; $j$ = 1,2,…,$v$) are the plot means; is a parameter for the overall mean; the $_i$ ($i$ = 1,2,...,$r$) are parameters for $r$ replicates; the $_j$ are parameters

for $v$ provenances; and the $_{ij}$ are the residuals in the model, i.e. what is left over from the proposed model. By making the assumption that the $_{ij}$ are distributed according to the normal distribution with zero mean and variance $^2$, it is possible to test the significance of provenance differences using analysis of variance (ANOVA). DataPlus generated GenStat code for these analyses. The ANOVA command in GenStat was used to perform the analyses on all the quantitative and qualitative plot means. The plot survivals and the log-transformed plot variances were also analysed; significant differences between provenances for the analysis of plot variances would tell us that the seedlings from some of the provenances are more variable than others.

For the trials laid out as latinised row–column designs, mixed-model analysis was carried out. Here the plot means were modelled as

$$Y_{ij} = \quad + \quad _i + \quad _g + \quad _j + \quad _{ij}$$

where the $_g$ ($g$ = 1,2,…$s$) are parameters for the $s$ long columns in the latinised design and the $_{ij}$ are correlated random effects made up of components for rows within replicates, columns within replicates and the residuals. Hence, the random part of the mixed model is more complicated than for the randomised complete block design since we have to estimate variance components for both the rows and columns within replicates. But the inclusion of these terms in the model can reduce the size of the residuals considerably and therefore give us a much better fit to the data and more chance to detect significant differences between provenances if they exist. DataPlus was used to generate GenStat code for the residual maximum likelihood analysis of the mixed model.

The provenances were grouped into countries and regions as detailed in Table 1. Hence, the provenance effects in Equation 1, above, could be sub-modelled into effects for regions and countries within regions as follows:

$$_j = \quad _k + \quad _{km} + \quad _{kmj}$$

where the $_k$ are effects for each region ($k$ = 1,2,3,4), $_{km}$ are effects for the countries within each region ($m$ = 1,2,…,18) and the $_{kmj}$ are effects for the provenances within each country. DataPlus was used to generate GenStat code to carry out the analysis of variance to partition the estimated provenance means into variation between provenances within countries and countries within regions. Estimated provenance means from the individual site analyses were assembled into two-way tables of sites by provenances for each of the 14 traits plus survival.

The grouping of provenances into countries and regions facilitates determination of provenance variation for a given trait at different levels. The following scenarios may arise from the above separate analyses:

a. no significant differences between either provenances, countries or regions
b. no significant differences between provenances, but significant between countries and regions
c. no significant differences between provenances or between countries, but significant between regions
d. no significant differences between provenances or between regions, but significant between countries

e. significant differences are found on provenance, country, and regional levels

f. significant differences between provenances, but not between countries and regions

g. significant differences between provenances and between countries, but not between regions

h. significant differences between provenances and between regions, but not between countries.

## 5.3 Site-by-provenance interaction

### 5.3.1 Analysis of variance

For each variate, the site-by-provenance tables were processed by first fitting a two-factor model to investigate the presence of site-by-provenance interaction. The model was of the form

(observation) = (overall mean) + (site effect) + (provenance effect) + (site.provenance effect)

or symbolically

$$Y_{ij} = \quad + \quad _i + \quad _j + \ . \quad _{ij} \qquad (2)$$

where $Y_{ij}$ ($i$ = 1,2,...,$l$; $j$ = 1,2,...,$v$) are entries in a $l$ $v$ site-by-provenance table; is a parameter for the overall mean; the $_i$ and $_j$ are parameters for the sites and provenances, respectively; and the $._{ij}$ are the interaction effects between sites and provenances. Because not every provenance was present at every site, the two-way tables were incomplete and so a non-orthogonal analysis of variance was carried out using the FIT command of GenStat. A pooled error term was obtained by pooling the residual mean squares ($s_j^2$) from the individual site analyses, having first checked that the variances were homogeneous across all sites. In other words, an analysis of variance table of the form

| Source of variation | degrees of freedom | mean square |
|---|---|---|
| site | $l - 1$ | |
| provenance | $v - 1$ | |
| site.provenance | $(l - 1)(v - 1)$ | |
| residual | $l(r - 1)(v - 1)$ | $S^2 = \quad s^2/(lr)$ |

was obtained for each of the 14 variates where $r$ is the number of replicates at each site; for our trials $r$ = 4. As was done with the individual analyses, the provenance variation was again further partitioned into differences between provenances within countries and countries within regions.

### 5.3.2 Joint regression analysis

The site-by-provenance interaction for the quantitative variates height (*Ht*) and diameter at breast height (*Dbh*) was analysed in more detail using the method of joint regression analysis (Williams et al. 2002). Here the two-factor model was expanded to take the form

(observation) = (overall mean) + (provenance regression coefficient)
(site effect) + (provenance effect) + (residual)

or symbolically

$Y_{ij} = \quad + \ _j \ _i + \ _j + \ _{ij}$

This model contains extra parameters not present in the simple two-factor model in Section 5.3.1. The extra parameters are the provenance regression coefficients ( $_j$), introduced as multipliers for the site effects. If there is no interaction, all the provenance regression coefficients are equal to one and the model simplifies to the two-factor model in Section 5.3.1. Normally there will be some interaction and the $_j$ will vary about one; some will be higher and some will be lower. Only provenances represented at four or more sites were included in these analyses; this left 43 provenances over the 14 sites and 47 provenances if all sites were analysed. Estimated provenance means were plotted against the regression coefficients for each provenance to investigate possible structure in the interaction.

## 5.4 Multivariate analysis

The estimated provenance means from the Section 5.3.1 analyses of the 14 quantitative and qualitative variates across 14 sites were subjected to a principal component analysis. This multivariate technique derives a linear combination of the variates that maximises the variation between the provenances; this is known as the first principal component. The coefficients in the linear combination are called loadings and indicate the relative importance of the particular variates in elucidating differences in provenances from different geographical regions as well as providing a convenient summary of the geographical variation. The importance of the first principal component depends on how much of the overall variation across the 14 variates is captured. A second principal component can be obtained which is uncorrelated with the first and captures further variation that has not been picked up by the first. We normally hope that we can summarise most of the variation between provenances with just two principal components. In other words, the principal components analysis tries to reduce the information in 14 variates down to just two, or at most three, principal components which can then be conveniently represented on two-dimensional graphs.

# 6 Results

## 6.1 Individual site analyses

Table 3 summarises the results from separate analyses for 25 individual sites on 14 growth traits and survival, indicating the distribution of the eight possible scenarios of significant differences. The overall results show that the larger extent of variation between seed sources is caused by either the country origins or provenance regions or both. As far as the frequency of significance is concerned, the influence of provenance region is most dominant with 119 significant cases (scenarios b, c, e and h) compared to that of country origin, 109 cases (b, d, e and g), and provenance origin, 74 cases (e, f, g and h). There are 12 cases only (i.e. scenario f) where the significant differences are explained solely by provenance effect. In this scenario, the differences between country origins and between provenance regions were not significant.

**Table 3.** Distribution of different scenarios of significance from separate analysis of 25 trials for 14 growth traits and survival.

| Trait | Scenario of significance* | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | g | h | |
| *Surv* | 11 | 1 | 4 | 3 | 2 | 1 | 2 | 1 | 25 |
| *Ht* | 5 | 5 | 4 | 1 | 6 | 2 | 2 | – | 25 |
| *Dbh* | 4 | 4 | 3 | 1 | 6 | 3 | – | – | 21 |
| *Axpst* | 6 | – | 2 | 2 | 2 | 2 | – | – | 14 |
| *Strst* | 1 | 2 | 3 | 3 | 3 | – | 1 | 1 | 14 |
| *Denpb* | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 2 | 14 |
| *Thkpb* | 4 | 1 | 4 | – | 3 | – | – | 2 | 14 |
| *Angpb* | 3 | 4 | 1 | 3 | 2 | 1 | – | – | 14 |
| *Lenpb* | 6 | 5 | 1 | – | 1 | – | 1 | – | 14 |
| *Lendb* | 5 | 1 | 1 | 2 | 3 | 1 | 1 | – | 14 |
| *Thkdb* | 4 | 4 | – | 1 | 5 | – | – | – | 14 |
| *Stmhe* | 11 | 2 | – | – | – | 1 | – | – | 14 |
| *Folhe* | 7 | 1 | 4 | 1 | – | – | – | 1 | 14 |
| *Flwre* | 3 | 1 | 2 | 2 | 4 | – | – | 2 | 14 |
| *Frtre* | 5 | 1 | 1 | 1 | 5 | – | 1 | – | 14 |
| Total | 77 | 34 | 32 | 22 | 44 | 12 | 9 | 9 | 239 |

* a = no significant differences either between provenances, countries or regions
b = no significant differences between provenances, but significant between countries and regions
c = no significant differences between provenances and between countries, but significant between regions
d = no significant differences between provenances and between regions, but significant between countries
e = significant differences between provenances, between countries and between regions
f = significant differences between provenances, but not between countries and regions
g = significant differences between provenances and countries, but not between regions
h = significant differences between provenances and between regions, but not between countries

Estimated means from individual analyses of 25 trials are summarised in Appendixes 1 and 2. Appendix 1 provides information on survival and both quantitative and qualitative traits for 14 growth trials. Each table in Appendix 1 has a column for each site. The rows of each table correspond to the 60 provenances that were

planted. There is a table for each of our 14 traits (two quantitative and 12 qualitative) and another for survival percentage (*Surv*). A blank cell means that the particular provenance was not planted at a site. Also included in the tables are (i) columns for the country of provenance origin (grouped by region), provenance number and the CSIRO seedlot number and (ii) rows showing the residual mean squares from the individual analyses and the standard error of differences for the comparison of two provenance means. The last three rows in each table indicate the significant level at provenance, country and region levels. Appendix 2 shows quantitative growth data only; information on height (Appendix 2.1) and survival (Appendix 2.2) was available for 11 other sites and on diameter at breast height (*Dbh*) for seven of the 11 sites (Appendix 2.3).

It is somewhat complicated to discuss the results for each trait because of the large number of seed sources and sites involved. Therefore, to assist in the presentation of results, we have decided to also show here (and in advance of the results in Section 6.2) the estimated provenance means from the site-by-provenance interaction model (Equation 2). These provenance means (Table 4) give us a convenient summary for each trait across all 14 sites. However, the information in Table 4 should be treated as a general guide only, and should be examined in conjunction with more detailed information for specific sites presented in Appendixes 1 and 2.

### 6.1.1 General trends

*Survival*

Mean trial survival ranged from very poor (i.e. 23% for IPT-7 in Orissa, India and 38% for IPT-25 in Malawi) to very good (more than 85%) (Appendixes 1.1 and 2.1). There were no significant differences in survival between seedlots in 11 out of 25 trials. The trials that were found to have significant differences did not show a clear pattern of variation, so it was not feasible to elaborate on the differences between provenances. It appears most likely that the different standards of trial maintenance might have contributed to the differences in the survival rate.

*Height and diameter*

Similar to the results observed for survival, there were marked differences in the growth rate between planting sites. Relatively, trees grew notably slower at IPT-5 (Dongshan, China), IPT-7 (Balukhanda, India), IPT-11 (Sam Son, Vietnam) and IPT-17 (Takuapa, Thailand). The trials at Dongshan and Sam Son were located near the seashore, and were clearly affected by the strong winds.

Despite significant differences between provenances within countries and between countries within regions, height and diameter growth showed a similar trend in that natural provenances from Southeast Asia and land races from Asia generally grew faster than natural provenances from Australia/Pacific and land races from Africa. Natural provenances from Australia and the Pacific recorded the slowest growth; in most cases, the region means are smaller than overall site means (Appendixes 1.2, 1.3, 2.2, 2.3).

No particular group of provenances was found to grow consistently well across all the trial sites, indicating seed source and site interaction (see Section 6.2 for more detail). Nevertheless, several provenances from Malaysia contributed to the overall better growth for provenances from the Southeast Asian region.

**Table 4.** Pooled mean values of 14 growth and morphological characteristics at 14 trial sites.

| | Prov. no. | CSIRO seedlot | *Ht* | *Dbh* | *Axpst* | *Strst* | *Denpb* | *Thkpb* | *Angpb* | *Lenpb* | *Lendb* | *Thkdb* | *Stmhe* | *Folhe* | *Flwre* | *Frtre* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Natural – Australia/Pacific | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 3.8 | 2.7 | 4.9 | 3.0 | 2.3 | 2.6 | 1.5 | 1.5 | 1.3 | 1.6 | 1.9 | 1.8 | 1.1 | 1.9 |
| | 2 | 16166 | 3.8 | 2.7 | 5.1 | 3.2 | 1.7 | 3.0 | 1.6 | 1.6 | 1.9 | 1.9 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 3 | 18008 | 4.5 | 3.0 | 5.2 | 3.3 | 2.1 | 2.7 | 1.6 | 1.4 | 1.5 | 1.7 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 4 | 18378 | 4.3 | 2.0 | 5.0 | 2.9 | 2.2 | 3.0 | 1.5 | 1.6 | 1.3 | 1.6 | 1.8 | 1.7 | 1.1 | 1.9 |
| PNG | 5 | 18153 | 4.5 | 3.1 | 5.3 | 3.3 | 2.2 | 2.7 | 1.6 | 1.4 | 1.4 | 1.9 | 1.8 | 1.8 | 1.1 | 1.8 |
| Fiji | 6 | 18270 | 3.9 | 2.6 | 4.5 | 2.1 | 2.3 | 2.3 | 1.9 | 1.4 | 1.6 | 2.0 | 1.9 | 1.7 | 1.1 | 1.8 |
| | 7 | 18271 | 4.0 | 2.6 | 5.1 | 2.9 | 2.4 | 2.6 | 1.7 | 1.4 | 1.5 | 1.9 | 1.9 | 1.7 | 1.1 | 1.9 |
| | 8 | 18272 | 4.3 | 2.9 | 4.8 | 2.9 | 2.3 | 2.3 | 1.8 | 1.3 | 1.5 | 1.9 | 1.9 | 1.7 | 1.0 | 1.8 |
| Guam | 9 | 18121 | 3.8 | 2.7 | 5.1 | 3.6 | 2.1 | 2.5 | 1.5 | 1.3 | 1.3 | 1.9 | 1.8 | 1.8 | 1.1 | 1.8 |
| Solomon | 10 | 18402 | 4.5 | 3.6 | 5.0 | 3.1 | 2.0 | 2.6 | 1.5 | 1.4 | 1.6 | 1.9 | 1.9 | 1.8 | 1.0 | 1.9 |
| | 11 | 18403 | 4.7 | 3.6 | 4.0 | 2.9 | 2.5 | 2.4 | 1.4 | 1.3 | 1.7 | 2.1 | 1.9 | 1.9 | 1.0 | 1.9 |
| Vanuatu | 12 | 18312 | 4.2 | 3.0 | 5.2 | 3.4 | 2.2 | 2.7 | 1.5 | 1.4 | 1.4 | 1.9 | 1.8 | 1.8 | 1.1 | 1.9 |
| Tonga | 12a | 18040 | 4.0 | 2.7 | 4.5 | 3.3 | 2.3 | 2.7 | 1.7 | 1.1 | 1.7 | 2.0 | 1.8 | 1.7 | 1.1 | 1.8 |
| **Region mean** | | | **4.2** | **2.8** | **4.9** | **3.1** | **2.2** | **2.6** | **1.6** | **1.4** | **1.5** | **1.9** | **1.9** | **1.8** | **1.1** | **1.8** |
| Natural – Southeast Asia | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 4.5 | 3.3 | 5.2 | 3.0 | 2.0 | 2.6 | 1.8 | 1.4 | 1.4 | 1.6 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 14 | 18158 | 4.7 | 3.3 | 5.4 | 3.0 | 2.1 | 2.5 | 1.8 | 1.3 | 1.3 | 1.4 | 1.9 | 1.8 | 1.0 | 1.9 |
| | 15 | 18160 | 4.7 | 3.5 | 5.6 | 3.3 | 2.3 | 2.6 | 1.9 | 1.4 | 1.5 | 1.5 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 16 | 18161 | 4.8 | 3.8 | 5.6 | 3.2 | 2.0 | 2.2 | 1.6 | 1.3 | 1.5 | 1.5 | 1.9 | 1.9 | 1.2 | 1.9 |
| | 17 | 18244 | 4.8 | 3.4 | 5.2 | 3.6 | 1.9 | 2.6 | 1.6 | 1.4 | 1.4 | 1.5 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 18 | 18348 | 4.4 | 3.3 | 5.4 | 3.4 | 2.0 | 2.4 | 1.7 | 1.3 | 1.4 | 1.5 | 1.9 | 1.8 | 1.0 | 1.9 |
| | 19 | 18374 | 4.6 | 3.5 | 4.8 | 3.1 | 2.2 | 2.4 | 1.5 | 1.1 | 1.3 | 1.8 | 1.9 | 1.8 | 1.0 | 1.9 |
| | 20 | 18375 | 4.3 | 3.2 | 4.7 | 3.3 | 2.1 | 2.3 | 1.7 | 1.3 | 1.3 | 1.5 | 1.9 | 1.8 | 1.0 | 1.9 |

Note: *Ht* = height; *Dbh* = diameter at breast height; *Axpst* = axis persistence; *Strst* = stem straightness; characteristics of permanent branches, *Denpb* = density, *Thkpb* = thickness, *Angpb* = angle, *Lenpb* = length; characteristics of deciduous branchlets, *Lendb* = length, *Thkdb* = thickness; *Stmhe* = stem damage; *Folhe* = foliage damage; *Flwre* = flowering; *Frtre* = fruiting. See text for full explanation.

**Table 4.** (cont'd) Pooled mean values of 14 growth and morphological characteristics at 14 trial sites.

| | Prov. no. | CSIRO seedlot | *Ht* | *Dbh* | *Axpst* | *Strst* | *Denpb* | *Thkpb* | *Angpb* | *Lenpb* | *Lendb* | *Thkdb* | *Stmhe* | *Folhe* | *Flwre* | *Frtre* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 21 | 18376 | 4.6 | 3.5 | 5.1 | 3.3 | 2.3 | 2.4 | 1.6 | 1.5 | 1.4 | 1.8 | 1.8 | 1.9 | 1.0 | 1.9 |
| Philippines | 22 | 18117 | 4.4 | 2.9 | 5.4 | 3.3 | 2.2 | 2.8 | 1.6 | 1.4 | 1.3 | 1.7 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 23 | 18154 | 4.2 | 3.1 | 5.2 | 3.5 | 2.1 | 2.5 | 1.6 | 1.5 | 1.6 | 1.8 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 24 | 18357 | 4.5 | 3.3 | 5.4 | 3.9 | 2.0 | 2.6 | 1.8 | 1.6 | 1.2 | 1.6 | 1.9 | 1.9 | 1.1 | 1.9 |
| Thailand | 25 | 18296 | 4.4 | 3.2 | 5.1 | 3.1 | 2.1 | 2.5 | 1.7 | 1.3 | 1.3 | 1.5 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 26 | 18297 | 4.5 | 3.4 | 5.1 | 3.3 | 2.2 | 2.5 | 1.6 | 1.4 | 1.3 | 1.5 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 27 | 18298 | 4.5 | 3.6 | 5.3 | 3.1 | 2.2 | 2.5 | 1.7 | 1.3 | 1.3 | 1.4 | 1.8 | 1.8 | 1.1 | 1.9 |
| | 28 | 18299 | 4.4 | 3.2 | 5.2 | 3.2 | 2.1 | 2.4 | 1.6 | 1.4 | 1.6 | 1.7 | 1.9 | 1.8 | 1.0 | 1.9 |
| **Region mean** | | | **4.5** | **3.4** | **5.2** | **3.3** | **2.1** | **2.5** | **1.7** | **1.4** | **1.4** | **1.6** | **1.9** | **1.8** | **1.1** | **1.9** |
| Introduced – Asia | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 4.4 | 3.1 | 5.3 | 3.4 | 1.9 | 2.7 | 1.6 | 1.4 | 1.5 | 1.8 | 1.8 | 1.8 | 1.2 | 1.8 |
| | 30 | 18268 | 4.7 | 3.6 | 5.5 | 3.6 | 2.0 | 2.6 | 1.6 | 1.5 | 1.4 | 1.7 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 31 | 18586 | 4.0 | 2.9 | 5.5 | 3.7 | 1.7 | 2.8 | 1.6 | 1.4 | 1.4 | 1.6 | 1.9 | 1.8 | 1.1 | 1.8 |
| India | 32 | 18013 | 4.5 | 3.3 | 5.2 | 3.4 | 2.0 | 2.6 | 1.6 | 1.4 | 1.5 | 1.8 | 1.8 | 1.9 | 1.2 | 1.8 |
| | 33 | 18014 | 4.3 | 3.3 | 5.3 | 3.5 | 1.9 | 2.6 | 1.5 | 1.3 | 1.4 | 1.8 | 1.9 | 1.8 | 1.2 | 1.8 |
| | 34 | 18015 | 4.5 | 3.4 | 5.3 | 3.5 | 1.9 | 2.7 | 1.6 | 1.3 | 1.2 | 1.6 | 1.9 | 1.8 | 1.2 | 1.8 |
| | 35 | 18118 | 4.5 | 3.0 | 5.4 | 3.4 | 2.3 | 2.7 | 1.5 | 1.3 | 1.4 | 1.5 | 1.8 | 1.9 | 1.3 | 1.8 |
| | 36 | 18119 | 4.2 | 3.0 | 5.6 | 3.5 | 2.0 | 2.7 | 1.6 | 1.4 | 1.4 | 1.7 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 37 | 18120 | 4.2 | 3.0 | 5.4 | 3.4 | 2.1 | 2.5 | 1.6 | 1.3 | 1.5 | 1.7 | 1.9 | 1.9 | 1.4 | 1.7 |
| Sri Lanka | 38 | 18286 | 4.2 | 2.7 | 5.1 | 3.3 | 2.2 | 2.5 | 1.5 | 1.4 | 1.2 | 1.5 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 39 | 18287 | 4.0 | 3.0 | 5.2 | 3.3 | 2.1 | 2.7 | 1.7 | 1.5 | 1.4 | 1.7 | 1.8 | 1.8 | 1.3 | 1.8 |
| | 40 | 18288 | 4.4 | 3.3 | 5.2 | 3.4 | 2.0 | 2.6 | 1.6 | 1.3 | 1.4 | 1.8 | 1.8 | 1.8 | 1.2 | 1.8 |
| Vietnam | 41 | 18085 | 4.5 | 3.1 | 5.3 | 3.7 | 2.0 | 2.6 | 1.5 | 1.4 | 1.3 | 1.7 | 1.8 | 1.9 | 1.3 | 1.8 |
| | 42 | 18086 | 4.8 | 3.5 | 5.6 | 3.5 | 2.0 | 2.5 | 1.5 | 1.3 | 1.5 | 1.7 | 1.9 | 1.9 | 1.3 | 1.8 |
| | 43 | 18127 | 5.0 | 3.7 | 5.5 | 3.8 | 1.9 | 2.5 | 1.5 | 1.4 | 1.2 | 1.6 | 1.9 | 1.8 | 1.3 | 1.7 |

Note: *Ht* = height; *Dbh* = diameter at breast height; *Axpst* = axis persistence; *Strst* = stem straightness; characteristics of permanent branches, *Denpb* = density, *Thkpb* = thickness, *Angpb* = angle, *Lenpb* = length; characteristics of deciduous branchlets, *Lendb* = length, *Thkdb* = thickness; *Stmhe* = stem damage; *Folhe* = foliage damage; *Flwre* = flowering; *Frtre* = fruiting. See text for full explanation.

**Table 4.** (cont'd) Pooled mean values of 14 growth and morphological characteristics at 14 trial sites.

| | Prov. no. | CSIRO seedlot | *Ht* | *Dbh* | *Axpst* | *Strst* | *Denpb* | *Thkpb* | *Angpb* | *Lenpb* | *Lendb* | *Thkdb* | *Stmhe* | *Folhe* | *Flwre* | *Frtre* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Vietnam (cont'd) | 44 | 18128 | 4.4 | 3.3 | 5.3 | 3.7 | 2.0 | 2.6 | 1.5 | 1.5 | 1.4 | 1.8 | 1.8 | 1.8 | 1.3 | 1.8 |
| | 45 | 18152 | 4.0 | 2.7 | 5.1 | 3.3 | 2.0 | 2.6 | 1.6 | 1.5 | 1.3 | 1.7 | 1.8 | 1.8 | 1.2 | 1.8 |
| **Region mean** | | | **4.4** | **3.2** | **5.3** | **3.5** | **2.0** | **2.6** | **1.6** | **1.4** | **1.4** | **1.7** | **1.9** | **1.8** | **1.2** | **1.8** |
| Introduced – Africa | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 4.6 | 3.4 | 5.4 | 3.7 | 2.0 | 2.7 | 1.7 | 1.5 | 1.4 | 1.7 | 1.9 | 1.9 | 1.1 | 1.9 |
| Egypt | 47 | 18122 | 4.0 | 2.8 | 5.2 | 3.5 | 2.0 | 2.7 | 1.5 | 1.4 | 1.4 | 1.6 | 1.9 | 1.8 | 1.1 | 1.9 |
| | 48 | 18125 | 4.1 | 2.9 | 5.1 | 3.6 | 2.0 | 2.7 | 1.5 | 1.5 | 1.5 | 1.8 | 1.9 | 1.8 | 1.1 | 1.8 |
| | 49 | 18126 | 4.0 | 2.5 | 5.2 | 3.1 | 2.0 | 2.7 | 1.4 | 1.4 | 1.4 | 1.7 | 1.9 | 1.8 | 1.0 | 1.8 |
| Kenya | 50 | 18134 | 4.0 | 2.9 | 5.3 | 3.5 | 1.9 | 2.7 | 1.6 | 1.4 | 1.6 | 1.8 | 1.9 | 1.8 | 1.0 | 1.9 |
| | 51 | 18135 | 4.4 | 2.8 | 5.5 | 4.2 | 2.0 | 3.0 | 1.7 | 1.6 | 1.5 | 1.9 | 1.9 | 1.6 | 1.1 | 1.8 |
| | 52 | 18136 | 4.4 | 3.0 | 5.9 | 4.1 | 1.9 | 2.9 | 1.8 | 1.6 | 1.9 | 1.9 | 1.9 | 1.7 | 1.0 | 1.9 |
| | 53 | 18137 | 4.1 | 2.9 | 5.3 | 3.7 | 2.0 | 2.9 | 1.6 | 1.5 | 1.6 | 1.8 | 1.9 | 1.8 | 1.1 | 1.9 |
| | 54 | 18141 | 5.1 | 3.6 | 5.9 | 4.1 | 2.0 | 2.9 | 1.7 | 1.7 | 1.6 | 1.9 | 1.9 | 1.9 | 1.2 | 1.8 |
| | 55 | 18142 | 4.4 | 3.1 | 5.3 | 3.7 | 2.2 | 2.6 | 1.6 | 1.5 | 1.5 | 1.8 | 1.9 | 1.9 | 1.1 | 1.9 |
| | 56 | 18143 | 3.9 | 2.8 | 5.1 | 3.4 | 2.0 | 2.6 | 1.6 | 1.5 | 1.7 | 1.9 | 1.8 | 1.8 | 1.1 | 1.9 |
| | 57 | 18144 | 4.3 | 2.8 | 6.0 | 3.9 | 1.8 | 2.9 | 1.7 | 1.6 | 1.8 | 2.1 | 1.9 | 1.7 | 1.2 | 1.9 |
| Mauritius | 58 | 18565 | 4.3 | 3.1 | 5.4 | 3.6 | 2.0 | 2.7 | 1.6 | 1.5 | 1.3 | 1.6 | 1.9 | 1.8 | 1.1 | 1.9 |
| **Region mean** | | | **4.3** | **3.0** | **5.4** | **3.7** | **2.0** | **2.8** | **1.6** | **1.5** | **1.6** | **1.8** | **1.9** | **1.8** | **1.1** | **1.8** |
| Puerto Rico | 59 | 18752 | 4.3 | 3.1 | 5.2 | 3.2 | 2.1 | 2.7 | 1.6 | 1.4 | 1.4 | 1.6 | 1.9 | 1.9 | 1.1 | 1.9 |
| **Overall mean** | | | **4.3** | **3.1** | **5.2** | **3.4** | **2.1** | **2.6** | **1.6** | **1.4** | **1.4** | **1.7** | **1.9** | **1.8** | **1.1** | **1.8** |

Note: *Ht* = height; *Dbh* = diameter at breast height; *Axpst* = axis persistence; *Strst* = stem straightness; characteristics of permanent branches, *Denpb* = density, *Thkpb* = thickness, *Angpb* = angle, *Lenpb* = length; characteristics of deciduous branchlets, *Lendb* = length, *Thkdb* = thickness; *Stmhe* = stem damage; *Folhe* = foliage damage; *Flwre* = flowering; *Frtre* = fruiting. See text for full explanation.

Within the Australia and Pacific region, the most outstanding provenance came from Ela Beach, the sole representative seedlot from Papua New Guinea (PNG). This PNG provenance ranked among the fastest-growing at many trial sites in Asia and Africa.

When the relative mean growth across 14 sites, as shown in Table 4, is examined, it is evident that two seed sources from the introduced populations (seedlot 18127 from Ha Thinh, Vietnam and seedlot 18141 from Robinson Island, Kenya), are the fastest growing of all. However, these two seedlots were planted at only one out of the 14 sites (i.e. at Weipa, Australia), and thus we cannot confidently assume that they would behave the same elsewhere. Nonetheless, both seedlots will certainly be candidates for further testing in areas with soil and climatic conditions similar to those at Weipa.

*Stem form*

The mean values recorded for axis persistence indicate that *C. equisetifolia* has the propensity to develop single-stemmed trees, and differences between provenances were generally not significant (Appendix 1.4). In the trials where significant differences were recorded, it was provenances from Australia and the Pacific region that tended to have more multi-stemmed trees. These provenances from the Australia/Pacific region also tended to have stems that were less straight (Figure 6)(Appendix 1.5).

**Figure 6.** Poor stem form of a provenance from Fiji compared with a provenance from Sabah, Malaysia in a provenance trial in Thailand.

Overall, trees originating from planted stands (i.e. introduced populations) had better stem form than those from natural populations (see also Table 4). In particular, a few Kenyan land races (seedlots 18135, 18136 and 18141) had straight stems and almost perfect bole length without forking. This better stem form of the introduced populations may be the result of recurrent selection and collection of seed from good trees for plantation establishment.

*Branching habit (permanent branches)*

The branching data were found to vary considerably between trials sites. We believe this is due to different standards being applied during the scoring procedures rather than trees behaving differently in different environments. The trend in provenance differences is generally similar across different trials.

Although there is some evidence of variation between provenances (Figure 7), countries and regions in branching characteristics (Appendixes 1.6–1.9), the results generally suggest that *C. equisetifolia* trees are densely branched, light to medium in branch size, with a tendency toward horizontal branches.

On a regional basis, branching characteristics can be summarised as follows:

- *branch density* — densely branched in general, but slightly lighter in natural provenances
- *branch thickness* — light to heavy branching in general, but slightly lighter in land races from Africa
- *branch angle* — close to horizontal in all regions, but slightly more horizontal in natural provenances from Southeast Asia
- *branch length* — mostly longer than a quarter of total tree height, slightly longer in seedlots from Africa.

*Deciduous branchlets*

Except for a few sites, the mean data for branchlet thickness are consistent across sites in that most trees had fine branchlets (Appendix 1.10). The results at Dongshan, China (IPT-5) and Santa Rosa, Honduras (IPT-14) indicate that branchlets were coarse. We believe that this anomaly is attributable to different scoring standards.

The results obtained for branchlet length are not so consistent across trials; in fact, there are clear contrasts between some trials (Appendix 1.11). It is more appropriate in this case to look at the relative mean values in Table 4. Despite notable variation between provenances within countries, a general trend was that most trees tended to have long and fine branchlets, and that the branchlets were longer in the trees from Africa than in those from other regions.

*Health*

It was not considered feasible to assess health in great detail, as this would have needed qualified personnel who were not available. Our procedure merely examined whether there was evidence of damage, either biological or mechanical, to the stem and foliage, and the results showed that trees in most trials were generally not damaged (Appendixes 1.12 and 1.13). However, foliage damage was recorded on all seedlots in the trial in Kenya (IPT-12). The non-significant differences shown in most trials may be due to inadequate determination of the cause and extent of damage.

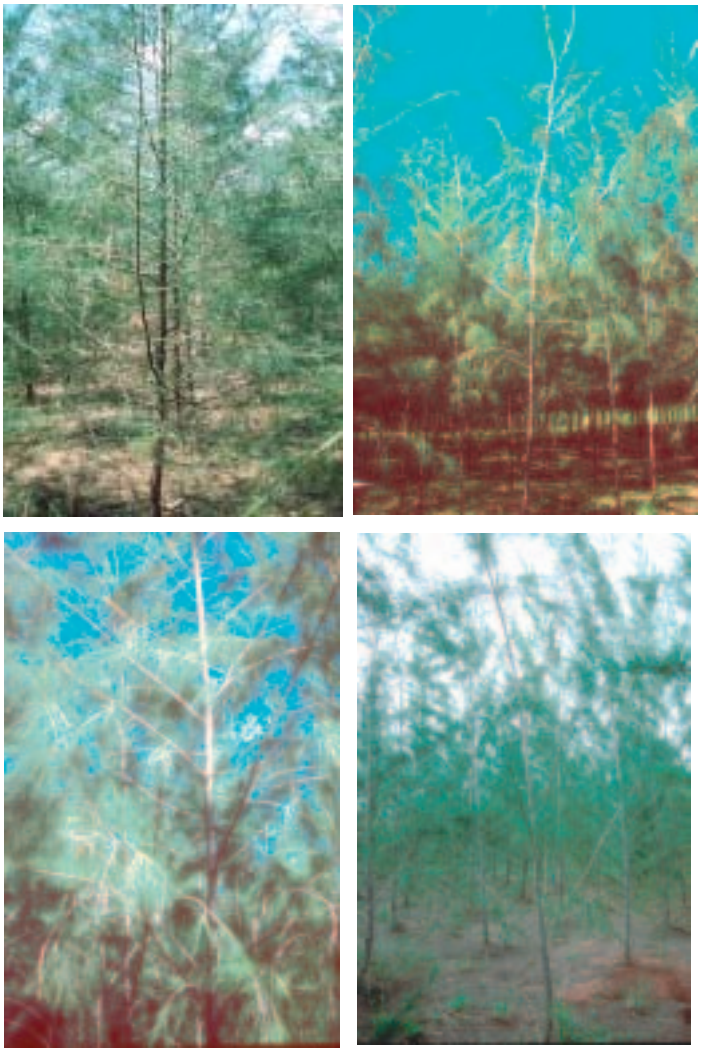

**Figure 7.** Variation in branching density of different provenances.

*Reproduction*

The age to first flowering varied between planting sites, suggesting the local environmental conditions are a likely factor. Many provenances in the trials at Weipa, Australia (IPT-01), Neveli, India (IPT-08), Malindi, Kenya (IPT-12) and La Soledad, Honduras (IPT-13) had trees flowering at ages between 26 and 32 months (Appendix 1.14). In contrast, there were very few or no flowering trees in the trials at Yangxi, China (IPT-04), Balukhanda, India (IPT-07), Nghe An, Vietnam (IPT-10), Sam Son, Vietnam (IPT-11) and Santa Rosa, Honduras (IPT-14) when aged between 30 and 48 months.

In the trials where flowering had commenced, seed sources from planted stands in Asia appeared to have more trees flowering, regardless of the trial locations. Variation between provenances did exist but there was no clear pattern of variation.

Data of fruit set (Appendix 1.15) did not correspond to that of flowering characteristic. Seed sources in the trials which had high numbers of trees flowering did not have high numbers of trees bearing fruit. *Casuarina equisetifolia* is predominantly dioecious (i.e. male and female flowers occurring on separate trees), with a small percentage of monoecious trees (male and female flowers on the same tree). In this report, however, we do not deal with sex of the trees. Seedlots with a high number of flowering trees would not necessarily correspond to those with a high number of trees bearing fruit if those flowering trees bore more male flowers.

Information on flowering and fruit set presented in this report should be treated with due consideration to the fact that these characteristics were recorded once only together with other morphological traits. Thus, it is likely that the time of assessment for some trials did not coincide with the peak flowering season, resulting in low numbers of trees flowering. In a more intensive study entailing monthly observations of flowering characteristics from ages 3 to 7 years in a trial at Lad Krathing, Thailand (IPT-03), Luechanimitchit (2002) found marked differences between provenances in the age to first flowering, sex ratio and total number of flowering trees. Trees originating from land races started first flowering earlier than those from natural provenances. At three years of age, all 14 land races had flowered compared to six out of 14 natural provenances. Sex ratios differed considerably between seed sources, but there was a tendency for more male than female trees in most seedlots.

### 6.1.2 Multiple regression

In order to investigate which environmental factors might have been responsible for variation in the growth performance among provenances, the details of the provenance seed collection sites in Table 1 (i.e. latitude, longitude, altitude and rainfall) were included as independent variates in a multiple regression for height and diameter. The mean values of height and diameter presented in Table 4 were used for this purpose. After taking into account the variation between countries, there was still a highly significant positive relationship for both height and diameter with rainfall. Graphs of these regressions are given in Figures 8 and 9, respectively, where the provenance numbers are colour coded to distinguish provenance regions. There were no significant effects for latitude, longitude and altitude (after first adjusting for differences between countries).

## 6.2 Site-by-provenance interaction

The analysis of the two-way tables of site-by-provenance data for each variate covered:

- *Homogeneity of variances*
  For most of the variates, the residual mean squares were within the 10-fold range discussed by Williams et al. (2002, p. 68). Where the range was greater than 10-fold (e.g. *Thkpb, Axpst, Angpb, Thkdb* and *Lendb*), it was not extreme and so a weighted analysis was not pursued for any of the variates. Hence, pooled residual mean squares were obtained as the arithmetic average of the individual residual mean squares for each site, divided by the number of replicates at each site (i.e. four). The pooled residual mean squares have been included in the tables in Appendixes 1 and 2.

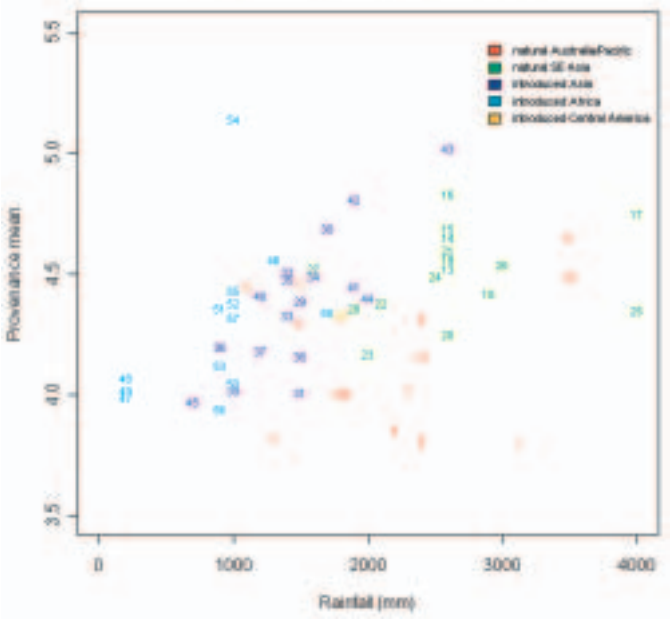


**Figure 8.** Plot of provenance means for height (*Ht*) versus rainfall at seed collection sites. Different **colours** indicate the regional origin of the provenances.

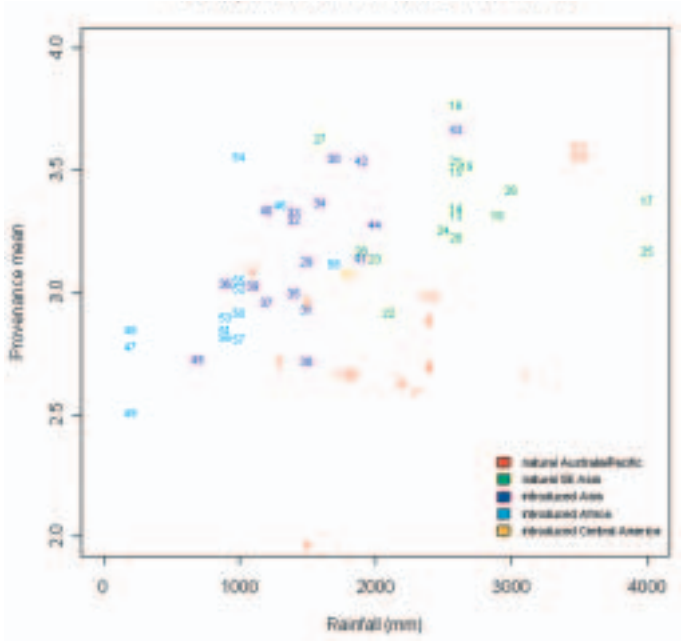


**Figure 9.** Plot of provenance means for diameter at breast height (*Dbh*) versus rainfall at seed collection sites. Different **colours** indicate the regional origin of the provenances.

- *Non-orthogonal analysis of variance*

  Analyses were carried out for each variate, where the site and provenance factors were fitted to each two-way table and the site.provenance interaction was compared with the pooled residual mean square (Table 5). The results showed that the interaction was statistically significant for all variates. Hence we proceeded to further investigate the interactions by partitioning into components.

- *Analysis of nested treatment structure*

  The 60 provenances came from 19 countries, which have been further grouped into four broad regions: natural distributions in Australia and the Pacific, seven countries, 13 provenances; natural distribution in Southeast Asia, three countries, 16 provenances; location of introductions in Asia, four countries, 17 provenances; and location of introductions in Africa, four countries, 13 provenances. In addition, there was a single entry from Puerto Rico that represented Central America. The non-orthogonal analyses of variance of the two-way tables were re-run to show the breakdown of the provenances into the nested structure; results are included in Table 5.

Joint regression analysis was conducted on height and diameter for both the main 14 sites and with the extra sites added in. In general, the results were not particularly illuminating and probably reflected the fact that the site-by-provenance interaction, although significant, was not as large as in the example described by Williams et al. (2002, Chapter 5). For example, from Table 5, the variance ratio for testing the site-by-provenance interaction for *Ht* is 1.69 compared with the 8.73 in Table 5.5 of Williams et al. (2002). The estimated means and regression coefficients for height and diameter are included in Table 6. Plots of estimated means versus regression coefficients for 14 sites using the provenance numbers as symbols are shown in Figures 10 and 11. The provenance numbers are colour coded in a similar manner to that used for Figures 8 and 9.

A principal component analysis was carried out on all 14 variates because, in general, the correlations between the variates were not high (Table 7). Estimated means for each variate were weighted by the inverse of the standard errors obtained from the individual analyses. The first two principal components accounted for 51% of the variation. The loadings for the first two principal components are given in Table 8. A large absolute value for a variate (characteristic) loading indicates the importance of the variate in the formation of the principal component analysis. The first principal component is based largely on axis persistence and stem straightness, whereas the second principal component relates to branchlet length and branchlet thickness; these results concur with those from Pinyopusarerk and Williams (2000) which were based on just the Weipa site (IPT-01).

A plot of the scores for the first and second principal components is shown in Figure 12 using the provenance numbers as symbols and the same colour codes as in Figures 8 and 9. There appears to be a pattern of variation among provenances from the species' natural distribution. With a few overlaps, provenances from Australia and the Pacific region (numbers 1–12a, in red colour) are separated from provenances from Southeast Asia (numbers 13–28, in green colour). Similarly, there is also a tendency for a separation between seedlots from location of introductions in Asia

**Table 5.** Mean squares from site-by-provenance analyses of variance including the pooled residual mean square from the individual site analyses.

| Variate | Site.provenance | Pooled residual | Site | Region | Region.country | Site.region | Site.region.country | Seedlot | Residual |
|---|---|---|---|---|---|---|---|---|---|
| *Ht* | 0.262 | 0.155 | 88.050 | 3.180 | 0.570 | 0.440 | 0.320 | 0.260 | 0.188 |
| *Dbh* | 0.230 | 0.140 | 54.000 | 4.850 | 0.550 | 0.290 | 0.320 | 0.180 | 0.164 |
| *Axpst* | 0.151 | 0.067 | 9.530 | 1.690 | 0.280 | 0.200 | 0.150 | 0.180 | 0.137 |
| *Strst* | 0.119 | 0.058 | 17.240 | 3.050 | 0.740 | 0.200 | 0.150 | 0.180 | 0.086 |
| *Denpb* | 0.055 | 0.026 | 3.210 | 0.810 | 0.110 | 0.110 | 0.050 | 0.070 | 0.043 |
| *Thkpb* | 0.054 | 0.032 | 13.520 | 0.590 | 0.140 | 0.090 | 0.070 | 0.600 | 0.039 |
| *Angpb* | 0.024 | 0.014 | 2.520 | 0.240 | 0.090 | 0.040 | 0.020 | 0.030 | 0.022 |
| *Lenpb* | 0.023 | 0.014 | 1.120 | 0.170 | 0.050 | 0.030 | 0.030 | 0.020 | 0.018 |
| *Lendb* | 0.035 | 0.012 | 2.120 | 0.410 | 0.090 | 0.050 | 0.050 | 0.050 | 0.029 |
| *Thkdb* | 0.032 | 0.013 | 1.630 | 1.080 | 0.170 | 0.050 | 0.030 | 0.040 | 0.029 |
| *Stmhe* | 0.009 | 0.006 | 0.676 | 0.012 | 0.008 | 0.171 | 0.007 | 0.004 | 0.009 |
| *Folhe* | 0.012 | 0.006 | 1.860 | 0.050 | 0.020 | 0.030 | 0.010 | 0.010 | 0.011 |
| *Flwre* | 0.015 | 0.005 | 0.570 | 0.540 | 0.040 | 0.040 | 0.020 | 0.010 | 0.009 |
| *Frtre* | 0.008 | 0.003 | 1.574 | 0.117 | 0.015 | 0.028 | 0.007 | 0.003 | 0.005 |
| *Surv* | 116.4 | 67.6 | 13105.0 | 601.0 | 95.0 | 243.0 | 119.0 | 50.7 | 87.7 |
| *Ht* (25 sites) | 0.27 | 0.15 | 143.24 | 6.66 | 1.08 | 0.42 | 0.31 | 0.39 | 0.20 |
| *Dbh* (21 sites) | 0.24 | 0.13 | 73.28 | 9.00 | 1.27 | 0.36 | 0.30 | 0.29 | 0.17 |
| *Surv* (25 sites) | 141.2 | 66.3 | 10463 | 815 | 179 | 177 | 158 | 137 | 118 |

Note: *Ht* = height; *Dbh* = diameter at breast height; *Axpst* = axis persistence; *Strst* = stem straightness; characteristics of permanent branches, *Denpb* = density, *Thkpb* = thickness, *Angpb* = angle, *Lenpb* = length; characteristics of deciduous branchlets, *Lendb* = length, *Thkdb* = thickness; *Stmhe* = stem damage; *Folhe* = foliage damage; *Flwre* = flowering; *Frtre* = fruiting; *Surv* = survival. See text for full explanation.

(numbers 29–45, in dark blue colour) and Africa (numbers 46–58, in light blue colour). The introduced Asian seed sources align more closely to the natural provenances from Southeast Asia, suggesting that early introductions into Asia might have originated from Southeast Asian countries. Many seedlots from Africa position closer to Australia and the Pacific, although at least two seedlots — Benin (46) and Mauritius (58) — are close to those from Asia and Southeast Asia.

**Table 6.** Joint regression analysis results for height (*Ht*) at 14 and 25 sites and for diameter at breast height (*Dbh*) at 14 and 21 sites.

| Prov. No. | CSIRO No. | *Ht* 14 sites | | *Dbh* 14 sites | | *Ht* 25 sites | | *Dbh* 21 sites | |
|---|---|---|---|---|---|---|---|---|---|
| | | seedmn | coeff | seedmn | coeff | seedmn | coeff | seedmn | coeff |
| 1 | 15958 | 3.82 | 0.89 | 2.67 | 0.82 | 3.71 | 0.90 | 2.63 | 0.83 |
| 2 | 16166 | 3.82 | 1.03 | 2.74 | 0.93 | 3.88 | 1.06 | 2.88 | 1.02 |
| 3 | 18008 | 4.46 | 1.00 | 2.98 | 0.82 | 4.41 | 1.00 | 3.04 | 0.83 |
| 5 | 18153 | 4.47 | 1.23 | 3.09 | 1.13 | 4.50 | 1.10 | 3.29 | 1.09 |
| 6 | 18270 | 3.86 | 0.94 | 2.62 | 0.91 | 3.83 | 0.93 | 2.72 | 0.99 |
| 7 | 18271 | 4.03 | 0.84 | 2.58 | 0.71 | 4.02 | 0.84 | 2.66 | 0.75 |
| 8 | 18272 | 4.29 | 1.05 | 2.89 | 0.95 | 4.14 | 0.89 | 2.84 | 0.81 |
| 9 | 18121 | 3.82 | 0.90 | 2.70 | 0.81 | 3.68 | 0.81 | 2.71 | 0.80 |
| 10 | 18402 | * | * | * | * | 4.34 | 0.97 | 3.44 | 1.08 |
| 12 | 18312 | 4.17 | 1.11 | 2.98 | 1.12 | 4.30 | 1.09 | 3.22 | 1.12 |
| 13 | 18157 | 4.55 | 1.15 | 3.36 | 1.26 | 4.48 | 1.09 | 3.46 | 1.18 |
| 14 | 18158 | 4.66 | 1.06 | 3.35 | 0.96 | 4.68 | 1.03 | 3.51 | 1.04 |
| 15 | 18160 | * | * | * | * | 4.33 | 0.94 | 3.42 | 1.13 |
| 17 | 18244 | 4.79 | 1.23 | 3.38 | 1.18 | 4.66 | 1.12 | 3.45 | 1.18 |
| 18 | 18348 | 4.45 | 0.94 | 3.31 | 1.01 | 4.30 | 0.92 | 3.31 | 1.03 |
| 22 | 18117 | 4.38 | 1.11 | 2.94 | 0.98 | 4.36 | 1.05 | 2.93 | 1.03 |
| 23 | 18154 | 4.10 | 0.74 | 3.11 | 0.84 | 4.25 | 0.87 | 3.17 | 0.87 |
| 25 | 18296 | 4.33 | 0.99 | 3.19 | 1.07 | 4.43 | 1.07 | 3.32 | 1.12 |
| 26 | 18297 | 4.55 | 1.14 | 3.42 | 1.09 | 4.53 | 1.13 | 3.53 | 1.11 |
| 27 | 18298 | 4.54 | 1.07 | 3.66 | 1.13 | 4.54 | 1.13 | 3.76 | 1.24 |
| 28 | 18299 | 4.35 | 1.10 | 3.15 | 1.16 | 4.43 | 1.12 | 3.47 | 1.25 |
| 29 | 18267 | 4.38 | 1.08 | 3.13 | 1.03 | 4.43 | 1.08 | 3.25 | 1.03 |
| 30 | 18268 | 4.69 | 0.91 | 3.55 | 0.95 | 4.59 | 0.99 | 3.47 | 0.99 |
| 32 | 18013 | 4.52 | 1.01 | 3.38 | 1.17 | 4.37 | 0.98 | 3.39 | 1.03 |
| 33 | 18014 | 4.32 | 1.02 | 3.31 | 1.04 | 4.27 | 0.96 | 3.39 | 1.01 |
| 34 | 18015 | 4.53 | 1.12 | 3.40 | 1.21 | 4.36 | 1.00 | 3.29 | 1.00 |
| 35 | 18118 | 4.50 | 1.02 | 3.07 | 1.15 | 4.54 | 1.04 | 3.25 | 1.15 |
| 36 | 18119 | 4.19 | 0.93 | 3.04 | 1.05 | 4.20 | 0.94 | 3.16 | 1.03 |
| 39 | 18287 | 4.04 | 0.99 | 3.01 | 0.96 | 4.17 | 1.04 | 3.14 | 1.01 |
| 40 | 18288 | 4.52 | 1.09 | 3.38 | 1.04 | 4.54 | 1.12 | 3.44 | 1.06 |
| 41 | 18085 | 4.54 | 0.79 | 3.16 | 0.94 | 4.44 | 0.95 | 3.28 | 0.98 |
| 42 | 18086 | 4.83 | 0.98 | 3.56 | 0.99 | 4.75 | 0.93 | 3.58 | 0.85 |
| 43 | 18127 | 5.05 | 1.00 | 3.71 | 1.14 | 4.83 | 0.91 | 3.66 | 0.99 |
| 44 | 18128 | 4.36 | 0.90 | 3.28 | 1.01 | 4.51 | 1.04 | 3.41 | 1.06 |
| 45 | 18152 | 3.74 | 0.80 | 2.58 | 0.86 | 4.01 | 0.92 | 2.83 | 0.88 |
| 46 | 18355 | 4.57 | 0.93 | 3.36 | 0.91 | 4.68 | 0.97 | 3.58 | 1.00 |

Note: only seedlots represented at four or more sites were included, namely 43 seedlots for 14 sites and 47 seedlots for all sites.

**Table 6.** (cont'd) Joint regression analysis results for height (*Ht*) at 14 and 25 sites and for diameter at breast height (*Dbh*) at 14 and 21 sites.

| Prov. No. | CSIRO No. | *Ht* 14 sites | | *Dbh* 14 sites | | *Ht* 25 sites | | *Dbh* 21 sites | |
|---|---|---|---|---|---|---|---|---|---|
| | | seedmn | coeff | seedmn | coeff | seedmn | coeff | seedmn | coeff |
| 47 | 18122 | 3.99 | 0.89 | 2.78 | 0.91 | 3.85 | 0.87 | 2.70 | 0.84 |
| 48 | 18125 | 4.05 | 0.98 | 2.84 | 0.94 | 4.10 | 1.08 | 2.94 | 1.00 |
| 49 | 18126 | 4.37 | 0.57 | 2.97 | 0.56 | 4.05 | 0.82 | 2.74 | 0.70 |
| 50 | 18134 | 4.03 | 0.93 | 2.93 | 1.01 | 4.16 | 0.98 | 2.98 | 1.07 |
| 51 | 18135 | * | * | * | * | 4.01 | 1.03 | 3.06 | 0.93 |
| 52 | 18136 | * | * | * | * | 4.21 | 1.11 | 3.03 | 1.03 |
| 53 | 18137 | 4.11 | 0.91 | 2.90 | 0.97 | 4.00 | 1.05 | 2.89 | 1.03 |
| 55 | 18142 | 4.44 | 0.99 | 3.04 | 0.93 | 4.39 | 0.97 | 3.11 | 0.91 |
| 56 | 18143 | 3.91 | 0.99 | 2.76 | 0.90 | 3.60 | 0.79 | 2.73 | 0.81 |
| 58 | 18565 | 4.29 | 1.12 | 3.07 | 1.12 | 4.19 | 0.98 | 3.13 | 1.06 |
| 59 | 18752 | 4.28 | 1.11 | 3.04 | 1.08 | 4.23 | 1.07 | 3.13 | 1.07 |

Note: only seedlots represented at four or more sites were included, namely 43 seedlots for 14 sites and 47 seedlots for all sites.

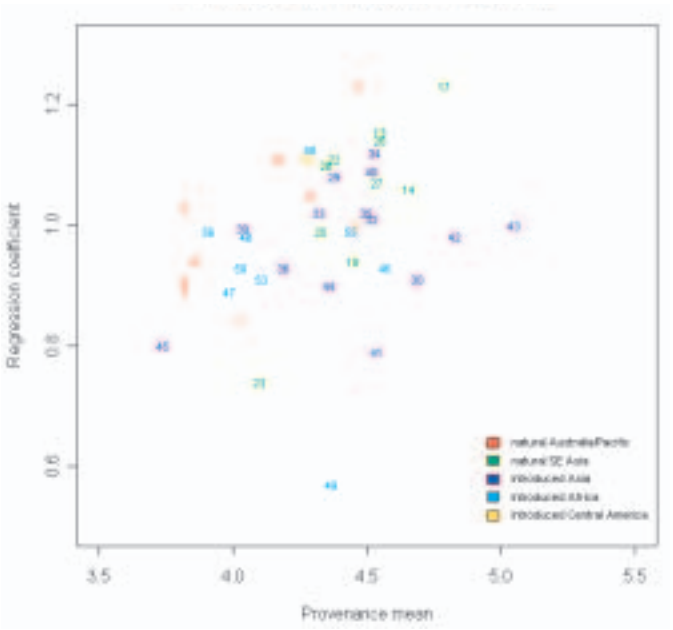


**Figure 10.** Joint regression analysis for height (*Ht*) (14 sites). Different colours indicate the regional origin of the provenances.

**Table 7.** Correlation matrix for 14 growth and morphological characteristics.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Ht* | 1.000 | | | | | | | | | | | | | |
| *Dbh* | 0.787 | 1.000 | | | | | | | | | | | | |
| *Axpst* | 0.320 | 0.181 | 1.000 | | | | | | | | | | | |
| *Strst* | 0.250 | 0.173 | 0.675 | 1.000 | | | | | | | | | | |
| *Denpb* | –0.049 | –0.141 | –0.580 | –0.548 | 1.000 | | | | | | | | | |
| *Thkpb* | –0.186 | –0.437 | 0.411 | 0.449 | –0.373 | 1.000 | | | | | | | | |
| *Angpb* | 0.082 | 0.079 | 0.170 | –0.082 | 0.064 | –0.033 | 1.000 | | | | | | | |
| *Lenpb* | –0.041 | –0.245 | 0.437 | 0.453 | –0.355 | 0.668 | 0.059 | 1.000 | | | | | | |
| *Lendb* | –0.178 | –0.142 | 0.005 | 0.076 | –0.095 | 0.296 | 0.146 | 0.293 | 1.000 | | | | | |
| *Thkdb* | –0.248 | –0.240 | –0.196 | 0.077 | 0.094 | 0.247 | –0.087 | 0.205 | 0.688 | 1.000 | | | | |
| *Stmhe* | 0.112 | 0.064 | 0.160 | 0.096 | –0.036 | –0.048 | 0.233 | 0.107 | –0.023 | –0.190 | 1.000 | | | |
| *Folhe* | 0.392 | 0.556 | 0.044 | 0.036 | –0.066 | –0.272 | –0.234 | –0.209 | –0.311 | –0.361 | 0.263 | 1.000 | | |
| *Flwre* | 0.131 | 0.070 | 0.368 | 0.266 | –0.227 | 0.053 | –0.227 | –0.031 | –0.224 | –0.094 | –0.006 | 0.283 | 1.000 | |
| *Frtre* | –0.064 | 0.064 | –0.204 | –0.297 | 0.096 | –0.068 | 0.219 | –0.109 | 0.097 | –0.175 | –0.093 | –0.070 | –0.733 | 1.000 |
| | | | | | | | | | | | | | | |
| | *Ht* | *Dbh* | *Axpst* | *Strst* | *Denpb* | *Thkpb* | *Angpb* | *Lenpb* | *Lendb* | *Thkdb* | *Stmhe* | *Folhe* | *Flwre* | *Frtre* |

Note: *Ht* = height; *Dbh* = diameter at breast height; *Axpst* = axis persistence; *Strst* = stem straightness; characteristics of permanent branches, *Denpb* = density, *Thkpb* = thickness, *Angpb* = angle, Lenpb = length; characteristics of deciduous branchlets, *Lendb* = length, *Thkdb* = thickness; *Stmhe* = stem damage; *Folhe* = foliage damage; *Flwre* = flowering; *Frtre* = fruiting. See text for full explanation.

**Table 8.** The first two principal component loadings weighted according to the standard deviations of 14 characteristics from individual site analyses.

| Variate | Loadings | |
|---|---|---|
| | pcp1 | pcp2 |
| *Ht* | –0.0756 | 0.2614 |
| *Dbh* | –0.0183 | 0.3739 |
| *Axpst* | –0.4191 | 0.1287 |
| *Strst* | –0.6122 | 0.0599 |
| *Denpb* | 0.3019 | –0.0404 |
| *Thkpb* | –0.3468 | –0.3117 |
| *Angpb* | 0.0260 | –0.0483 |
| *Lenpb* | –0.3234 | –0.2513 |
| *Lendb* | –0.0870 | –0.4397 |
| *Thkdb* | –0.0600 | –0.4409 |
| *Stmhe* | –0.0198 | 0.0331 |
| *Folhe* | 0.0001 | 0.2811 |
| *Flwre* | –0.2883 | 0.3567 |
| *Frtre* | 0.1795 | –0.1113 |

Note: *Ht* = height; *Dbh* = diameter at breast height; *Axpst* = axis persistence; *Strst* = stem straightness; characteristics of permanent branches, *Denpb* = density, *Thkpb* = thickness, *Angpb* = angle, *Lenpb* = length; characteristics of deciduous branchlets, *Lendb* = length, *Thkdb* = thickness; *Stmhe* = stem damage; *Folhe* = foliage damage; *Flwre* = flowering; *Frtre* = fruiting. See text for full explanation.

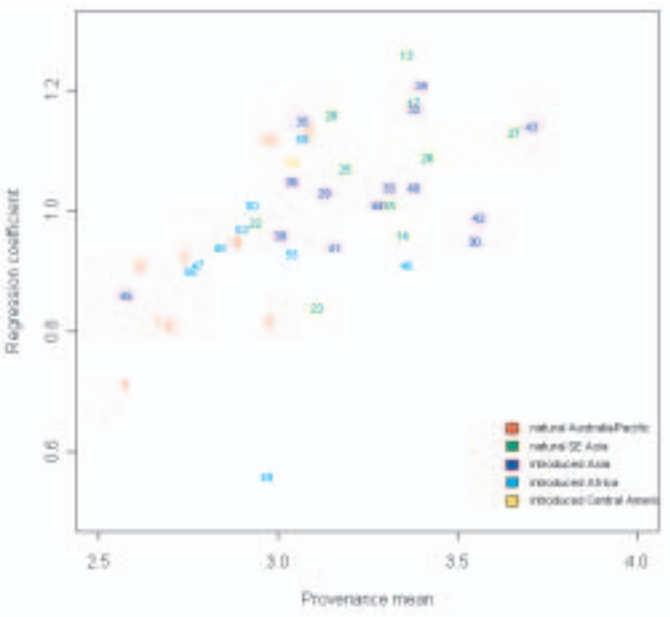


**Figure 11.** Joint regression analysis for diameter at breast height (*Dbh*) (14 sites) Different colours indicate the regional origin of the provenances.

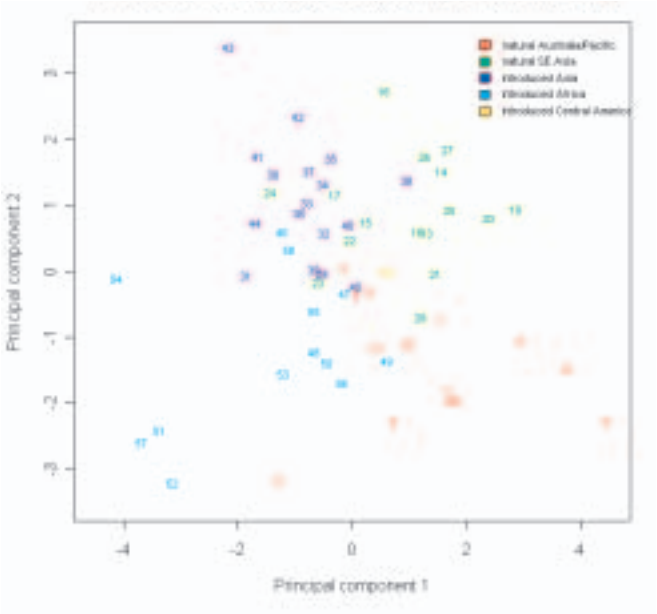


**Figure 12.** Plot of scores for principal components 1 and 2 (14 sites). Different colours indicate the regional origin of the provenances.

# 7 Conclusions

Results of these international provenance trials reveal a considerable amount of genetic variation among provenances and land races of *C. equisetifolia*. There was evidence of a significant site-by-provenance interaction, although it was not as large as we had anticipated from the numerous and diverse provenances involved. In general, much of the variation between provenances could be best explained by country or region effects. This conclusion was further strengthened by the results obtained from the principal component analysis, which revealed a separation between natural provenances from Southeast Asia and Australia/Pacific, and a separation between introduced populations from Asia and Africa.

The following general trends are evident at the country and region levels:

- Natural provenances from Southeast Asia and land races from Asia were generally more vigorous, while natural provenances from Australia/Pacific region grew slowest. However, a few individual seedlots from Australia/Pacific and Africa were also fast-growing.
- Most seed sources had good axis persistence (i.e. good length of bole), but trees from planted stands scored better in terms of stem straightness.
- Although there were differences in the branching habit among seed sources of *C. equisetifolia*, in general trees were densely branched with horizontal branches. These characteristics, together with the fine, needle-like branchlets, are the basis of the species' suitability for planting as windbreaks in coastal areas.
- Although there was little evidence of any provenance variation in flowering, introduced populations from Asia and Africa appeared to flower more intensively than those from other regions, and especially those from the natural distribution.

This series of international provenance trials confirms the wide adaptability of *C. equisetifolia*. Though a littoral species in its natural habitats, it is well adapted to inland areas, as confirmed by the location of many of these provenance trials. No one provenance showed superior performance for all growth traits. For example, some provenances in Southeast Asia grew vigorously but their stem form was inferior to land races from Africa. However, provenance performance should be judged by the capacity to satisfy the planting objectives. If firewood production is the main objective, selection of fast-growing provenances, irrespective of form, is appropriate. If pole production is the main objective, provenances with good axis persistence and stem straightness are more suitable. Likewise, good stem axis persistence and high branch density are desirable traits for windbreak planting. The growth and morphological data presented in Appendixes 1 and 2 can be used to assist the selection of particular seed sources to match planting sites and objectives.

Seed production areas can be established based on the good-performing provenances. In addition, individual countries wishing to embark on a breeding program for *C. equisetifolia* should examine the results from sites of similar ecological conditions to develop a breeding strategy. Countries such as China, India and Vietnam will benefit greatly from the introduction of a new breeding population, judging from the

greater productivity of new seed sources when compared with existing local genetic material in many trials. Although different strategies may be required for different countries, we recommend starting with a single breeding population comprising good-performing provenances from all regions. Due consideration must be given to the earlier and heavier flowering of land races relative to natural provenances, as this would affect the output from multi-provenance seed orchards. Flowering phenology among provenances needs to be investigated.

# 8 Acknowledgments

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| | |
|---|---|
| *Australia* | Comalco Minerals and Alumina, Weipa, Queensland |
| *Benin* | Unite Recherche Forestière, Cotonou |
| *Cuba* | Instituto de Investigaciones Forestales, Havana |
| *Egypt* | Desert Development Center, American University in Cairo |
| *Fiji* | Forestry Department, Suva |
| *Guam* | Division of Forestry and Soil Resources, Department of Agriculture, Agana |
| *Honduras* | Conservacion y Silvicultura de Especies Forestales, Siguatepeque |
| *India:* | BAIF Development Research Foundation, Warje, Pune<br>Institute of Forest Genetics and Tree Breeding, Coimbatore<br>Silvicultural Research Division, Bhubaneswar, Orissa<br>Tamil Nadu Forestry Department (Research), Coimbatore |
| *Kenya* | Kenya Forestry Research Institute, Muguga |
| *Kiribati* | Forest and Tree Resources Development, Department of Agriculture, Tarawa |
| *Malawi* | Forestry Research Institute, Zomba |
| *Malaysia* | Forestry Department, Kuching, Sarawak<br>Forest Research Centre, Forestry Department, Sabah<br>Universiti Pertanian Malaysia, Selangor (now Universiti Putra Malaysia) |
| *Mauritius* | Forestry Service, Ministry of Agriculture and Natural Resources, Curepipe |
| *Pakistan* | Atomic Energy Agricultural Research Centre, Tando Jam, Sindh |
| *Papua New Guinea* | Papua New Guinea Forest Research Institute, Lae |
| *People's Republic of China* | China Eucalypt Research Centre, Zhanjiang, Guangdong<br>Fujian Forestry Research Institute, Fuzhou<br>Research Institute of Tropical Forestry, Longdong, Guangzhou |
| *Philippines* | Ecosystems Research and Development Bureau, College, Laguna |
| *Puerto Rico* | Southern Forest Experiment Station, Institute of Tropical Forestry, Tree Seed Laboratory, Rio Piedras |
| *Republic of China* | Taiwan Forestry Research Institute, Taipei |

| | |
|---|---|
| *Samoa* | School of Agriculture, University of the South Pacific, Alafua Campus, Apia |
| *Solomon Islands* | Forest Research Station, Munda, Western Province |
| *Sri Lanka* | Coconut Research Institute, Lunuwilla<br>Forest Research Center, Department of Forest Conservation, Boyagane, Kurunegala<br>University of Jayewardenepura, Nugegoda<br>University of Peradeniya, Peradeniya |
| *Thailand* | Faculty of Forestry, Kasetsart University, Bangkok<br>Royal Forest Department, Bangkok |
| *Tonga* | Forestry, Ministry of Agriculture and Forests, Nuku'alofa |
| *Vanuatu* | Department of Forestry, Port Vila |
| *Vietnam* | Research Centre for Forest Tree Improvement, Forest Science Institute of Vietnam, Hanoi. |

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(printed version published in 2004)

# Appendixes

Evaluation of international provenance trials of *Casuarina equisetifolia*
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ACIAR Technical Reports No 58e
(printed version published in 2004)

**Appendix 1.1** Mean values for survival (percentage of plants at stated number of months after planting) (*Surv*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 100 | 98 | 88 | 73 | 46 | 68 | 8 | 55 | 75 | 63 | | 92 | 83 | 50 |
| | 2 | 16166 | 101 | | | 70 | | | | | | 64 | 63 | | 95 | 33 |
| | 3 | 18008 | 97 | 94 | 93 | 66 | 52 | 32 | 13 | 42 | 100 | | | 42 | 80 | 47 |
| | 4 | 18378 | 101 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 94 | 99 | 90 | 61 | 67 | 42 | 8 | | 92 | 27 | 66 | 76 | 98 | |
| Fiji | 6 | 18270 | 96 | 100 | 84 | | 44 | 43 | | | 100 | | | | | |
| | 7 | 18271 | 99 | 99 | 86 | 75 | 56 | 56 | | | 73 | | | 73 | | |
| | 8 | 18272 | 99 | | | | | | | | | | 68 | | 92 | 39 |
| Guam | 9 | 18121 | 99 | 96 | 94 | 69 | 50 | 59 | 4 | 56 | | | 74 | 55 | 83 | 40 |
| Solomon | 10 | 18402 | 100 | | | | | | | | | | | | 93 | 52 |
| | 11 | 18403 | 98 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 99 | | | 75 | 45 | | | | | | 54 | 60 | 95 | |
| Tonga | 12a | 18040 | | | | 60 | 52 | | 1 | | | | | | | |
| **Region mean** | | | 98 | 98 | 89 | 69 | 52 | 50 | 7 | 51 | 88 | 51 | 65 | 66 | 90 | 44 |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 96 | 100 | 81 | 53 | 27 | 53 | | 62 | 77 | 44 | 57 | 37 | | |
| | 14 | 18158 | 94 | 96 | 88 | 46 | 44 | 38 | 18 | 45 | 98 | 31 | | 66 | 94 | 40 |
| | 15 | 18160 | 100 | | | | | | | 53 | | | | | | |
| | 16 | 18161 | 97 | | | | | | | | | 48 | | | | |
| | 17 | 18244 | 99 | 97 | 94 | 51 | 44 | 39 | | 49 | 81 | 63 | 75 | 49 | | |
| | 18 | 18348 | 102 | | | 43 | 50 | | | | | | | 47 | 80 | |
| | 19 | 18374 | 94 | | | | | | | | | | 77 | | | |
| | 20 | 18375 | 95 | | | | | | | | | | | | | |
| | 21 | 18376 | 98 | | | | | | | | | | | | | 23 |

**Appendix 1.1** (cont'd) Mean values for survival (percentage of plants at stated number of months after planting) (*Surv*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 95 | 96 | 90 | 43 | 41 | 63 | | | 35 | 65 | | | 99 | |
| | 23 | 18154 | 96 | 97 | 86 | | 64 | 69 | 26 | 63 | 50 | 40 | 71 | 58 | | |
| | 24 | 18357 | 98 | | | | 49 | | | | | | | | | |
| Thailand | 25 | 18296 | 99 | | 90 | 33 | 45 | 49 | | | 79 | | 74 | 86 | | |
| | 26 | 18297 | 98 | | 82 | 43 | 65 | 45 | | | 100 | | | | 93 | 40 |
| | 27 | 18298 | 95 | 99 | 88 | 28 | 63 | 15 | | | | | 67 | 77 | | |
| | 28 | 18299 | 100 | 100 | | 41 | 62 | | | | | | 82 | | 91 | 50 |
| **Region mean** | | | 97 | 98 | 87 | 42 | 50 | 46 | 22 | 54 | 74 | 48 | 72 | 60 | 91 | 38 |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 97 | 88 | 87 | 62 | 47 | 49 | | | 96 | | 78 | 68 | | |
| | 30 | 18268 | 98 | 99 | 83 | 56 | 57 | 46 | | | 85 | | | 56 | | |
| | 31 | 18586 | 96 | | | | | | | | | | | | 85 | |
| India | 32 | 18013 | 100 | 99 | 89 | 65 | 45 | 44 | 40 | 45 | 98 | 67 | | | | |
| | 33 | 18014 | 97 | 100 | 88 | 71 | 55 | 42 | | 63 | 81 | 43 | | 65 | 93 | 44 |
| | 34 | 18015 | 101 | | | 48 | 58 | | | 61 | | 48 | 84 | | 95 | 46 |
| | 35 | 18118 | 94 | 98 | 94 | 53 | 62 | 41 | 42 | | 100 | | | | | |
| | 36 | 18119 | 101 | 99 | 75 | 48 | 56 | 47 | | | 88 | 60 | 71 | 81 | 91 | |
| | 37 | 18120 | 98 | | | | 57 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 97 | | | | | | | | | | | | | |
| | 39 | 18287 | 99 | | 88 | 67 | 40 | 41 | | | 73 | | 65 | 79 | 92 | |
| | 40 | 18288 | 96 | | 85 | 58 | 48 | 56 | | | | | 41 | | | |
| Vietnam | 41 | 18085 | 99 | 94 | 91 | | | 44 | 45 | 71 | 77 | | | 72 | | |
| | 42 | 18086 | 100 | | | | 47 | | | | | 57 | | | 98 | 45 |
| | 43 | 18127 | 100 | | | 38 | 51 | | 53 | | | 47 | | | 97 | |
| | 44 | 18128 | 100 | 100 | 87 | 44 | 62 | 67 | | 68 | 98 | 52 | 69 | 84 | | |
| | 45 | 18152 | 99 | | | 57 | 53 | | | 53 | | | 49 | | | |
| **Region mean** | | | 98 | 97 | 87 | 56 | 53 | 48 | 45 | 60 | 88 | 53 | 65 | 72 | 93 | 45 |

**Appendix 1.1** (cont'd) Mean values for survival (percentage of plants at stated number of months after planting) (*Surv*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 100 | | | 67 | 61 | | | | | | 69 | 65 | 91 | 28 |
| Egypt | 47 | 18122 | 91 | 98 | 94 | 70 | 62 | 53 | 11 | 43 | 92 | 61 | | 66 | | |
| | 48 | 18125 | 94 | 91 | 88 | | 36 | 49 | | 61 | 100 | 71 | 64 | 48 | | |
| | 49 | 18126 | 100 | | | | | | | | | 40 | | | 92 | 30 |
| Kenya | 50 | 18134 | 96 | 92 | 79 | 51 | 40 | 62 | 11 | 71 | 88 | 63 | | 75 | | |
| | 51 | 18135 | 100 | | | | | | | | | 55 | | | | |
| | 52 | 18136 | 100 | | | | | | | | | 64 | | | | |
| | 53 | 18137 | 97 | 99 | 92 | 63 | 62 | 77 | 44 | 78 | 92 | 47 | | 64 | | |
| | 54 | 18141 | 100 | | | | | | | | | | | | | |
| | 55 | 18142 | 99 | | | 78 | 48 | | | 74 | | | | | 91 | 37 |
| | 56 | 18143 | 99 | | | 65 | 42 | | | | | 51 | 84 | | | |
| | 57 | 18144 | 100 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 93 | | | | | | | | | | 90 | | 96 | 36 |
| **Region mean** | | | 98 | 95 | 88 | 66 | 50 | 60 | 22 | 65 | 93 | 56 | 77 | 64 | 93 | 33 |
| Puerto Rico | 59 | 18752 | 100 | | | | | | | | | | 71 | | 94 | 37 |
| **Overall mean** | | | 98 | 97 | 88 | 57 | 51 | 50 | 23 | 58 | 85 | 53 | 69 | 66 | 92 | 40 |
| | | RMS | 23.55 | 19.89 | 133.60 | 293.20 | 550.00 | 152.50 | 390.80 | 265.70 | 358.10 | 464.00 | 389.90 | 253.70 | 88.32 | 422.80 |
| | | SED | 3.03 | 3.15 | 8.17 | 12.11 | 18.26 | 8.73 | 13.98 | 11.53 | 15.45 | 17.59 | 13.96 | 11.26 | 6.65 | 14.54 |
| | | Prov. | ns | ns | ns | ns | ns | *** | ns | ns | ns | * | ns | *** | ns | ns |
| | | Country | ns | ns | ns | ns | ns | *** | ns | ** | *** | ns | ns | *** | ns | ns |
| | | Region | ns | ns | ns | *** | ns | *** | *** | ns | ns | * | ns | ns | ns | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.2** Mean values for height growth *(Ht)* in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 4.3 | 6.1 | 3.2 | 3.4 | 1.4 | 3.3 | 1.9 | 3.7 | 4.0 | 2.7 | | 6.3 | 6.2 | 5.5 |
| | 2 | 16166 | 4.5 | | | 2.8 | | | | | | 3.2 | 1.4 | | 7.2 | 3.8 |
| | 3 | 18008 | 4.7 | 6.6 | 3.4 | 3.5 | 2.0 | 3.4 | 2.3 | 4.2 | 7.3 | | | 6.6 | 6.7 | 6.1 |
| | 4 | 18378 | 4.7 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 5.6 | 7.4 | 3.2 | 3.0 | 1.7 | 3.2 | 1.8 | 4.1 | 7.4 | 2.9 | 1.9 | 7.0 | 7.8 | |
| Fiji | 6 | 18270 | 4.1 | 6.5 | | | 1.4 | 3.1 | | | 4.9 | | | | | |
| | 7 | 18271 | 4.6 | 6.1 | 3.0 | 2.8 | 2.0 | 3.2 | | | 4.7 | | | 6.6 | | |
| | 8 | 18272 | 4.1 | | 3.0 | | | | | | 7.1 | | 1.7 | | 5.9 | 6.4 |
| Guam | 9 | 18121 | 4.2 | 6.1 | 3.0 | 2.7 | 1.4 | 3.0 | 2.4 | 3.5 | | | 1.7 | 6.0 | 5.7 | 5.7 |
| Solomon | 10 | 18402 | 4.8 | | | | | | | | | | | | 7.9 | 5.1 |
| | 11 | 18403 | 5.1 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 4.3 | | | 3.2 | 1.3 | | | | | | 1.4 | 6.6 | 7.7 | |
| Tonga | 12a | 18040 | | | | 2.6 | 1.6 | | 2.7 | | | | | | | |
| **Region mean** | | | **4.6** | **6.5** | **3.2** | **3.0** | **1.6** | **3.2** | **2.2** | **3.9** | **5.9** | **2.9** | **1.6** | **6.5** | **6.9** | **5.4** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 5.4 | 7.2 | 2.8 | 3.3 | 1.2 | 3.5 | | 4.6 | 6.5 | 3.8 | 2.0 | 7.1 | | |
| | 14 | 18158 | 5.1 | 7.1 | 3.4 | 3.1 | 1.8 | 3.6 | 3.5 | 4.7 | 7.6 | 3.5 | | 7.2 | 7.5 | 4.9 |
| | 15 | 18160 | 5.4 | | | | | | | 4.3 | | | | | | |
| | 16 | 18161 | 5.5 | | | | | | | | | 3.6 | | | | |
| | 17 | 18244 | 5.5 | 7.3 | 3.4 | 4.0 | 1.4 | 3.2 | | 4.4 | 7.1 | 3.7 | 1.8 | 8.0 | | |
| | 18 | 18348 | 4.9 | | | 3.4 | 1.9 | | | | | | | 7.3 | 6.5 | |
| | 19 | 18374 | 4.9 | | | | | | | | | | 2.3 | | | |
| | 20 | 18375 | 4.7 | | | | | | | | | | | | | |
| | 21 | 18376 | 5.3 | | | | | | | | | | | | | 5.5 |

**Appendix 1.2** (cont'd) Mean values for height growth *(Ht)* in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 5.1 | 7.3 | 3.3 | 2.3 | 1.6 | 3.7 | | | 4.7 | 3.6 | | | 7.9 | |
| | 23 | 18154 | 5.0 | 6.3 | 3.2 | | 2.2 | 4.2 | 3.4 | 4.2 | 3.2 | 2.4 | 2.4 | 6.7 | | |
| | 24 | 18357 | 5.0 | | | | 1.8 | | | | | | | | | |
| Thailand | 25 | 18296 | 5.4 | | 3.3 | 2.8 | 1.4 | 3.3 | | | 5.5 | | 2.5 | 6.8 | | |
| | 26 | 18297 | 4.7 | | 3.2 | 2.9 | 2.0 | 3.5 | | | 6.6 | | | | 8.1 | 5.2 |
| | 27 | 18298 | 5.3 | 7.1 | 3.3 | 3.7 | 1.7 | 3.0 | | | | | 2.1 | 7.2 | | |
| | 28 | 18299 | 4.6 | 7.4 | | 3.1 | 1.4 | | | | | | 2.1 | | 7.4 | 5.1 |
| **Region mean** | | | **5.1** | **7.1** | **3.2** | **3.2** | **1.7** | **3.5** | **3.4** | **4.4** | **5.9** | **3.4** | **2.2** | **7.2** | **7.5** | **5.1** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 5.1 | 6.5 | 3.2 | 2.7 | 1.3 | 3.4 | | | 6.7 | | 2.2 | 7.0 | | |
| | 30 | 18268 | 5.0 | 6.8 | 3.4 | 3.9 | 2.4 | 3.6 | | | 6.5 | | | 6.9 | | |
| | 31 | 18586 | 4.7 | | | | | | | | | | | | 6.5 | |
| India | 32 | 18013 | 4.5 | 6.3 | 3.2 | 2.9 | 1.5 | 3.1 | 3.9 | 4.5 | 7.1 | 4.1 | | | | |
| | 33 | 18014 | 4.9 | 6.3 | 3.0 | 3.0 | 1.7 | 3.7 | | 4.5 | 6.3 | 2.9 | | 6.6 | 7.3 | 5.6 |
| | 34 | 18015 | 4.6 | | | 3.1 | 1.7 | | | 4.9 | | 3.1 | 2.1 | | 7.6 | 5.8 |
| | 35 | 18118 | 5.0 | 7.0 | 2.8 | 3.7 | 1.5 | 3.4 | 3.7 | | 5.9 | | | | | |
| | 36 | 18119 | 5.1 | 6.7 | 3.4 | 2.9 | 1.7 | 3.1 | | | 4.9 | 3.3 | 2.1 | 6.5 | 6.8 | |
| | 37 | 18120 | 4.5 | | | | 1.6 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 4.3 | | | | | | | | | | | | | |
| | 39 | 18287 | 4.5 | | 3.1 | 2.8 | 1.1 | 3.5 | | | 5.2 | | 2.1 | 6.8 | 6.5 | |
| | 40 | 18288 | 4.6 | | 3.5 | 4.0 | 1.1 | 3.4 | | | | | 2.1 | | | |
| Vietnam | 41 | 18085 | 4.7 | 6.5 | 3.6 | | | 3.5 | 4.1 | 4.1 | 5.6 | | | 6.9 | | |
| | 42 | 18086 | 4.9 | | | | 2.2 | | | | | 3.9 | | | 7.5 | 6.1 |
| | 43 | 18127 | 5.1 | | | 3.9 | 1.7 | | 4.7 | | | 4.1 | | | 7.7 | |
| | 44 | 18128 | 4.4 | 6.7 | 3.5 | 4.1 | 1.6 | 3.6 | | 4.6 | 4.9 | 3.2 | 2.3 | 6.9 | | |
| | 45 | 18152 | 4.1 | | | 2.6 | 1.5 | | | 3.8 | | | 2.2 | | | |
| **Region mean** | | | **4.7** | **6.6** | **3.3** | **3.3** | **1.6** | **3.4** | **4.1** | **4.4** | **5.9** | **3.5** | **2.2** | **6.8** | **7.1** | **5.8** |

**Appendix 1.2** (cont'd) Mean values for height growth *(Ht)* in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 5.0 | | | 3.8 | 2.1 | | | | | | 2.2 | 7.0 | 7.0 | 5.6 |
| Egypt | 47 | 18122 | 4.0 | 6.7 | 3.0 | 2.7 | 1.9 | 3.2 | 2.9 | 4.4 | 4.2 | 2.8 | | 6.7 | | |
| | 48 | 18125 | 3.8 | 6.0 | 3.1 | | 1.5 | 3.1 | | 3.7 | 6.4 | 4.0 | 1.3 | 6.5 | | |
| | 49 | 18126 | 4.0 | | | | | | | | | 4.1 | | | 6.0 | 5.3 |
| Kenya | 50 | 18134 | 4.7 | 6.7 | 2.9 | 3.0 | 2.1 | 3.7 | 1.7 | 3.8 | 4.1 | 3.4 | | 7.0 | | |
| | 51 | 18135 | 5.0 | | | | | | | | | 3.1 | | | | |
| | 52 | 18136 | 5.1 | | | | | | | | | 3.1 | | | | |
| | 53 | 18137 | 5.3 | 6.9 | 3.5 | 3.1 | 1.7 | 3.4 | 2.4 | 4.2 | 4.1 | 2.8 | | 6.4 | | |
| | 54 | 18141 | 5.6 | | | | | | | | | | | | | |
| | 55 | 18142 | 5.4 | | | 3.1 | 1.8 | | | 4.0 | | | | | 6.7 | 6.0 |
| | 56 | 18143 | 4.4 | | | 3.1 | 1.3 | | | | | 2.4 | 1.7 | | | |
| | 57 | 18144 | 4.8 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 4.5 | | | | | | | | | | 1.8 | | 7.1 | 6.0 |
| **Region mean** | | | **4.7** | **6.6** | **3.1** | **3.1** | **1.8** | **3.3** | **2.3** | **4.0** | **4.7** | **3.2** | **1.7** | **6.7** | **6.7** | **5.7** |
| Puerto Rico | 59 | 18752 | 4.9 | | | | | | | | | | 1.8 | | 7.5 | 5.1 |
| **Overall mean** | | | **4.8** | **6.7** | **3.2** | **3.2** | **1.7** | **3.4** | **3.0** | **4.2** | **5.7** | **3.3** | **2.0** | **6.8** | **7.1** | **5.5** |
| | | RMS | 0.2799 | 0.3580 | 0.2801 | 0.8765 | 0.2705 | 0.2535 | 1.1260 | 0.3579 | 1.4620 | 1.3150 | 0.3234 | 0.1027 | 0.6824 | 1.0100 |
| | | SED | 0.036 | 0.423 | 0.374 | 0.662 | 0.368 | 0.356 | 0.750 | 0.423 | 0.987 | 0.936 | 0.402 | 0.227 | 0.584 | 0.711 |
| | | Prov. | ** | ns | ns | ns | * | ns | ns | ns | * | ns | ns | ** | ns | * |
| | | Country | *** | * | ns | ns | ns | ns | ns | ns | *** | ns | ns | *** | ** | ns |
| | | Region | *** | *** | ns | ns | ns | ns | *** | ** | ** | ns | ** | *** | * | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant *P* 0.05; ** = significant *P* 0.01; *** = significant *P* 0.001.

**Appendix 1.3** Mean values for diameter at breast height (*Dbh*) growth in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 2.4 | 4.1 | 1.4 | 2.4 | 0.7 | 2.7 | 2.0 | 2.1 | 1.9 | 3.7 | 1.3 | 4.5 | 4.1 | 4.0 |
| | 2 | 16166 | 3.1 | | | 2.0 | | | | | | 4.3 | 1.3 | | 4.9 | 2.2 |
| | 3 | 18008 | 2.9 | 4.6 | 1.8 | 2.5 | 1.2 | 2.2 | 1.4 | 2.6 | 4.1 | | | 4.3 | 4.3 | 4.8 |
| | 4 | 18378 | 2.3 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 3.5 | 5.6 | 1.8 | 2.3 | 1.0 | 2.8 | 1.0 | 2.2 | 3.8 | 3.2 | 1.1 | 5.4 | 5.7 | |
| Fiji | 6 | 18270 | 2.8 | 4.6 | 1.5 | | 0.7 | 2.0 | | | 2.8 | | | | | |
| | 7 | 18271 | 2.8 | 3.7 | 1.2 | 1.9 | 1.4 | 2.7 | | | 2.4 | | | 4.4 | | |
| | 8 | 18272 | 3.0 | | | | | | | | | | 1.1 | | 4.3 | 4.6 |
| Guam | 9 | 18121 | 2.7 | 4.3 | 1.6 | 1.8 | 1.0 | 3.1 | | 2.0 | | | 1.1 | 4.4 | 4.0 | 4.2 |
| Solomon | 10 | 18402 | 3.7 | | | | | | | | | | | | 6.4 | 3.7 |
| | 11 | 18403 | 3.9 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 2.6 | | | 2.5 | 0.9 | | | | | | 0.8 | 5.0 | 5.9 | |
| Tonga | 12a | 18040 | | | | 1.8 | 0.7 | | | | | | | | | |
| **Region mean** | | | **3.0** | **4.5** | **1.6** | **2.1** | **0.9** | **2.6** | **1.5** | **2.2** | **3.0** | **3.7** | **1.1** | **4.7** | **4.9** | **3.9** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 3.9 | 6.2 | 1.4 | 2.5 | 0.6 | 2.5 | | 2.9 | 3.9 | 3.8 | 1.5 | 6.0 | | |
| | 14 | 18158 | 3.5 | 5.5 | 1.7 | 2.4 | 1.7 | 3.1 | 1.8 | 3.0 | 4.3 | 4.3 | | 5.4 | 5.2 | 3.3 |
| | 15 | 18160 | 4.1 | | | | | | | 2.6 | | | | | | |
| | 16 | 18161 | 4.3 | | | | | | | | | 4.4 | | | | |
| | 17 | 18244 | 3.7 | 5.5 | | 3.4 | 1.0 | 2.1 | | 2.6 | 4.2 | 3.7 | 1.1 | 6.3 | | |
| | 18 | 18348 | 3.9 | | | 2.6 | 1.0 | | | | | | | 5.7 | 4.9 | |
| | 19 | 18374 | 4.1 | | | | | | | | | | 1.4 | | | |
| | 20 | 18375 | 3.9 | | | | | | | | | | 1.1 | | | |
| | 21 | 18376 | 4.0 | | | | | | | | | | | | | 4.2 |
| Philippines | 22 | 18117 | 3.0 | 4.6 | | 2.0 | 0.9 | 3.4 | | | 2.2 | 4.3 | | | 5.1 | |
| | 23 | 18154 | 3.5 | 4.6 | 1.7 | | 1.2 | 4.2 | 2.8 | 2.7 | 1.4 | 3.5 | 1.4 | 5.3 | | |
| | 24 | 18357 | 3.7 | | | | 0.9 | | | | | | | | | |

**Appendix 1.3** (cont'd) Mean values for diameter at breast height (*Dbh*) growth in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Thailand | 25 | 18296 | 4.5 | | 1.6 | 2.0 | 0.8 | 2.0 | | | 3.4 | | 1.9 | 5.3 | | |
| | 26 | 18297 | 3.8 | | | 2.3 | 1.1 | 3.1 | | | 4.2 | | | | 5.8 | 3.7 |
| | 27 | 18298 | 4.2 | 5.6 | 1.7 | 3.0 | 1.4 | 3.9 | | | | | 1.2 | 6.0 | | |
| | 28 | 18299 | 3.5 | 5.9 | | 2.6 | 0.7 | | | | | | 1.3 | | 5.7 | 3.1 |
| **Region mean** | | | **3.9** | **5.4** | **1.6** | **2.5** | **1.0** | **3.0** | **2.3** | **2.7** | **3.4** | **4.0** | **1.4** | **5.7** | **5.3** | **3.6** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 3.5 | 4.8 | 1.7 | 1.8 | 0.5 | 3.4 | | | 3.8 | | 1.5 | 5.1 | | |
| | 30 | 18268 | 3.9 | 5.6 | 1.7 | 3.2 | 1.6 | 3.5 | | | 3.5 | | | 5.3 | | |
| | 31 | 18586 | 3.6 | | | | | | | | | | | | 4.6 | |
| India | 32 | 18013 | 3.5 | 5.5 | 1.5 | 2.1 | 1.0 | 2.5 | 2.1 | 3.0 | 4.2 | 4.6 | | | | |
| | 33 | 18014 | 3.9 | 5.3 | 1.6 | 2.2 | 1.2 | 3.4 | | 2.8 | 3.7 | 3.5 | | 5.3 | 6.0 | 3.9 |
| | 34 | 18015 | 3.4 | | | 2.5 | 0.9 | | | 3.3 | | 3.8 | 1.4 | | 6.5 | 4.1 |
| | 35 | 18118 | 3.4 | 5.6 | 1.3 | 2.8 | 0.9 | 2.1 | 1.6 | | 2.9 | | | | | |
| | 36 | 18119 | 3.7 | 5.4 | 1.6 | 2.2 | 0.9 | 2.2 | | | 2.8 | 4.3 | 1.3 | 5.0 | 5.2 | |
| | 37 | 18120 | 3.4 | | | | 0.7 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 3.0 | | | | | | | | | | | | | |
| | 39 | 18287 | 3.2 | | 1.7 | 2.0 | 0.6 | 3.9 | | | 2.8 | | 1.4 | 5.1 | 4.7 | |
| | 40 | 18288 | 3.3 | | 1.6 | 3.2 | 0.7 | 3.1 | | | | | 2.1 | | | |
| Vietnam | 41 | 18085 | 3.5 | 5.0 | 2.1 | | | 2.4 | 2.2 | 2.5 | 2.8 | | | 5.5 | | |
| | 42 | 18086 | 3.3 | | | | 1.5 | | | | | 4.2 | | | 5.3 | 5.4 |
| | 43 | 18127 | 3.6 | | | 3.1 | 1.0 | | 2.6 | | | 5.0 | | | 5.9 | |
| | 44 | 18128 | 3.5 | 5.4 | 2.0 | 3.1 | 0.9 | 2.9 | | 2.7 | 2.7 | 4.1 | 1.6 | 5.5 | | |
| | 45 | 18152 | 2.7 | | | 2.0 | 0.7 | | | 2.2 | | | 1.2 | | | |
| **Region mean** | | | **3.4** | **5.3** | **1.7** | **2.5** | **0.9** | **2.9** | **2.1** | **2.7** | **3.2** | **4.2** | **1.5** | **5.2** | **5.4** | **4.5** |

**Appendix 1.3** (cont'd) Mean values for diameter at breast height (*Dbh*) growth in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 3.7 | | | 3.1 | 1.3 | | | | | | 1.8 | 5.5 | 5.1 | 3.6 |
| Egypt | 47 | 18122 | 2.8 | 4.7 | 1.6 | 1.7 | 1.2 | 2.3 | 2.0 | 2.5 | 2.0 | 4.1 | | 4.9 | | |
| | 48 | 18125 | 2.7 | 4.4 | 1.5 | | 1.2 | 2.4 | | 2.0 | 3.4 | 4.6 | 0.8 | 4.6 | | |
| | 49 | 18126 | 2.1 | | | | | | | | | 4.3 | | | 3.6 | 4.1 |
| Kenya | 50 | 18134 | 3.2 | 4.9 | 1.6 | 2.2 | 0.8 | 3.4 | 1.5 | 2.3 | 2.1 | 3.9 | | 5.2 | | |
| | 51 | 18135 | 3.3 | | | | | | | | | 3.5 | | | | |
| | 52 | 18136 | 3.3 | | | | | | | | | 4.0 | | | | |
| | 53 | 18137 | 3.7 | 5.3 | | 2.1 | 1.0 | 2.5 | 1.8 | 2.5 | 1.9 | 4.0 | | 4.5 | | |
| | 54 | 18141 | 3.9 | | | | | | | | | | | | | |
| | 55 | 18142 | 3.5 | | | 2.0 | 1.2 | | | 2.3 | | | | | 4.7 | 4.2 |
| | 56 | 18143 | 3.5 | | | 2.3 | 0.8 | | | | | 3.0 | 1.1 | | | |
| | 57 | 18144 | 3.1 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 3.0 | | | | | | | | | | 1.1 | | 5.1 | 4.6 |
| **Region mean** | | | **3.2** | **4.8** | **1.6** | **2.2** | **1.1** | **2.6** | **1.8** | **2.3** | **2.4** | **3.9** | **1.2** | **4.9** | **4.6** | **4.1** |
| Puerto Rico | 59 | 18752 | 3.4 | | | | | | | | | | 1.3 | | 5.5 | 3.5 |
| **Overall mean** | | | **3.4** | **5.1** | **1.6** | **2.4** | **1.0** | **2.8** | **1.9** | **2.5** | **3.1** | **4.0** | **1.3** | **5.2** | **5.1** | **4.0** |
| | | RMS | 0.1952 | 0.3387 | 0.3019 | 1.0920 | 0.2068 | 1.2100 | 0.4240 | 0.3473 | 0.6441 | 0.6849 | 0.4113 | 0.1399 | 0.6981 | 1.1310 |
| | | SED | 0.025 | 0.412 | 0.389 | 0.739 | 0.322 | 0.778 | 0.460 | 0.065 | 0.655 | 0.676 | 0.454 | 0.264 | 0.591 | 0.752 |
| | | Prov. | *** | ns | ns | ns | ** | ns | ns | * | ns | * | ns | ** | ns | * |
| | | Country | *** | *** | ns | ns | ns | ns | ns | *** | ns | ns | ns | *** | *** | ns |
| | | Region | *** | *** | ns | ns | ns | ns | * | ** | ** | ns | ns | *** | ** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.4** Mean values for axis persistence (*Axpst*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 3.5 | 5.2 | 4.7 | 5.7 | 3.6 | 3.8 | 3.9 | 5.5 | 5.8 | 6.0 | | 5.4 | 5.6 | 4.8 |
| | 2 | 16166 | 5.1 | | | 5.0 | | | | | | 5.0 | 5.8 | | 5.7 | 4.8 |
| | 3 | 18008 | 5.1 | 5.4 | 5.3 | 4.7 | 4.2 | 4.3 | 4.7 | 5.4 | 5.7 | | | 6.0 | 5.8 | 4.6 |
| | 4 | 18378 | 4.5 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 5.2 | 5.3 | 5.7 | 5.7 | 3.8 | 4.5 | 4.6 | 5.4 | 5.6 | 6.0 | 6.0 | 5.8 | 5.9 | |
| Fiji | 6 | 18270 | 2.7 | 5.5 | 5.3 | | 3.5 | 3.6 | | | 5.0 | | | | | |
| | 7 | 18271 | 4.2 | 5.8 | 5.4 | 4.6 | 4.4 | 4.1 | | | 5.3 | | | 5.6 | | |
| | 8 | 18272 | 3.2 | | | | | | | | | | 5.9 | | 5.3 | 4.9 |
| Guam | 9 | 18121 | 4.0 | 5.6 | 5.4 | 5.2 | 3.6 | 4.6 | 5.3 | 5.3 | | | 6.0 | 5.9 | 5.4 | 4.6 |
| Solomon | 10 | 18402 | 4.0 | | | | | | | | | | | | 5.7 | 4.8 |
| | 11 | 18403 | 3.5 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 4.3 | | | 5.2 | 4.6 | | | | | | 5.5 | 5.8 | 5.8 | |
| Tonga | 12a | 18040 | | | | 4.5 | 4.3 | | 3.3 | | | | | | | |
| **Region mean** | | | **4.1** | **5.5** | **5.3** | **5.1** | **4.0** | **4.1** | **4.4** | **5.4** | **5.5** | **5.6** | **5.8** | **5.7** | **5.6** | **4.7** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 5.1 | 5.3 | 5.8 | 5.3 | 3.4 | 4.4 | | 5.5 | 5.8 | 5.1 | 5.5 | 5.8 | | |
| | 14 | 18158 | 5.5 | 5.8 | 5.5 | 5.5 | 4.1 | 4.6 | 5.0 | 5.4 | 5.9 | 6.0 | | 5.7 | 5.7 | 4.6 |
| | 15 | 18160 | 5.3 | | | | | | | 5.6 | | | | | | |
| | 16 | 18161 | 5.5 | | | | | | | | | 5.6 | | | | |
| | 17 | 18244 | 5.1 | 5.6 | 5.6 | 4.9 | 3.7 | 4.5 | | 5.6 | 5.6 | 5.9 | 5.6 | 5.9 | | |
| | 18 | 18348 | 4.7 | | | 5.6 | 4.4 | | | | | | | 6.0 | 5.8 | |
| | 19 | 18374 | 4.3 | | | | | | | | | | 5.4 | | | |
| | 20 | 18375 | 4.2 | | | | | | | | | | | | | |
| | 21 | 18376 | 4.3 | | | | | | | | | | | | | 5.1 |

**Appendix 1.4** (cont'd) Mean values for axis persistence (*Axpst*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 5.5 | 5.9 | 5.5 | 5.4 | 4.3 | 4.4 | | | 5.5 | 5.6 | | | 5.9 | |
| | 23 | 18154 | 4.3 | 5.1 | 5.2 | | 4.8 | 4.2 | 5.1 | 5.4 | 5.8 | 5.7 | 5.9 | 5.7 | | |
| | 24 | 18357 | 4.6 | | | | 4.5 | | | | | | | | | |
| Thailand | 25 | 18296 | 4.7 | | 5.5 | 4.1 | 3.3 | 4.7 | | | 5.6 | | 6.0 | 6.0 | | |
| | 26 | 18297 | 4.7 | | 4.9 | 4.8 | 4.2 | 4.4 | | | 5.7 | | | | 5.9 | 4.6 |
| | 27 | 18298 | 5.2 | 5.8 | 5.5 | 4.8 | 3.9 | 4.6 | | | | | 5.9 | 6.0 | | |
| | 28 | 18299 | 5.2 | 5.5 | | 5.1 | 3.8 | | | | | | 5.5 | | 5.9 | 4.6 |
| **Region mean** | | | **4.9** | **5.6** | **5.4** | **5.1** | **4.0** | **4.5** | **5.0** | **5.5** | **5.7** | **5.7** | **5.7** | **5.9** | **5.8** | **4.7** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 4.7 | 5.3 | 5.7 | 5.0 | 4.1 | 4.7 | | | 5.8 | | 5.8 | 5.8 | | |
| | 30 | 18268 | 5.1 | 5.1 | 5.5 | 5.7 | 5.0 | 4.9 | | | 5.8 | | | 5.8 | | |
| | 31 | 18586 | 5.3 | | | | | | | | | | | | 5.7 | |
| India | 32 | 18013 | 5.0 | 5.4 | 5.5 | 5.4 | 3.5 | 4.7 | 5.0 | 5.3 | | 5.6 | | | | |
| | 33 | 18014 | 5.1 | 5.4 | 5.6 | 4.9 | 4.1 | 4.7 | | 5.3 | 5.9 | 5.8 | | 5.9 | 5.8 | 5.2 |
| | 34 | 18015 | 4.8 | | | 5.6 | 3.7 | | | 5.4 | | 5.8 | 5.8 | | 5.9 | 5.2 |
| | 35 | 18118 | 5.2 | 5.4 | 5.7 | 5.8 | 3.6 | 4.3 | 5.3 | | 5.8 | | | | | |
| | 36 | 18119 | 5.1 | 5.0 | 5.3 | 5.6 | 4.4 | 4.8 | | | 5.2 | 5.8 | 5.9 | 5.8 | 5.8 | |
| | 37 | 18120 | 5.0 | | | | 4.2 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 4.6 | | | | | | | | | | | | | |
| | 39 | 18287 | 4.2 | | 5.7 | 5.2 | 3.8 | 4.8 | | | 5.5 | | 6.0 | 5.8 | 5.8 | |
| | 40 | 18288 | 4.4 | | 5.3 | 5.7 | 3.5 | 4.9 | | | | | 5.8 | | | |
| Vietnam | 41 | 18085 | 5.0 | 5.7 | 5.2 | | | 4.9 | 5.0 | 5.6 | 5.3 | | | 5.9 | | |
| | 42 | 18086 | 4.7 | | | | 5.5 | | | | | 5.6 | | | 5.8 | 5.2 |
| | 43 | 18127 | 5.0 | | | 5.6 | 4.6 | | 5.6 | | | 5.0 | | | 5.8 | |
| | 44 | 18128 | 5.0 | 5.4 | 5.4 | 5.8 | 3.8 | 4.4 | | 5.5 | 5.5 | 5.7 | 6.0 | 5.9 | | |
| | 45 | 18152 | 4.7 | | | 5.1 | 3.8 | | | 5.2 | | | 6.0 | | | |
| **Region mean** | | | **4.9** | **5.3** | **5.5** | **5.4** | **4.1** | **4.7** | **5.2** | **5.4** | **5.6** | **5.6** | **5.9** | **5.9** | **5.8** | **5.2** |

**Appendix 1.4** (cont'd) Mean values for axis persistence (*Axpst*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 4.9 | | | 6.0 | 4.7 | | | | | | 6.0 | 5.9 | 5.7 | 3.9 |
| Egypt | 47 | 18122 | 4.1 | 5.4 | 5.6 | 5.1 | 4.3 | 4.5 | 5.2 | 5.6 | 5.8 | 5.4 | | 5.6 | | |
| | 48 | 18125 | 3.9 | 5.4 | 5.3 | | 3.8 | 4.3 | | 5.2 | 5.5 | 5.8 | 6.0 | 6.0 | | |
| | 49 | 18126 | 4.9 | | | | | | | | | 6.0 | | | 5.8 | 4.3 |
| Kenya | 50 | 18134 | 5.3 | 5.6 | 5.7 | 5.3 | 4.3 | 4.5 | 5.3 | 5.4 | 5.4 | 5.3 | | 5.9 | | |
| | 51 | 18135 | 5.2 | | | | | | | | | 5.8 | | | | |
| | 52 | 18136 | 5.7 | | | | | | | | | 6.0 | | | | |
| | 53 | 18137 | 5.4 | 5.6 | 5.7 | 4.9 | 4.1 | 4.5 | 5.1 | 5.5 | 5.9 | 5.2 | | 6.0 | | |
| | 54 | 18141 | 5.4 | | | | | | | | | | | | | |
| | 55 | 18142 | 5.1 | | | 5.1 | 4.6 | | | 5.3 | | | | | 5.8 | 4.6 |
| | 56 | 18143 | 4.7 | | | 5.1 | 3.4 | | | | | 5.9 | 6.0 | | | |
| | 57 | 18144 | 5.5 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 5.3 | | | | | | | | | | 5.7 | | 5.9 | 5.0 |
| **Region mean** | | | **5.0** | **5.5** | **5.6** | **5.2** | **4.2** | **4.4** | **5.2** | **5.4** | **5.6** | **5.7** | **5.9** | **5.9** | **5.8** | **4.5** |
| Puerto Rico | 59 | 18752 | 4.5 | | | | | | | | | | 5.6 | | 5.9 | 4.9 |
| **Overall mean** | | | **4.7** | **5.5** | **5.4** | **5.2** | **4.1** | **4.5** | **4.9** | **5.4** | **5.6** | **5.6** | **5.8** | **5.8** | **5.8** | **4.8** |
| | | RMS | 0.2142 | 0.0715 | 0.1345 | 0.6657 | 0.5522 | 0.2670 | 0.6811 | 0.1040 | 0.1868 | 0.2695 | 0.1450 | 0.0308 | 0.0370 | 0.4004 |
| | | SED | 0.330 | 0.189 | 0.189 | 0.577 | 0.526 | 0.365 | 0.584 | 0.020 | 0.353 | 0.424 | 0.269 | 0.124 | 0.135 | 0.447 |
| | | Prov | *** | *** | ns | ns | * | ns | ns | ns | ns | ns | ns | *** | ns | ns |
| | | Country | *** | ** | ** | ns | ns | ns | ns | ns | ns | ns | ns | ns | ** | ns |
| | | Region | *** | * | ns | ns | ns | *** | * | ns | ns | ns | ns | ns | * | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.5** Mean values for stem straightness (*Strst*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 3.4 | 3.0 | 1.6 | 3.8 | 2.7 | 2.1 | 2.6 | 4.3 | 5.1 | 4.1 | | 2.1 | 1.5 | 4.3 |
| | 2 | 16166 | 3.0 | | | 3.8 | | | | | | 3.7 | 4.0 | | 1.7 | 4.2 |
| | 3 | 18008 | 3.7 | 3.6 | 2.9 | 3.5 | 3.0 | 2.3 | 2.6 | 4.4 | 4.9 | | | 3.4 | 1.6 | 3.7 |
| | 4 | 18378 | 3.2 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 3.9 | 3.7 | 2.8 | 4.1 | 2.9 | 1.7 | 2.0 | 4.5 | 4.8 | 3.9 | 4.3 | 3.6 | 2.1 | |
| Fiji | 6 | 18270 | 2.9 | 1.9 | 1.1 | | 2.6 | 1.4 | | | 2.9 | | | | | |
| | 7 | 18271 | 3.3 | 3.2 | 1.5 | 3.4 | 3.2 | 2.2 | | | 4.2 | | | 2.4 | | |
| | 8 | 18272 | 3.0 | | | | | | | | | | 4.2 | | 1.1 | 4.1 |
| Guam | 9 | 18121 | 4.0 | 4.3 | 3.1 | 4.1 | 3.0 | 1.9 | 3.4 | 3.8 | | | 4.1 | 3.5 | 2.5 | 4.3 |
| Solomon | 10 | 18402 | 3.4 | | | | | | | | | | | | 1.6 | 3.8 |
| | 11 | 18403 | 3.2 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 3.5 | | | 4.1 | 3.4 | | | | | | 4.1 | 3.3 | 1.6 | |
| Tonga | 12a | 18040 | | | | 3.4 | 3.0 | | 3.4 | | | | | | | |
| **Region mean** | | | **3.4** | **3.3** | **2.2** | **3.8** | **3.0** | **1.9** | **2.8** | **4.3** | **4.4** | **3.9** | **4.1** | **3.0** | **1.7** | **4.1** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 2.8 | 3.4 | 2.2 | 3.5 | 3.0 | 2.0 | | 4.1 | 4.7 | | 4.2 | 2.5 | | |
| | 14 | 18158 | 3.1 | 3.1 | 2.1 | 3.7 | 2.9 | 1.8 | 3.2 | 4.2 | 4.3 | 3.4 | | 2.5 | 1.7 | 3.8 |
| | 15 | 18160 | 3.4 | | | | | | | 4.4 | | 3.6 | | | | |
| | 16 | 18161 | 3.5 | | | | | | | | | | | | | |
| | 17 | 18244 | 3.9 | 4.0 | 2.8 | 3.5 | 3.0 | 2.9 | | 4.8 | 4.8 | | 4.5 | 4.1 | | |
| | 18 | 18348 | 3.5 | | | 3.7 | 3.2 | | | | | | | 3.5 | 1.7 | |
| | 19 | 18374 | 3.4 | | | | | | | | | | 4.3 | | | |
| | 20 | 18375 | 3.6 | | | | | | | | | | | | | |
| | 21 | 18376 | 3.4 | | | | | | | | | | | | | 4.0 |

**Appendix 1.5** (cont'd) Mean values for stem straightness (*Strst*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 4.1 | 3.6 | 2.8 | 3.7 | 3.1 | 2.0 | | | 4.5 | 4.1 | | | 2.1 | |
| | 23 | 18154 | 3.9 | 4.1 | 3.0 | | 3.3 | 2.6 | 3.5 | 4.2 | 4.1 | 3.9 | 4.5 | 3.6 | | |
| | 24 | 18357 | 4.5 | | | | 3.2 | | | | | | | | | |
| Thailand | 25 | 18296 | 3.6 | | 3.5 | 2.6 | 2.7 | 2.0 | | | 4.4 | | 4.3 | 3.3 | | |
| | 26 | 18297 | 3.6 | | 2.7 | 3.4 | 2.9 | 2.5 | | | 4.5 | | | | 1.7 | 4.0 |
| | 27 | 18298 | 3.3 | 3.6 | 2.7 | 3.7 | 2.6 | 1.9 | | | | | 4.2 | 3.1 | | |
| | 28 | 18299 | 3.2 | 4.2 | | 3.4 | 2.8 | | | | | | 4.3 | | 1.8 | 3.4 |
| **Region mean** | | | **3.5** | **3.7** | **2.7** | **3.5** | **3.0** | **2.2** | **3.3** | **4.3** | **4.5** | **3.8** | **4.3** | **3.2** | **1.8** | **3.8** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 3.9 | 3.7 | 3.2 | 3.5 | 2.8 | 2.3 | | | 5.0 | | 4.1 | 3.2 | | |
| | 30 | 18268 | 4.0 | 4.0 | 3.1 | 4.1 | 3.2 | 2.0 | | | 5.1 | | | 3.7 | | |
| | 31 | 18586 | 3.9 | | | | | | | | | | | | 2.3 | |
| India | 32 | 18013 | 3.7 | 3.9 | 2.8 | 4.1 | 2.8 | 2.0 | 3.3 | 4.2 | 4.9 | 3.9 | | | | |
| | 33 | 18014 | 3.6 | 4.0 | 3.7 | 3.5 | 2.8 | 2.4 | | 4.2 | 5.2 | 4.1 | | 3.5 | 2.2 | 3.8 |
| | 34 | 18015 | 3.7 | | | 4.2 | 2.8 | | | 4.1 | | 3.7 | 3.8 | | 2.0 | 4.3 |
| | 35 | 18118 | 3.8 | 3.6 | 3.1 | 4.4 | 2.8 | 1.9 | 2.5 | | 5.0 | | | | | |
| | 36 | 18119 | 3.6 | 3.8 | 2.8 | 3.7 | 3.2 | 2.6 | | | 5.0 | 4.0 | 4.2 | 3.4 | 1.9 | |
| | 37 | 18120 | 3.7 | | | | 3.1 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 3.6 | | | | | | | | | | | | | |
| | 39 | 18287 | 3.1 | | 2.8 | 4.0 | 3.0 | 2.4 | | | 4.9 | | 4.3 | 3.0 | 1.8 | |
| | 40 | 18288 | 3.6 | | 3.0 | 4.2 | 2.7 | 2.1 | | | | | 4.2 | | | |
| Vietnam | 41 | 18085 | 4.0 | 4.3 | 3.3 | | | 2.4 | 3.5 | 4.3 | 4.6 | | | 4.1 | | |
| | 42 | 18086 | 3.6 | | | | 3.6 | | | | | 4.0 | | | 1.9 | 3.8 |
| | 43 | 18127 | 3.6 | | | 4.4 | 3.3 | | 4.2 | | | 3.7 | | | 2.0 | |
| | 44 | 18128 | 3.9 | 4.1 | 3.5 | 4.8 | 2.8 | 2.4 | | 4.3 | 4.6 | 4.0 | 4.4 | 3.8 | | |
| | 45 | 18152 | 3.5 | | | 3.6 | 2.9 | | | 4.3 | | 3.9 | 4.4 | | | |
| **Region mean** | | | **3.7** | **3.9** | **3.1** | **4.0** | **3.0** | **2.2** | **3.4** | **4.2** | **4.9** | **3.9** | **4.2** | **3.5** | **2.0** | **3.9** |

**Appendix 1.5** (cont'd) Mean values for stem straightness (*Strst*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 4.0 | | | 4.9 | 3.0 | | | | | | 3.8 | 3.4 | 2.1 | 4.2 |
| Egypt | 47 | 18122 | 4.2 | 3.9 | 2.5 | 3.9 | 3.1 | 2.2 | 3.3 | 4.4 | 5.2 | 3.8 | | 2.9 | | |
| | 48 | 18125 | 4.0 | 4.1 | 3.0 | | 3.2 | 2.4 | | 4.3 | 5.1 | 3.9 | 4.5 | 3.2 | | |
| | 49 | 18126 | 3.9 | | | | | | | | | 4.0 | | | 1.7 | 3.2 |
| Kenya | 50 | 18134 | 3.7 | 3.1 | 3.2 | 3.8 | 3.1 | 2.7 | 3.1 | 4.2 | 4.7 | 4.0 | | 4.2 | | |
| | 51 | 18135 | 4.5 | | | | | | | | | 4.0 | | | | |
| | 52 | 18136 | 4.4 | | | | | | | | | 4.0 | | | | |
| | 53 | 18137 | 4.0 | 4.0 | 2.9 | 3.7 | 3.0 | 3.1 | 3.5 | 4.6 | 5.3 | 4.0 | | 3.3 | | |
| | 54 | 18141 | 4.4 | | | | | | | | | | | | | |
| | 55 | 18142 | 4.3 | | | 3.6 | 3.2 | | | 4.5 | | | | | 3.1 | 4.0 |
| | 56 | 18143 | 3.8 | | | 4.1 | 2.7 | | | | | 3.7 | 4.2 | | | |
| | 57 | 18144 | 4.2 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 3.6 | | | | | | | | | | 4.2 | | 2.4 | 4.2 |
| **Region mean** | | | **4.1** | **3.8** | **2.9** | **4.0** | **3.0** | **2.6** | **3.3** | **4.4** | **5.1** | **3.9** | **4.2** | **3.4** | **2.3** | **3.9** |
| Puerto Rico | 59 | 18752 | 3.6 | | | | | | | | | | 4.4 | | 1.8 | 3.5 |
| **Overall mean** | | | **3.7** | **3.7** | **2.8** | **3.8** | **3.0** | **2.2** | **3.1** | **4.3** | **4.7** | **3.9** | **4.2** | **3.3** | **1.9** | **3.9** |
| | | RMS | 0.1367 | 0.0830 | 0.2923 | 0.4258 | 0.1316 | 0.2703 | 0.3721 | 0.1365 | 0.3715 | | | 0.2137 | 0.1212 | 0.2189 |
| | | SED | 0.260 | 0.204 | 0.382 | 0.461 | 0.257 | 0.368 | 0.103 | 0.026 | 0.498 | 0.267 | 0.239 | 0.327 | 0.246 | 0.331 |
| | | Prov. | * | *** | * | ns | ns | * | ns | ns | ns | ns | ns | *** | ns | ns |
| | | Country | *** | *** | *** | *** | * | ns | ns | ns | ns | * | ns | *** | *** | * |
| | | Region | *** | *** | *** | * | ns | ** | *** | * | *** | ns | ns | ns | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.6** Mean values for density of permanent branches (*Denpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 2.0 | 2.5 | 2.5 | 2.3 | 2.1 | 2.0 | 1.9 | 2.5 | 2.0 | 2.1 | | 3.1 | 2.6 | 2.3 |
| | 2 | 16166 | 1.4 | | | 1.4 | | | | | | 1.6 | 1.0 | | 1.4 | 2.2 |
| | 3 | 18008 | 2.4 | 2.4 | 2.9 | 2.0 | 2.0 | 2.1 | 1.6 | 2.7 | 1.4 | | | 2.8 | 1.9 | 1.8 |
| | 4 | 18378 | 2.2 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 2.4 | 2.5 | 3.0 | 1.9 | 2.0 | 1.9 | 2.2 | 2.8 | 2.0 | 1.6 | 1.3 | 3.0 | 2.4 | |
| Fiji | 6 | 18270 | 2.4 | 2.6 | 2.7 | | 2.4 | 2.1 | | | 2.1 | | | | | |
| | 7 | 18271 | 2.3 | 2.8 | 2.9 | 1.9 | 1.8 | 2.2 | | | 2.2 | | | 3.4 | | |
| | 8 | 18272 | 2.5 | | | | | | | | | | 1.3 | | 2.7 | 2.0 |
| Guam | 9 | 18121 | 2.2 | 2.4 | 2.9 | 2.0 | 2.1 | 2.0 | 1.7 | 2.5 | | | 1.2 | 2.8 | 2.2 | 2.0 |
| Solomon | 10 | 18402 | 2.1 | | | | | | | | | | | | 1.8 | 2.0 |
| | 11 | 18403 | 2.4 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 1.7 | | | 2.4 | 2.0 | | | | | | 1.5 | 3.0 | 2.1 | |
| Tonga | 12a | 18040 | | | | 2.5 | 2.3 | | 1.7 | | | | | | | |
| **Region mean** | | | **2.2** | **2.5** | **2.8** | **2.0** | **2.1** | **2.0** | **1.8** | **2.6** | **1.9** | **1.8** | **1.2** | **3.0** | **2.1** | **2.0** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 2.0 | 2.0 | 2.2 | 1.8 | 2.2 | 1.9 | | 2.4 | 2.3 | 1.5 | 1.8 | 2.1 | | |
| | 14 | 18158 | 2.0 | 2.0 | 2.3 | 1.9 | 2.0 | 2.0 | 2.4 | 2.6 | 2.0 | 2.0 | | 2.4 | 1.8 | 2.0 |
| | 15 | 18160 | 2.4 | | | | | | | 2.7 | | | | | | |
| | 16 | 18161 | 1.7 | | | | | | | | | 2.0 | | | | |
| | 17 | 18244 | 1.9 | 2.0 | 2.2 | 1.6 | 2.0 | 1.8 | | 2.5 | 1.6 | 2.0 | 1.6 | 2.3 | | |
| | 18 | 18348 | 2.2 | | | 1.7 | 2.0 | | | | | | | 2.3 | 1.7 | |
| | 19 | 18374 | 2.4 | | | | | | | | | | 1.3 | | | |
| | 20 | 18375 | 2.1 | | | | | | | | | | | | | |
| | 21 | 18376 | 2.5 | | | | | | | | | | | | | 2.1 |

**Appendix 1.6** (cont'd) Mean values for density of permanent branches (*Denpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 2.1 | 2.3 | 2.9 | 1.5 | 2.4 | 2.0 | | | 1.9 | 2.4 | | | 2.4 | |
| | 23 | 18154 | 2.2 | 2.5 | 2.5 | | 2.0 | 2.1 | 1.4 | 2.5 | 2.0 | 2.4 | 1.5 | 2.9 | | |
| | 24 | 18357 | 1.9 | | | | 2.0 | | | | | | | | | |
| Thailand | 25 | 18296 | 2.3 | | 2.8 | 1.8 | 2.0 | 2.0 | | | 2.2 | | 1.4 | 2.5 | | |
| | 26 | 18297 | 2.3 | | 2.9 | 2.1 | 2.1 | 1.9 | | | 1.9 | | | | 2.2 | 2.1 |
| | 27 | 18298 | 2.5 | 2.6 | 2.8 | 1.9 | 2.0 | 2.0 | | | | | 1.8 | 2.4 | | |
| | 28 | 18299 | 2.2 | 2.2 | | 2.0 | 2.0 | | | | | | 1.6 | | 1.4 | 2.4 |
| **Region mean** | | | **2.2** | **2.2** | **2.6** | **1.8** | **2.1** | **2.0** | **1.9** | **2.5** | **2.0** | **2.0** | **1.5** | **2.4** | **1.9** | **2.2** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.8 | 2.0 | 2.7 | 1.4 | 2.1 | 1.9 | | | 1.8 | | 1.5 | 2.4 | | |
| | 30 | 18268 | 2.0 | 2.6 | 2.7 | 1.7 | 1.9 | 1.9 | | | 1.2 | | | 2.6 | | |
| | 31 | 18586 | 1.8 | | | | | | | | | | | | 1.4 | |
| India | 32 | 18013 | 1.9 | 2.1 | 2.7 | 1.4 | 2.1 | 1.9 | 1.7 | 2.2 | 1.6 | 2.1 | | | | |
| | 33 | 18014 | 1.7 | 1.8 | 2.7 | 1.6 | 2.0 | 1.9 | | 2.4 | 1.7 | 1.3 | | 2.6 | 1.5 | 2.3 |
| | 34 | 18015 | 1.9 | | | 1.7 | 1.9 | | | 2.6 | | 1.1 | 1.4 | | 1.4 | 2.2 |
| | 35 | 18118 | 2.2 | 2.4 | 2.8 | 1.8 | 2.2 | 1.9 | 2.5 | | 2.0 | | | | | |
| | 36 | 18119 | 2.2 | 2.4 | 2.6 | 1.7 | 2.0 | 1.8 | | | 1.8 | 2.0 | 1.3 | 2.6 | 1.6 | |
| | 37 | 18120 | 2.0 | | | | 2.2 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 2.2 | | | | | | | | | | | | | |
| | 39 | 18287 | 2.0 | | 2.6 | 1.8 | 2.2 | 1.9 | | | 1.9 | | 1.5 | 2.5 | 1.7 | |
| | 40 | 18288 | 1.8 | | 2.6 | 1.8 | 2.0 | 1.9 | | | | | 1.7 | | | |
| Vietnam | 41 | 18085 | 1.9 | 2.1 | 2.7 | | | 2.0 | 1.9 | 2.5 | 1.8 | | | 2.6 | | |
| | 42 | 18086 | 2.0 | | | | 2.0 | | | | | 2.0 | | | 1.7 | 2.0 |
| | 43 | 18127 | 2.1 | | | 1.9 | 2.0 | | 1.4 | | | 1.3 | | | 1.6 | |
| | 44 | 18128 | 2.0 | 2.1 | 2.1 | 1.7 | 2.1 | 2.0 | | 2.8 | 1.8 | 1.7 | 1.3 | 2.5 | | |
| | 45 | 18152 | 1.7 | | | 1.6 | 2.1 | | | 2.7 | | | 1.7 | | | |
| **Region mean** | | | **1.9** | **2.2** | **2.6** | **1.7** | **2.1** | **1.9** | **1.9** | **2.5** | **1.7** | **1.6** | **1.5** | **2.5** | **1.6** | **2.2** |

**Appendix 1.6** (cont'd) Mean values for density of permanent branches (*Denpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 2.0 | | | 1.8 | 2.0 | | | | | | 0.9 | 2.5 | 1.8 | 2.3 |
| Egypt | 47 | 18122 | 1.9 | 2.0 | 2.6 | 1.8 | 2.0 | 1.9 | 2.1 | 2.7 | 2.0 | 1.3 | | 2.7 | | |
| | 48 | 18125 | 1.6 | 1.9 | 2.6 | | 2.0 | 2.0 | | 2.7 | 1.7 | 2.0 | 1.3 | 2.5 | | |
| | 49 | 18126 | 1.9 | | | | | | | | | 2.6 | | | 1.5 | 1.7 |
| Kenya | 50 | 18134 | 2.0 | 2.0 | 2.6 | 1.4 | 2.0 | 1.8 | 1.4 | 2.7 | 1.8 | 1.3 | | 2.6 | | |
| | 51 | 18135 | 2.1 | | | | | | | | | 1.7 | | | | |
| | 52 | 18136 | 1.7 | | | | | | | | | 1.9 | | | | |
| | 53 | 18137 | 2.1 | 2.2 | 2.6 | 1.6 | 2.1 | 1.9 | 1.8 | 2.9 | 2.0 | 1.5 | | 2.6 | | |
| | 54 | 18141 | 2.0 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.9 | | | 2.1 | 2.0 | | | 2.7 | | | | | | 2.5 |
| | 56 | 18143 | 1.8 | | | 1.8 | 2.0 | | | | | 1.5 | 1.6 | | | |
| | 57 | 18144 | 1.8 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.7 | | | | | | | | | | 1.4 | | 1.6 | 2.4 |
| **Region mean** | | | **1.9** | **2.1** | **2.6** | **1.7** | **2.0** | **1.9** | **1.7** | **2.7** | **1.9** | **1.7** | **1.3** | **2.6** | **1.6** | **2.2** |
| Puerto Rico | 59 | 18752 | 2.1 | | | | | | | | | | 1.4 | | 1.9 | 2.0 |
| **Overall mean** | | | **2.0** | **2.3** | **2.6** | **1.8** | **2.1** | **2.0** | **1.8** | **2.6** | **1.9** | **1.8** | **1.4** | **2.6** | **1.8** | **2.1** |
| | | RMS | 0.0709 | 0.0688 | 0.0712 | 0.0780 | 0.0424 | 0.0275 | 0.2084 | 0.0670 | 0.0766 | 0.2989 | 0.1471 | 0.0782 | 0.1294 | 0.1022 |
| | | SED | 0.190 | 0.186 | 0.189 | 0.198 | 0.146 | 0.117 | 0.323 | 0.013 | 0.226 | 0.446 | 0.271 | 0.198 | 0.253 | 0.226 |
| | | Prov. | *** | ns | ns | *** | * | ns | * | ns | * | ns | ns | ns | *** | ns |
| | | Country | *** | ** | *** | ns | ns | ns | * | ns | ns | * | ns | ** | *** | ns |
| | | Region | *** | *** | ns | *** | ns | * | ns | ** | ** | ns | ns | *** | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant *P* 0.05; ** = significant *P* 0.01; *** = significant *P* 0.001.

**Appendix 1.7** Mean values for thickness of permanent branches (*Thkpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 2.2 | 2.1 | 2.0 | 2.6 | 2.8 | 1.0 | 4.0 | 2.2 | 4.0 | 3.1 | | 2.4 | 2.6 | 2.8 |
| | 2 | 16166 | 2.1 | | | 2.8 | | | | | | 3.2 | 3.2 | | 3.9 | 3.4 |
| | 3 | 18008 | 2.3 | 1.8 | 2.6 | 2.6 | 2.9 | 1.1 | 3.9 | 2.1 | 4.0 | | | 2.8 | 3.0 | 2.6 |
| | 4 | 18378 | 2.5 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 2.1 | 2.4 | 2.3 | 2.8 | 3.0 | 1.0 | 4.0 | 2.6 | 4.0 | 2.5 | 3.3 | 2.6 | 2.8 | |
| Fiji | 6 | 18270 | 2.0 | 2.2 | 1.6 | | 2.8 | 1.0 | | | 2.9 | | | | | |
| | 7 | 18271 | 2.2 | 2.3 | 2.4 | 2.6 | 3.0 | 1.2 | | | 3.7 | | | 2.1 | | |
| | 8 | 18272 | 2.0 | | | | | | | | | | 3.4 | | 1.4 | 2.5 |
| Guam | 9 | 18121 | 2.0 | 2.1 | 2.2 | 2.8 | 2.9 | 1.0 | 4.0 | 2.2 | | | 3.1 | 2.1 | 1.5 | 2.7 |
| Solomon | 10 | 18402 | 1.8 | | | | | | | | | | | | 3.1 | 2.7 |
| | 11 | 18403 | 1.8 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 2.2 | | | 2.8 | 2.8 | | | | | | 3.2 | 2.7 | 2.8 | |
| Tonga | 12a | 18040 | | | | 2.7 | 3.0 | | 4.0 | | | | | | | |
| **Region mean** | | | **2.1** | **2.1** | **2.2** | **2.7** | **2.9** | **1.1** | **4.0** | **2.3** | **3.7** | **2.9** | **3.2** | **2.4** | **2.6** | **2.8** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 2.1 | 2.2 | 2.3 | 2.3 | 3.0 | 1.0 | | 2.1 | 4.0 | 2.7 | 3.2 | 2.5 | | |
| | 14 | 18158 | 1.9 | 1.7 | 2.0 | 2.7 | 2.7 | 1.0 | 3.7 | 1.8 | 4.0 | 2.7 | | 2.6 | 2.5 | 3.0 |
| | 15 | 18160 | 2.0 | | | | | | | 2.3 | | | | | | |
| | 16 | 18161 | 1.8 | | | | | | | | | 2.0 | | | | |
| | 17 | 18244 | 2.0 | 1.9 | 2.1 | 2.9 | 2.9 | 1.2 | | 2.2 | 3.8 | 2.3 | 3.0 | 2.7 | | |
| | 18 | 18348 | 1.9 | | | 2.8 | 2.9 | | | | | | | 2.1 | 2.2 | |
| | 19 | 18374 | 1.8 | | | | | | | | | | 2.9 | | | |
| | 20 | 18375 | 1.7 | | | | | | | | | | | | | |
| | 21 | 18376 | 2.0 | | | | | | | | | | | | | 2.4 |

**Appendix 1.7** (cont'd) Mean values for thickness of permanent branches (*Thkpb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 1.9 | 2.3 | 2.5 | 2.8 | 2.8 | 1.0 | | | 3.7 | 3.0 | | | 3.4 | |
| | 23 | 18154 | 2.0 | 1.8 | 2.1 | | 3.0 | 1.0 | 3.9 | 2.3 | 3.9 | 2.1 | 2.8 | 2.5 | | |
| | 24 | 18357 | 2.0 | | | | 2.9 | | | | | | | | | |
| Thailand | 25 | 18296 | 2.0 | | 2.2 | 2.4 | 2.9 | 1.0 | | | 3.5 | | 3.1 | 2.4 | | |
| | 26 | 18297 | 1.7 | | 2.0 | 2.7 | 2.8 | 1.0 | | | 3.8 | | | | 2.6 | 2.8 |
| | 27 | 18298 | 1.8 | 1.9 | 2.1 | 2.8 | 3.0 | 1.0 | | | | | 2.6 | 2.3 | | |
| | 28 | 18299 | 1.9 | 1.8 | | 2.5 | 3.0 | | | | | | 2.8 | | 2.4 | 2.7 |
| **Region mean** | | | **1.9** | **1.9** | **2.1** | **2.6** | **2.9** | **1.0** | **3.8** | **2.2** | **3.8** | **2.5** | **2.9** | **2.4** | **2.6** | **2.7** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 2.1 | 2.1 | 2.5 | 2.8 | 3.0 | 1.1 | | | 4.0 | | 3.2 | 2.6 | | |
| | 30 | 18268 | 1.9 | 2.0 | 2.1 | 2.8 | 2.7 | 1.0 | | | 4.0 | | | 2.8 | | |
| | 31 | 18586 | 2.2 | | | | | | | | | | | | 3.0 | |
| India | 32 | 18013 | 2.1 | 1.9 | 2.1 | 2.8 | 2.9 | 1.0 | 3.9 | 2.0 | 4.0 | 3.0 | | | | |
| | 33 | 18014 | 1.9 | 2.0 | 2.3 | 2.8 | 2.7 | 1.0 | | 2.0 | 4.0 | 2.0 | | 2.6 | 3.0 | 3.0 |
| | 34 | 18015 | 2.0 | | | 2.9 | 2.8 | | | 2.1 | | 2.5 | 3.3 | | 3.3 | 2.9 |
| | 35 | 18118 | 2.2 | 1.9 | 2.4 | 2.7 | 2.9 | 1.0 | 3.9 | | 4.0 | | | | | |
| | 36 | 18119 | 1.9 | 2.0 | 2.3 | 2.8 | 2.9 | 1.0 | | | 4.0 | 2.7 | 3.3 | 2.6 | 2.6 | |
| | 37 | 18120 | 2.0 | | | | 2.8 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.9 | | | | | | | | | | | | | |
| | 39 | 18287 | 2.1 | | 2.4 | 2.9 | 2.9 | 1.1 | | | 4.0 | | 2.8 | 2.6 | 3.3 | |
| | 40 | 18288 | 2.0 | | 2.1 | 2.4 | 2.9 | 1.0 | | | | | 3.4 | | | |
| Vietnam | 41 | 18085 | 1.9 | 2.0 | 2.1 | | | 1.0 | 3.9 | 2.2 | 4.0 | | | 2.6 | | |
| | 42 | 18086 | 1.8 | | | | 2.8 | | | | | 2.3 | | | 2.8 | 2.7 |
| | 43 | 18127 | 2.0 | | | 2.5 | 2.8 | | 3.9 | | | 1.6 | | | 3.2 | |
| | 44 | 18128 | 2.0 | 1.7 | 2.2 | 2.8 | 3.0 | 1.0 | | 2.4 | 3.8 | 2.3 | 3.3 | 2.8 | | |
| | 45 | 18152 | 2.2 | | | 2.7 | 3.0 | | | 2.3 | | | 2.8 | | | |
| **Region mean** | | | **2.0** | **2.0** | **2.2** | **2.7** | **2.9** | **1.0** | **3.9** | **2.2** | **4.0** | **2.3** | **3.2** | **2.6** | **3.0** | **2.9** |

**Appendix 1.7** (cont'd) Mean values for thickness of permanent branches (*Thkpb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 2.3 | | | 3.0 | 2.9 | | | | | | 3.9 | 2.6 | 2.7 | 2.4 |
| Egypt | 47 | 18122 | 2.0 | 2.2 | 2.2 | 2.7 | 2.7 | 1.0 | 4.0 | 2.3 | 4.0 | 3.0 | | 2.7 | | |
| | 48 | 18125 | 2.3 | 2.2 | 1.7 | | 3.0 | 1.0 | | 2.5 | 4.0 | 3.0 | 3.1 | 2.6 | | |
| | 49 | 18126 | 2.2 | | | | | | | | | 3.0 | | | 2.8 | 2.5 |
| Kenya | 50 | 18134 | 2.1 | 2.1 | 2.4 | 2.8 | 2.9 | 1.0 | 4.0 | 2.4 | 3.9 | 2.7 | | 2.9 | | |
| | 51 | 18135 | 2.4 | | | | | | | | | 3.0 | | | | |
| | 52 | 18136 | 2.6 | | | | | | | | | 2.7 | | | | |
| | 53 | 18137 | 2.3 | 2.8 | 2.5 | 2.7 | 2.9 | 1.0 | 4.0 | 2.7 | 4.0 | 3.2 | | 2.8 | | |
| | 54 | 18141 | 2.3 | | | | | | | | | | | | | |
| | 55 | 18142 | 2.2 | | | 2.6 | 2.9 | | | 2.4 | | | | | 2.9 | 2.5 |
| | 56 | 18143 | 2.1 | | | 2.5 | 2.9 | | | | | 2.2 | 3.4 | | | |
| | 57 | 18144 | 2.3 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 2.3 | | | | | | | | | | 3.1 | | 3.1 | 2.5 |
| **Region mean** | | | **2.3** | **2.3** | **2.2** | **2.7** | **2.9** | **1.0** | **4.0** | **2.4** | **4.0** | **2.8** | **3.4** | **2.7** | **2.9** | **2.5** |
| Puerto Rico | 59 | 18752 | 2.1 | | | | | | | | | | 3.0 | | 3.4 | 2.6 |
| Overall mean | | | 2.1 | 2.1 | 2.2 | 2.7 | 2.9 | 1.0 | 3.9 | 2.3 | 3.9 | 2.6 | 3.1 | 2.5 | 2.8 | 2.7 |
| | | RMS | 0.0725 | 0.0827 | 0.1564 | 0.0427 | 0.0372 | 0.0108 | 0.0162 | 0.0928 | 0.0764 | 0.3507 | 0.2957 | 0.0558 | 0.3911 | 0.1325 |
| | | SED | 0.190 | 0.203 | 0.280 | 0.146 | 0.136 | 0.073 | 0.090 | 0.017 | 0.226 | 0.484 | 0.385 | 0.167 | 0.065 | 0.257 |
| | | Prov. | ns | ** | ns | *** | ns | ns | ns | ns | ns | ns | ns | * | * | ** |
| | | Country | * | ns | ns | ** | ns | ns | ns | ns | ns | ns | ns | ** | *** | ns |
| | | Region | *** | *** | ns | *** | ns | ns | *** | ** | *** | ** | ns | *** | ** | * |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.8** Mean values for angle of permanent branches (*Angpb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 1.2 | 1.8 | 1.7 | 1.7 | 2.0 | 1.2 | 1.4 | 1.4 | 1.0 | 1.3 | | 1.8 | 2.0 | 1.2 |
| | 2 | 16166 | 1.1 | | | 1.9 | | | | | | 1.7 | 2.0 | | 2.0 | 1.2 |
| | 3 | 18008 | 1.5 | 1.5 | 1.5 | 2.0 | 1.9 | 1.3 | 1.6 | 1.6 | 1.0 | | | 2.0 | 2.0 | 1.4 |
| | 4 | 18378 | 1.3 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 1.5 | 1.5 | 1.6 | 1.9 | 2.0 | 1.2 | 1.5 | 1.4 | 1.0 | 1.5 | 2.0 | 1.8 | 2.0 | |
| Fiji | 6 | 18270 | 1.7 | 1.8 | 2.0 | | 2.0 | 1.3 | | | 1.8 | | | | | |
| | 7 | 18271 | 1.5 | 1.7 | 1.8 | 2.0 | 2.0 | 1.1 | | | 1.0 | | | 1.9 | | |
| | 8 | 18272 | 1.8 | | | | | | | | | | 2.0 | | 2.0 | 1.4 |
| Guam | 9 | 18121 | 1.2 | 1.2 | 1.5 | 2.0 | 2.0 | 1.0 | 1.7 | 1.3 | | | 2.0 | 1.5 | 2.0 | 1.2 |
| Solomon | 10 | 18402 | 1.3 | | | | | | | | | | | | 2.0 | |
| | 11 | 18403 | 1.1 | | | | | | | | | | | | | 1.1 |
| Vanuatu | 12 | 18312 | 1.2 | | | 1.9 | 1.7 | | | | | | 2.0 | 1.7 | 2.0 | |
| Tonga | 12a | 18040 | | | | 2.0 | 1.8 | | 2.0 | | | | | | | |
| **Region mean** | | | **1.4** | **1.6** | **1.7** | **1.9** | **1.9** | **1.2** | **1.7** | **1.4** | **1.2** | **1.5** | **2.0** | **1.8** | **2.0** | **1.3** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 1.9 | 1.9 | 2.0 | 2.0 | 2.0 | 1.4 | | 1.7 | 1.0 | 1.7 | 2.0 | 1.9 | | |
| | 14 | 18158 | 1.6 | 1.6 | 1.9 | 2.0 | 2.0 | 1.6 | 1.8 | 1.7 | 1.0 | 1.9 | | 2.0 | 2.0 | 1.4 |
| | 15 | 18160 | 1.8 | | | | | | | 1.6 | | | | | | |
| | 16 | 18161 | 1.8 | | | | | | | | | 1.0 | | | | |
| | 17 | 18244 | 1.6 | 1.5 | 1.6 | 2.0 | 1.9 | 1.2 | | 1.5 | 1.0 | 1.3 | 2.0 | 2.0 | | |
| | 18 | 18348 | 1.6 | | | 2.0 | 2.0 | | | | | | | 1.9 | 2.0 | |
| | 19 | 18374 | 1.3 | | | | | | | | | | 1.8 | | | |
| | 20 | 18375 | 1.5 | | | | | | | | | | | | | |
| | 21 | 18376 | 1.6 | | | | | | | | | | | | | 1.2 |

**Appendix 1.8** (cont'd) Mean values for angle of permanent branches (*Angpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 1.3 | 1.8 | 1.7 | 1.8 | 2.0 | 1.3 | | | 1.0 | 1.7 | | | 2.0 | |
| | 23 | 18154 | 1.3 | 1.4 | 1.8 | | 1.9 | 1.1 | 1.6 | 1.3 | 1.3 | 1.1 | 2.0 | 1.7 | | |
| | 24 | 18357 | 1.7 | | | | 2.0 | | | | | | | | | |
| Thailand | 25 | 18296 | 1.6 | | 1.4 | 2.0 | 2.0 | 1.4 | | | 1.7 | | 1.8 | 2.0 | | |
| | 26 | 18297 | 1.4 | | 1.8 | 2.0 | 2.0 | 1.2 | | | 1.2 | | | | 2.0 | 1.2 |
| | 27 | 18298 | 1.6 | 1.6 | 1.7 | 2.0 | 2.0 | 1.6 | | | | | 1.5 | 2.0 | | |
| | 28 | 18299 | 1.7 | 1.5 | | 2.0 | 1.8 | | | | | | 2.0 | | 2.0 | 1.4 |
| **Region mean** | | | **1.6** | **1.6** | **1.7** | **2.0** | **2.0** | **1.3** | **1.7** | **1.5** | **1.2** | **1.5** | **1.9** | **1.9** | **2.0** | **1.3** |
| China | 29 | 18267 | 1.3 | 1.5 | 1.8 | 1.9 | 2.0 | 1.1 | | | 1.0 | | 2.0 | 1.9 | | |
| | 30 | 18268 | 1.3 | 1.6 | 1.8 | 2.0 | 2.0 | 1.1 | | | 1.0 | | | 1.9 | | |
| | 31 | 18586 | 1.4 | | | | | | | | | | | | 2.0 | |
| India | 32 | 18013 | 1.2 | 1.5 | 1.6 | 2.0 | 2.0 | 1.2 | 1.6 | 1.6 | 1.0 | 1.7 | | | | |
| | 33 | 18014 | 1.2 | 1.5 | 1.3 | 1.9 | 2.0 | 1.1 | | 1.3 | 1.0 | 1.0 | | 1.8 | 2.2 | 1.2 |
| | 34 | 18015 | 1.3 | | | 2.0 | 2.0 | | | 1.5 | | 1.5 | 1.9 | | 2.0 | 1.2 |
| | 35 | 18118 | 1.3 | 1.4 | 1.6 | 2.0 | 1.8 | 1.1 | 1.6 | | 1.0 | | | | | |
| | 36 | 18119 | 1.4 | 1.7 | 1.6 | 2.0 | 2.0 | 1.0 | | | 1.1 | 2.0 | 1.5 | 1.9 | 2.0 | |
| | 37 | 18120 | 1.3 | | | | 2.0 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.2 | | | | | | | | | | | | | |
| | 39 | 18287 | 1.5 | | 1.7 | 1.9 | 2.0 | 1.3 | | | 1.0 | | 2.0 | 2.0 | 2.0 | |
| | 40 | 18288 | 1.4 | | 1.8 | 2.0 | 2.0 | 1.2 | | | | | 1.8 | | | |
| Vietnam | 41 | 18085 | 1.2 | 1.4 | 1.4 | | | 1.1 | 1.5 | 1.5 | 1.1 | | | 1.8 | | |
| | 42 | 18086 | 1.2 | | | | 1.9 | | | | | 1.3 | | | 2.0 | 1.3 |
| | 43 | 18127 | 1.3 | | | 2.0 | 1.8 | | 1.3 | | | 1.5 | | | 2.0 | |
| | 44 | 18128 | 1.3 | 1.3 | 1.4 | 2.0 | 2.0 | 1.1 | | 1.3 | 1.1 | 1.0 | 2.0 | 1.9 | | |
| | 45 | 18152 | 1.5 | | | 2.0 | 2.0 | | | 1.6 | | | 1.4 | | | |
| **Region mean** | | | **1.3** | **1.5** | **1.6** | **2.0** | **2.0** | **1.1** | **1.5** | **1.5** | **1.0** | **1.4** | **1.8** | **1.9** | **2.0** | **1.2** |

**Appendix 1.8** (cont'd) Mean values for angle of permanent branches (*Angpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 1.5 | | | 2.0 | 1.9 | | | | | | 2.0 | 1.9 | 2.0 | 1.4 |
| Egypt | 47 | 18122 | 1.3 | 1.2 | 1.4 | 2.0 | 2.0 | 1.1 | 1.8 | 1.3 | 1.0 | 1.3 | | 1.5 | | |
| | 48 | 18125 | 1.4 | 1.3 | 1.7 | | 2.0 | 1.0 | | 1.4 | 1.0 | 1.7 | 1.9 | 1.7 | | |
| | 49 | 18126 | 1.0 | | | | | | | | | 1.5 | | | 1.7 | 1.2 |
| Kenya | 50 | 18134 | 1.2 | 1.7 | 1.6 | 2.0 | 1.9 | 1.0 | 2.0 | 1.4 | 1.0 | 1.3 | | 1.7 | | |
| | 51 | 18135 | 1.4 | | | | | | | | | 1.7 | | | | |
| | 52 | 18136 | 1.6 | | | | | | | | | 1.7 | | | | |
| | 53 | 18137 | 1.1 | 1.8 | 1.6 | 2.0 | 2.0 | 1.0 | 1.7 | 1.5 | 1.0 | 1.9 | | 1.5 | | |
| | 54 | 18141 | 1.4 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.2 | | | 1.9 | 2.0 | | | 1.5 | | | | | 1.9 | 1.3 |
| | 56 | 18143 | 1.1 | | | 1.9 | 2.0 | | | | | 1.7 | 1.9 | | | |
| | 57 | 18144 | 1.5 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.2 | | | | | | | | | | 2.0 | | 2.0 | 1.4 |
| **Region mean** | | | **1.3** | **1.5** | **1.6** | **2.0** | **2.0** | **1.0** | **1.8** | **1.4** | **1.0** | **1.6** | **1.9** | **1.6** | **1.9** | **1.3** |
| Puerto Rico | 59 | 18752 | 1.4 | | | | | | | | | | 1.7 | | 2.0 | 1.3 |
| **Overall mean** | | | **1.4** | **1.5** | **1.6** | **2.0** | **2.0** | **1.2** | **1.7** | **1.5** | **1.1** | **1.5** | **1.9** | **1.8** | **2.0** | **1.3** |
| | | RMS | 0.0332 | 0.0888 | 0.0677 | 0.0131 | 0.0244 | 0.0343 | 0.0507 | 0.0533 | 0.0295 | 0.1995 | 0.0786 | 0.0202 | 0.0097 | 0.0586 |
| | | SED | 0.130 | 0.211 | 0.184 | 0.081 | 0.111 | 0.131 | 0.431 | 0.010 | 0.140 | 0.365 | 0.198 | 0.101 | 0.035 | 0.171 |
| | | Prov. | *** | ns | ns | ns | ns | ns | ns | ns | *** | ns | ** | ns | ns | ns |
| | | Country | *** | ** | * | ns | ns | *** | ns | * | *** | ns | ns | *** | *** | ns |
| | | Region | *** | ns | ns | *** | ns | ** | ** | ns | *** | ns | ns | *** | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.9** Mean values for length of permanent branches (*Lenpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 1.5 | 1.9 | 1.7 | 1.8 | 1.1 | 1.5 | 1.9 | 1.3 | 1.1 | 1.0 | | 1.3 | 1.3 | 1.3 |
| | 2 | 16166 | 1.4 | | | 1.8 | | | | | | 1.0 | 1.6 | | 1.6 | 1.3 |
| | 3 | 18008 | 1.5 | 1.8 | 1.7 | 1.3 | 1.3 | 1.4 | 1.9 | 1.2 | 1.2 | | | 1.4 | 1.4 | 1.2 |
| | 4 | 18378 | 1.6 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 1.3 | 1.9 | 1.4 | 1.7 | 1.2 | 1.0 | 2.0 | 1.2 | 1.2 | 1.4 | 1.5 | 1.1 | 1.4 | |
| Fiji | 6 | 18270 | 1.4 | 1.8 | 1.4 | | 1.4 | 1.4 | | | 1.0 | | | | | |
| | 7 | 18271 | 1.3 | 1.9 | 1.6 | 1.5 | 1.7 | 1.3 | | | 1.0 | | | 1.1 | | |
| | 8 | 18272 | 1.3 | | | | | | | | | | 1.8 | | 1.1 | 1.2 |
| Guam | 9 | 18121 | 1.2 | 1.4 | 1.5 | 1.7 | 1.3 | 1.2 | 1.9 | 1.3 | | | 1.7 | 1.1 | 1.1 | 1.2 |
| Solomon | 10 | 18402 | 1.3 | | | | | | | | | | | | 1.2 | 1.4 |
| | 11 | 18403 | 1.2 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 1.4 | | | 1.4 | 1.6 | | | | | | | 1.1 | 1.3 | |
| Tonga | 12 a | 18040 | | | | 1.1 | 1.7 | | 1.1 | | | | | | | |
| **Region mean** | | | **1.4** | **1.8** | **1.5** | **1.5** | **1.4** | **1.3** | **1.8** | **1.3** | **1.1** | **1.1** | **1.7** | **1.2** | **1.3** | **1.3** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 1.4 | 1.8 | 1.8 | 1.1 | 1.6 | 1.2 | | 1.0 | 1.0 | 1.3 | 2.0 | 1.1 | | |
| | 14 | 18158 | 1.2 | 1.6 | 1.3 | 1.3 | 1.7 | 1.1 | 1.6 | 1.0 | 1.0 | 1.1 | | 1.1 | 1.1 | 1.2 |
| | 15 | 18160 | 1.4 | | | | | | | 1.2 | | 1.1 | | | | |
| | 16 | 18161 | 1.2 | | | | | | | | | 1.0 | | | | |
| | 17 | 18244 | 1.4 | 1.8 | 1.3 | 1.7 | 1.2 | 1.3 | | 1.2 | 1.0 | 1.0 | 2.0 | 1.3 | | |
| | 18 | 18348 | 1.3 | | | 1.1 | 1.7 | | | | | | | 1.1 | 1.1 | |
| | 19 | 18374 | 1.1 | | | | | | | | | | 2.0 | | | |
| | 20 | 18375 | 1.2 | | | | | | | | | | | | | |
| | 21 | 18376 | 1.4 | | | | | | | | | | | | | 1.3 |

**Appendix 1.9** (cont'd) Mean values for length of permanent branches (*Lenpb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 1.3 | 2.0 | 1.7 | 1.0 | 1.5 | 1.3 | | | 1.0 | 1.0 | | | 1.4 | |
| | 23 | 18154 | 1.4 | 1.7 | 1.6 | | 1.9 | 1.3 | 1.8 | 1.2 | 1.3 | 1.0 | 2.0 | 1.1 | | |
| | 24 | 18357 | 1.4 | | | | 1.8 | | | | | | | | | |
| Thailand | 25 | 18296 | 1.3 | | 1.5 | 1.2 | 1.6 | 1.3 | | | 1.1 | | 1.6 | 1.0 | | |
| | 26 | 18297 | 1.3 | | 1.4 | 1.4 | 1.7 | 1.4 | | | 1.0 | | | | 1.1 | 1.3 |
| | 27 | 18298 | 1.2 | 1.8 | 1.4 | 1.2 | 1.6 | 1.3 | | | | | 1.5 | 1.1 | | |
| | 28 | 18299 | 1.3 | 1.8 | | 1.5 | 1.7 | | | | | | 1.5 | | 1.3 | 1.4 |
| **Region mean** | | | **1.3** | **1.8** | **1.5** | **1.3** | **1.6** | **1.2** | **1.7** | **1.1** | **1.1** | **1.1** | **1.8** | **1.1** | **1.2** | **1.3** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.4 | 1.7 | 1.7 | 1.5 | 1.5 | 1.1 | | | 1.0 | | 1.7 | 1.2 | | |
| | 30 | 18268 | 1.4 | 1.8 | 1.5 | 1.8 | 1.7 | 1.0 | | | 1.3 | | | 1.2 | | |
| | 31 | 18586 | 1.3 | | | | | | | | | | | | 1.4 | |
| India | 32 | 18013 | 1.3 | 1.6 | 1.6 | 1.8 | 1.3 | 1.2 | 1.8 | 1.2 | 1.2 | 1.3 | | | | |
| | 33 | 18014 | 1.3 | 1.7 | 1.6 | 1.4 | 1.1 | 1.1 | | 1.2 | 1.2 | 1.0 | | 1.1 | 1.3 | 1.3 |
| | 34 | 18015 | 1.3 | | | 1.2 | 1.5 | | | 1.2 | | 1.4 | 1.4 | | 1.3 | 1.2 |
| | 35 | 18118 | 1.4 | 1.6 | 1.6 | 1.1 | 1.3 | 1.1 | 1.8 | | 1.5 | 1.0 | | | | |
| | 36 | 18119 | 1.3 | 1.8 | 1.7 | 1.4 | 1.3 | 1.3 | | | 1.1 | | 1.8 | 1.2 | 1.3 | |
| | 37 | 18120 | 1.2 | | | | 1.4 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.3 | | | | | | | | | | | | | |
| | 39 | 18287 | 1.3 | | 1.7 | 1.7 | 2.0 | 1.4 | | | 1.1 | | 1.8 | 1.2 | 1.4 | |
| | 40 | 18288 | 1.2 | | 1.6 | 1.1 | 1.5 | 1.3 | | | | | 1.5 | | | |
| Vietnam | 41 | 18085 | 1.3 | 1.8 | 1.6 | | | 1.3 | 1.7 | 1.3 | 1.3 | | | 1.1 | | |
| | 42 | 18086 | 1.3 | | | | 1.3 | | | | | 1.0 | | | 1.3 | 1.1 |
| | 43 | 18127 | 1.3 | | | 1.9 | 1.5 | | 1.7 | | | 1.0 | | | 1.2 | |
| | 44 | 18128 | 1.3 | 1.7 | 1.7 | 1.8 | 1.9 | 1.4 | | 1.3 | 1.2 | 1.0 | 1.8 | 1.3 | | |
| | 45 | 18152 | 1.4 | | | 1.5 | 1.9 | | | 1.2 | | 1.0 | 1.7 | | | |
| **Region mean** | | | **1.3** | **1.7** | **1.6** | **1.5** | **1.5** | **1.2** | **1.7** | **1.2** | **1.2** | **1.1** | **1.7** | **1.2** | **1.3** | **1.2** |

**Appendix 1.9** (cont'd) Mean values for length of permanent branches (*Lenpb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 1.3 | | | 1.9 | 1.6 | | | | | | 1.9 | 1.2 | 1.2 | 1.1 |
| Egypt | 47 | 18122 | 1.3 | 1.8 | 1.6 | 1.7 | 1.4 | 1.1 | 2.0 | 1.4 | 1.4 | 1.0 | | 1.2 | | |
| | 48 | 18125 | 1.6 | 1.9 | 1.4 | | 2.0 | 1.2 | | 1.4 | 1.1 | 1.0 | 1.8 | 1.1 | | |
| | 49 | 18126 | 1.4 | | | | | | | | | 0.9 | | | 1.4 | 1.2 |
| Kenya | 50 | 18134 | 1.3 | 1.8 | 1.7 | 1.3 | 1.4 | 1.3 | 2.0 | 1.3 | 1.2 | 1.0 | | 1.3 | | |
| | 51 | 18135 | 1.5 | | | | | | | | | 1.7 | | | | |
| | 52 | 18136 | 1.6 | | | | | | | | | 1.3 | | | | |
| | 53 | 18137 | 1.4 | 2.0 | 1.6 | 1.5 | 1.5 | 1.6 | 1.9 | 1.3 | 1.4 | 2.1 | | 1.3 | | |
| | 54 | 18141 | 1.7 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.3 | | | 1.6 | 1.5 | | | 1.3 | | | | | 1.4 | 1.3 |
| | 56 | 18143 | 1.4 | | | 1.7 | 1.5 | | | | | 1.0 | 1.5 | | | |
| | 57 | 18144 | 1.5 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.5 | | | | | | | | | | 1.8 | | 1.5 | 1.2 |
| **Region mean** | | | **1.4** | **1.9** | **1.6** | **1.6** | **1.6** | **1.3** | **2.0** | **1.3** | **1.2** | **1.3** | **1.8** | **1.2** | **1.4** | **1.2** |
| Puerto Rico | 59 | 18752 | 1.4 | | | | | | | | | | 1.7 | | 1.4 | 1.1 |
| | | | | | | | | | | | | | | | | |
| **Overall mean** | | | **1.3** | **1.8** | **1.6** | **1.5** | **1.5** | **1.3** | **1.8** | **1.2** | **1.2** | **1.1** | **1.7** | **1.2** | **1.3** | **1.2** |
| | | RMS | 0.0253 | 0.0237 | 0.0511 | 0.0525 | 0.1480 | 0.1156 | 0.0579 | 0.0393 | 0.0566 | | | 0.0156 | 0.0299 | 0.0399 |
| | | SED | 0.110 | 0.109 | 0.160 | 0.162 | 0.272 | 0.268 | 0.081 | 0.007 | 0.194 | 0.273 | 0.310 | 0.083 | 0.088 | 0.141 |
| | | Prov. | ns | ns | ns | *** | ns | ns | ns | ns | ns | * | ns | ns | ns | ns |
| | | Country | *** | *** | ns | *** | ns | ns | ** | ns | ns | *** | ns | ** | * | ns |
| | | Region | *** | ** | ns | *** | ** | ns | ** | ns | ns | ns | ns | ** | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.10** Mean values for thickness of deciduous branches (*Thkdb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 1.3 | 1.9 | 2.0 | 1.1 | 1.2 | 1.9 | 1.9 | 1.8 | 1.1 | 2.0 | | 2.0 | 1.4 | 1.1 |
| | 2 | 16166 | 2.0 | | | 2.0 | | | | | | 1.7 | 2.0 | | 2.0 | 1.2 |
| | 3 | 18008 | 1.7 | 1.9 | 2.0 | 2.0 | 1.2 | 1.8 | 1.8 | 1.8 | 1.5 | | | 2.0 | 1.5 | 1.0 |
| | 4 | 18378 | 1.5 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 2.0 | 2.0 | 2.0 | 2.0 | 1.3 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.9 | |
| Fiji | 6 | 18270 | 2.0 | 2.0 | 2.0 | | 1.7 | 2.0 | | | 2.0 | | | | | |
| | 7 | 18271 | 2.0 | 2.0 | 2.0 | 2.0 | 1.2 | 1.9 | | | 2.0 | | | 2.0 | | |
| | 8 | 18272 | 1.9 | | | | | | | | | | 2.0 | | 1.9 | 1.2 |
| Guam | 9 | 18121 | 1.9 | 2.0 | 2.0 | 2.0 | 1.5 | 2.0 | 2.0 | 1.9 | | | 2.0 | 2.0 | 1.8 | 1.1 |
| Solomon | 10 | 18402 | 2.0 | | | | | | | | | | | | 1.8 | 1.1 |
| | 11 | 18403 | 2.0 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 1.9 | | | 2.0 | 1.5 | | | | | | 1.9 | 2.0 | 1.8 | |
| Tonga | 12a | 18040 | | | | 2.0 | 1.6 | | 2.0 | | | | | | | |
| **Region mean** | | | **1.8** | **1.9** | **2.0** | **1.9** | **1.4** | **1.9** | **1.9** | **1.9** | **1.7** | **1.9** | **2.0** | **2.0** | **1.8** | **1.1** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 1.3 | 1.4 | 1.7 | 1.8 | 1.3 | 1.7 | | 1.7 | 1.2 | 2.0 | 2.0 | 1.9 | | |
| | 14 | 18158 | 1.1 | 1.6 | 1.5 | 1.5 | 1.0 | 1.7 | 1.3 | 1.8 | 1.0 | 2.0 | | 1.6 | 1.1 | 1.2 |
| | 15 | 18160 | 1.2 | | | | | | | 1.9 | | | | | | |
| | 16 | 18161 | 1.1 | | | | | | | | | 2.0 | | | | |
| | 17 | 18244 | 1.2 | 1.9 | 1.8 | 1.1 | 1.1 | 1.7 | | 1.7 | 1.1 | 2.0 | 2.0 | 1.9 | | |
| | 18 | 18348 | 1.5 | | | 1.2 | 1.3 | | | | | | | 1.8 | 1.2 | |
| | 19 | 18374 | 1.7 | | | | | | | | | | 2.0 | | | |
| | 20 | 18375 | 1.4 | | | | | | | | | | | | | |
| | 21 | 18376 | 1.8 | | | | | | | | | | | | | 1.1 |

**Appendix 1.10** (cont'd) Mean values for thickness of deciduous branches (*Thkdb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 1.9 | 2.0 | 2.0 | 1.2 | 1.3 | 2.0 | | | 1.9 | 1.7 | | | 1.6 | |
| | 23 | 18154 | 1.9 | 2.0 | 2.0 | | 1.3 | 2.0 | 1.9 | 1.9 | 1.8 | 1.9 | 2.0 | 2.0 | | |
| | 24 | 18357 | 1.2 | | | | 1.5 | | | | | | | | | |
| Thailand | 25 | 18296 | 1.4 | | 2.0 | 1.1 | 1.4 | 1.5 | | | 1.2 | | 2.0 | 1.7 | | |
| | 26 | 18297 | 1.1 | | 1.5 | 1.6 | 1.3 | 1.7 | | | 1.2 | | | | 1.1 | 1.1 |
| | 27 | 18298 | 1.1 | 1.4 | 1.4 | 1.5 | 1.3 | 1.3 | | | | | 1.8 | 1.7 | | |
| | 28 | 18299 | 1.5 | 1.9 | | 1.7 | 1.5 | | | | | | 2.0 | | 1.5 | 1.2 |
| **Region mean** | | | **1.4** | **1.7** | **1.7** | **1.4** | **1.3** | **1.7** | **1.6** | **1.8** | **1.4** | **1.9** | **2.0** | **1.8** | **1.3** | **1.1** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.6 | 2.0 | 2.0 | 1.6 | 1.2 | 2.0 | | | 1.9 | | 2.0 | 2.0 | | |
| | 30 | 18268 | 1.6 | 1.9 | 2.0 | 1.9 | 1.0 | 2.0 | | | 1.6 | | | 2.0 | | |
| | 31 | 18586 | 1.7 | | | | | | | | | | | | 1.3 | |
| India | 32 | 18013 | 1.5 | 1.9 | 2.0 | 1.9 | 1.6 | 2.0 | 1.8 | 1.7 | 1.9 | 2.0 | | | | |
| | 33 | 18014 | 1.3 | 2.0 | 2.0 | 2.0 | 1.3 | 1.9 | | 2.0 | 1.9 | 2.0 | | 2.0 | 1.4 | 1.2 |
| | 34 | 18015 | 1.4 | | | 1.9 | 1.3 | | | 1.7 | | 1.5 | 2.0 | | 1.5 | 1.1 |
| | 35 | 18118 | 1.4 | 1.7 | 2.0 | 1.0 | 1.3 | 1.7 | 1.8 | | 1.5 | | | | | |
| | 36 | 18119 | 1.6 | 1.7 | 1.8 | 1.9 | 1.2 | 1.8 | | | 1.8 | 2.0 | 2.0 | 2.0 | 1.2 | |
| | 37 | 18120 | 1.4 | | | | 1.5 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.4 | | | | | | | | | | | | | |
| | 39 | 18287 | 1.7 | | 2.0 | 1.7 | 1.3 | 1.9 | | | 1.2 | | 2.0 | 2.0 | 1.3 | |
| | 40 | 18288 | 1.6 | | 2.0 | 1.9 | 1.4 | 1.8 | | | | | 2.0 | | | |
| Vietnam | 41 | 18085 | 1.6 | 1.6 | 2.0 | | | 1.9 | 1.7 | 1.9 | 1.5 | | | 2.0 | | |
| | 42 | 18086 | 1.6 | | | | 1.0 | | | | | 2.0 | | | 1.6 | 1.0 |
| | 43 | 18127 | 1.5 | | | 1.8 | 1.1 | | 1.8 | | | 1.6 | | | 1.4 | |
| | 44 | 18128 | 1.8 | 2.0 | 1.9 | 1.8 | 1.7 | 1.8 | | 1.9 | 1.9 | 1.7 | 2.0 | 2.0 | | |
| | 45 | 18152 | 1.4 | | | 1.6 | 1.6 | | | 1.9 | | | 2.0 | | | |
| **Region mean** | | | **1.5** | **1.8** | **2.0** | **1.7** | **1.3** | **1.9** | **1.8** | **1.9** | **1.7** | **1.8** | **2.0** | **2.0** | **1.4** | **1.1** |

**Appendix 1.10** (cont'd) Mean values for thickness of deciduous branches (*Thkdb*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 1.5 | | | 1.9 | 1.1 | | | | | | 2.0 | 2.0 | 1.6 | 1.1 |
| Egypt | 47 | 18122 | 1.4 | 1.8 | 2.0 | 1.3 | 1.3 | 1.7 | 1.8 | 1.9 | 1.3 | 2.0 | | 2.0 | | |
| | 48 | 18125 | 1.5 | 1.9 | 2.0 | | 1.9 | 1.8 | | 2.0 | 1.6 | 2.0 | 2.0 | 2.0 | | |
| | 49 | 18126 | 1.4 | | | | | | | | | 2.0 | | | 1.5 | 1.2 |
| Kenya | 50 | 18134 | 1.9 | 1.7 | 2.0 | 2.0 | 1.1 | 2.0 | 2.0 | 1.8 | 2.0 | 2.0 | | 2.0 | | |
| | 51 | 18135 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 52 | 18136 | 1.8 | | | | | | | | | 2.0 | | | | |
| | 53 | 18137 | 1.8 | 2.0 | 2.0 | 1.9 | 1.0 | 2.0 | 2.0 | 2.0 | 1.7 | 2.0 | | 2.0 | | |
| | 54 | 18141 | 1.7 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.9 | | | 1.9 | 1.1 | | | 2.0 | | | | | 1.7 | 1.1 |
| | 56 | 18143 | 1.9 | | | 2.0 | 1.4 | | | | | 2.0 | 2.0 | | | |
| | 57 | 18144 | 1.9 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.3 | | | | | | | | | | 2.0 | | 1.4 | 1.1 |
| **Region mean** | | | **1.7** | **1.8** | **2.0** | **1.8** | **1.3** | **1.9** | **1.9** | **1.9** | **1.6** | **2.0** | **2.0** | **2.0** | **1.5** | **1.1** |
| Puerto Rico | 59 | 18752 | 1.4 | | | | | | | | | | 2.0 | | 1.3 | 1.2 |
| **Overall mean** | | | **1.6** | **1.8** | **1.9** | **1.7** | **1.3** | **1.8** | **1.8** | **1.9** | **1.6** | **1.9** | **2.0** | **1.9** | **1.5** | **1.1** |
| | | RMS | 0.0507 | 0.0538 | 0.0196 | 0.0408 | 0.1747 | 0.0481 | 0.0451 | 0.0414 | 0.0826 | 0.0598 | 0.0118 | 0.0220 | 0.0515 | 0.0192 |
| | | SED | 0.160 | 0.164 | 0.099 | 0.143 | 0.052 | 0.155 | 0.150 | 0.008 | 0.235 | 0.200 | 0.077 | 0.105 | 0.160 | 0.098 |
| | | Prov. | *** | ** | *** | *** | ns | ns | ns | ns | ns | ns | ns | ns | *** | ns |
| | | Country | *** | * | *** | *** | ns | *** | ** | ns | *** | * | ns | * | *** | ns |
| | | Region | *** | * | *** | *** | ns | *** | ** | ns | *** | ns | ns | ** | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.11** Mean values for length of deciduous branches (*Lendb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 1.2 | 1.0 | 1.0 | 2.0 | 1.3 | 1.3 | 1.5 | 1.8 | 1.1 | 1.7 | | 1.1 | 1.1 | 1.5 |
| | 2 | 16166 | 2.0 | | | 2.0 | | | | | | 1.3 | 2.0 | | 2.0 | 1.5 |
| | 3 | 18008 | 1.6 | 1.2 | 1.2 | 2.0 | 1.5 | 1.7 | 1.7 | 1.9 | 1.0 | | | 1.5 | 1.5 | 1.3 |
| | 4 | 18378 | 1.3 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 1.3 | 1.0 | 1.0 | 1.3 | 1.7 | 1.7 | 2.0 | 2.0 | 1.0 | 1.1 | 2.0 | 1.1 | 1.6 | |
| Fiji | 6 | 18270 | 1.5 | 1.0 | 1.0 | | 2.0 | 2.0 | | | 1.7 | | | | | |
| | 7 | 18271 | 1.9 | 1.1 | 1.0 | 1.9 | 1.7 | 1.8 | | | 1.4 | | | 1.1 | | |
| | 8 | 18272 | 1.6 | | | | | | | | | | 2.0 | | 1.6 | 1.2 |
| Guam | 9 | 18121 | 1.1 | 1.0 | 1.0 | 1.0 | 1.7 | 1.6 | 1.9 | 1.8 | | | 2.0 | 1.1 | 1.1 | 1.4 |
| Solomon | 10 | 18402 | 1.7 | | | | | | | | | | | | 1.5 | 1.5 |
| | 11 | 18403 | 1.7 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 1.4 | | | 1.6 | 1.7 | | | | | | 2.0 | 1.0 | 1.2 | |
| Tonga | 12a | 18040 | | | | 2.0 | 1.9 | | 1.9 | | | | | | | |
| **Region mean** | | | **1.5** | **1.1** | **1.0** | **1.7** | **1.7** | **1.7** | **1.8** | **1.9** | **1.2** | **1.4** | **2.0** | **1.1** | **1.4** | **1.4** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 1.5 | 1.1 | 1.1 | 2.0 | 1.7 | 1.3 | | 2.0 | 1.0 | 1.0 | 2.0 | 1.0 | | |
| | 14 | 18158 | 1.2 | 1.0 | 1.0 | 1.4 | 1.3 | 1.9 | 1.1 | 2.0 | 1.0 | 1.5 | | 1.1 | 1.1 | 1.3 |
| | 15 | 18160 | 1.5 | | | | | | | 2.0 | | 1.4 | | | | |
| | 16 | 18161 | 1.5 | | | | | | | | | 1.7 | | | | |
| | 17 | 18244 | 1.3 | 1.0 | 1.1 | 2.0 | 1.7 | 1.4 | | 1.9 | 1.0 | 1.3 | 2.0 | 1.1 | | |
| | 18 | 18348 | 1.5 | | | 2.0 | 1.1 | | | | | | | 1.3 | 1.2 | |
| | 19 | 18374 | 1.4 | | | | | | | | | | 2.0 | | | |
| | 20 | 18375 | 1.3 | | | | | | | | | | | | | |
| | 21 | 18376 | 1.6 | | | | | | | | | | | | | 1.2 |

**Appendix 1.11** (cont'd) Mean values for length of deciduous branches (*Lendb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 1.1 | 1.0 | 1.0 | 1.4 | 1.6 | 1.5 | | | 1.1 | 1.0 | | | 1.1 | |
| | 23 | 18154 | 1.9 | 1.1 | 1.1 | | 1.8 | 1.9 | 1.6 | 2.0 | 1.7 | 1.0 | 2.0 | 1.3 | | |
| | 24 | 18357 | 1.0 | | | | 1.7 | | | | | | | | | |
| Thailand | 25 | 18296 | 1.3 | | 1.0 | 1.1 | 2.0 | 1.5 | | | 1.2 | | 2.0 | 1.0 | | |
| | 26 | 18297 | 1.2 | | 1.0 | 1.3 | 1.5 | 1.6 | | | 1.0 | | | | 1.0 | 1.4 |
| | 27 | 18298 | 1.1 | 1.1 | 1.1 | 1.3 | 1.8 | 1.3 | | | | | 1.5 | 1.0 | | |
| | 28 | 18299 | 1.4 | 1.5 | | 1.7 | 1.9 | | | | | | 2.0 | | 1.5 | 1.3 |
| **Region mean** | | | **1.4** | **1.1** | **1.1** | **1.6** | **1.6** | **1.5** | **1.3** | **2.0** | **1.1** | **1.0** | **1.9** | **1.1** | **1.2** | **1.3** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.6 | 1.1 | 1.1 | 1.8 | 1.7 | 1.5 | | | 1.2 | | 2.0 | 1.1 | | |
| | 30 | 18268 | 1.3 | 1.0 | 1.0 | 1.9 | 1.5 | 1.7 | | | 1.0 | | | 1.1 | | |
| | 31 | 18586 | 1.5 | | | | | | | | | | | | 1.2 | |
| India | 32 | 18013 | 1.5 | 1.0 | 1.1 | 1.7 | 1.6 | 1.9 | 1.7 | 1.8 | 1.3 | 1.7 | | | | |
| | 33 | 18014 | 1.4 | 1.0 | 1.1 | 1.1 | 1.6 | 1.8 | | 2.0 | 1.0 | 2.0 | | 1.0 | 1.2 | 1.5 |
| | 34 | 18015 | 1.4 | | | 1.0 | 1.4 | | | 1.8 | | 1.5 | 2.0 | | 1.2 | 1.5 |
| | 35 | 18118 | 1.2 | 1.0 | 1.0 | 2.0 | 1.6 | 1.4 | 1.6 | | 1.0 | | | | | |
| | 36 | 18119 | 1.4 | 1.0 | 1.1 | 2.0 | 1.5 | 1.7 | | | 1.2 | 1.3 | 2.0 | 1.0 | 1.1 | |
| | 37 | 18120 | 1.2 | | | | 1.9 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.2 | | | | | | | | | | | | | |
| | 39 | 18287 | 1.5 | | 1.0 | 1.9 | 1.9 | 1.7 | | | 1.0 | | 2.0 | 1.0 | 1.1 | |
| | 40 | 18288 | 1.3 | | 1.0 | 1.4 | 1.9 | 1.8 | | | | | 2.0 | | | |
| Vietnam | 41 | 18085 | 1.2 | 1.0 | 1.0 | | | 1.6 | 1.4 | 1.9 | 1.0 | | | 1.0 | | |
| | 42 | 18086 | 1.5 | | | | 1.6 | | | | | 1.7 | | | 1.5 | 1.2 |
| | 43 | 18127 | 1.3 | | | 1.2 | 1.7 | | 1.4 | | | 1.5 | | | 1.2 | |
| | 44 | 18128 | 1.3 | 1.0 | 1.0 | 1.6 | 1.8 | 1.6 | | 1.9 | 1.2 | 1.5 | 2.0 | 1.1 | | |
| | 45 | 18152 | 1.2 | | | 1.1 | 1.9 | | | 1.9 | | 1.5 | 2.0 | | | |
| **Region mean** | | | **1.4** | **1.0** | **1.0** | **1.6** | **1.7** | **1.7** | **1.5** | **1.9** | **1.1** | **1.6** | **2.0** | **1.0** | **1.2** | **1.4** |

**Appendix 1.11** (cont'd) Mean values for length of deciduous branches (*Lendb*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 1.4 | | | 1.9 | 1.4 | | | | | | | 1.1 | 1.3 | 1.4 |
| Egypt | 47 | 18122 | 1.5 | 1.0 | 1.0 | 1.8 | 1.7 | 1.5 | 1.4 | 1.9 | 1.2 | 1.3 | | 1.0 | | |
| | 48 | 18125 | 1.7 | 1.2 | 1.0 | | 2.0 | 1.8 | | 2.0 | 1.2 | 1.7 | 2.0 | 1.1 | | |
| | 49 | 18126 | 1.6 | | | | | | | | | 1.6 | | | 1.3 | 1.2 |
| Kenya | 50 | 18134 | 1.8 | 1.2 | 1.0 | 2.0 | 1.5 | 2.0 | 2.0 | 1.9 | 1.4 | 1.7 | | 1.3 | | |
| | 51 | 18135 | 1.6 | | | | | | | | | 2.0 | | | | |
| | 52 | 18136 | 1.9 | | | | | | | | | 2.0 | | | | |
| | 53 | 18137 | 1.9 | 1.0 | 1.0 | 2.0 | 1.7 | 2.0 | 1.8 | 2.0 | 1.7 | 2.0 | | 1.0 | | |
| | 54 | 18141 | 1.6 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.8 | | | 1.8 | 1.4 | | | 2.0 | | | | | 1.7 | 1.4 |
| | 56 | 18143 | 2.0 | | | 2.0 | 1.7 | | | | | 1.3 | 2.0 | | | |
| | 57 | 18144 | 1.8 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.3 | | | | | | | | | | 2.0 | | 1.2 | 1.4 |
| **Region mean** | | | **1.7** | **1.1** | **1.0** | **1.9** | **1.6** | **1.8** | **1.7** | **1.9** | **1.4** | **1.7** | **2.0** | **1.1** | **1.4** | **1.4** |
| Puerto Rico | 59 | 18752 | 1.5 | | | | | | | | | | 2.0 | | 1.3 | 1.3 |
| **Overall mean** | | | **1.5** | **1.1** | **1.0** | **1.7** | **1.7** | **1.7** | **1.6** | **1.9** | **1.2** | **1.5** | **2.0** | **1.1** | **1.3** | **1.4** |
| | | RMS | 0.0285 | 0.0160 | 0.0078 | 0.0509 | 0.1432 | 0.0546 | 0.0837 | 0.0270 | 0.0705 | | | 0.0119 | 0.0284 | 0.0510 |
| | | SED | 0.120 | 0.090 | 0.063 | 0.160 | 0.020 | 0.165 | 0.205 | 0.005 | 0.217 | 0.394 | 0.087 | 0.077 | 0.005 | 0.160 |
| | | Prov. | *** | *** | ns | *** | ns | *** | ns | ns | ns | ns | *** | *** | *** | ns |
| | | Country | *** | ** | * | *** | * | *** | ** | ns | ns | ns | ns | *** | *** | ns |
| | | Region | *** | * | ns | *** | ns | ns | ** | ns | *** | ns | ns | *** | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.12** Mean values for stem damage (*Stmhe*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 2.0 | 2.0 | 1.9 | 2.0 | 1.6 | 1.8 | 2.0 | 1.6 | 2.0 | 2.0 | | 1.9 | 2.0 | 1.8 |
| | 2 | 16166 | 2.0 | | | 1.9 | | | | | | 2.0 | 2.0 | | 2.0 | 1.9 |
| | 3 | 18008 | 2.0 | 2.0 | 1.5 | 1.9 | 1.9 | 1.8 | | 1.7 | 2.0 | | | 1.6 | 2.0 | 2.0 |
| | 4 | 18378 | 2.0 | | | | | | 1.9 | | | | | | | |
| PNG | 5 | 18153 | 2.0 | 1.9 | 1.3 | 2.0 | 1.7 | 1.6 | 2.0 | 1.5 | 2.0 | 2.0 | 2.0 | 1.6 | 2.0 | |
| Fiji | 6 | 18270 | 1.9 | 2.0 | 1.8 | | 1.6 | 2.0 | | | 2.0 | | | | | |
| | 7 | 18271 | 2.0 | 2.0 | 1.8 | 1.9 | 1.7 | 1.8 | | | 1.9 | | | 1.8 | | |
| | 8 | 18272 | 2.0 | | | | | | | | | | 2.0 | | 2.0 | 2.0 |
| Guam | 9 | 18121 | 2.0 | 2.0 | 1.6 | 2.0 | 1.8 | 1.7 | 2.0 | 1.5 | | | 2.0 | 1.5 | 2.0 | 1.9 |
| Solomon | 10 | 18402 | 2.0 | | | | | | | | | | | | 2.0 | 2.0 |
| | 11 | 18403 | 2.0 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 2.0 | | | 1.9 | 1.6 | | | | | | 2.0 | 1.5 | 2.0 | |
| Tonga | 12a | 18040 | | | | 2.0 | 1.6 | | 2.0 | | | | | | | |
| **Region mean** | | | **2.0** | **2.0** | **1.7** | **1.9** | **1.7** | **1.8** | **2.0** | **1.6** | **2.0** | **2.0** | **2.0** | **1.6** | **2.0** | **1.9** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 2.0 | 2.0 | 1.5 | 1.9 | 1.6 | 1.9 | | 1.6 | 2.0 | 2.0 | 2.0 | 1.9 | | |
| | 14 | 18158 | 2.0 | 2.0 | 1.4 | 1.8 | 1.9 | 1.5 | 2.0 | 1.7 | 2.0 | 2.0 | | 1.9 | 2.0 | 1.9 |
| | 15 | 18160 | 2.0 | | | | | | | 1.6 | | 2.0 | | | | |
| | 16 | 18161 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 17 | 18244 | 2.0 | 2.0 | 1.6 | 1.9 | 2.0 | 1.9 | | 1.5 | 2.0 | 2.0 | 2.0 | 1.8 | | |
| | 18 | 18348 | 2.0 | | | 1.9 | 1.8 | | | | | | | 1.8 | 2.0 | |
| | 19 | 18374 | 2.0 | | | | | | | | | | 2.0 | | | |
| | 20 | 18375 | 2.0 | | | | | | | | | | | | | |
| | 21 | 18376 | 1.9 | | | | | | | | | | | | | 2.0 |

**Appendix 1.12** (cont'd) Mean values for stem damage (*Stmhe*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 2.0 | 2.0 | 1.8 | 2.0 | 1.8 | 1.7 | | | 1.9 | 2.0 | | | 2.0 | |
| | 23 | 18154 | 2.0 | 1.9 | 1.6 | | 1.9 | 1.7 | 2.0 | 1.4 | 1.9 | 2.0 | 2.0 | 1.9 | | |
| | 24 | 18357 | 2.0 | | | | 1.9 | | | | | | | | | |
| Thailand | 25 | 18296 | 2.0 | | 1.7 | 2.0 | 1.7 | 1.8 | | | 2.0 | | 2.0 | 1.8 | | |
| | 26 | 18297 | 2.0 | | 1.5 | 2.0 | 1.9 | 1.9 | | | 2.0 | | | | 2.0 | 1.9 |
| | 27 | 18298 | 2.0 | 2.0 | 1.5 | 1.7 | 1.9 | 1.7 | | | | | 2.0 | 1.7 | | |
| | 28 | 18299 | 2.0 | 2.0 | | 2.0 | 1.6 | | | | | | 2.0 | | 2.0 | 2.0 |
| **Region mean** | | | **2.0** | **2.0** | **1.6** | **1.9** | **1.8** | **1.8** | **2.0** | **1.6** | **2.0** | **2.0** | **2.0** | **1.8** | **2.0** | **1.9** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 2.0 | 1.9 | 1.6 | 1.9 | 1.3 | 1.8 | | | 1.9 | | 2.0 | 1.8 | | |
| | 30 | 18268 | 2.0 | 2.0 | 1.7 | 1.9 | 2.0 | 1.5 | | | 2.0 | | | 1.9 | | |
| | 31 | 18586 | 2.0 | | | | | | | | | | | | 2.0 | |
| India | 32 | 18013 | 2.0 | 1.9 | 1.6 | 2.0 | 1.8 | 1.5 | 2.0 | 1.5 | 2.0 | 2.0 | | | | |
| | 33 | 18014 | 2.0 | 2.0 | 1.7 | 1.9 | 1.8 | 1.7 | | 1.3 | 1.9 | 2.0 | | 1.9 | 2.0 | 2.0 |
| | 34 | 18015 | 2.0 | | | 1.9 | 1.9 | | | 1.3 | | 2.0 | 2.0 | | 2.0 | 2.0 |
| | 35 | 18118 | 2.0 | 2.0 | 1.7 | 1.9 | 1.5 | 1.6 | 2.0 | | 1.9 | | | | | |
| | 36 | 18119 | 2.0 | 2.0 | 1.7 | 1.9 | 1.7 | 1.6 | | | 2.0 | 2.0 | 2.0 | 1.8 | 2.0 | |
| | 37 | 18120 | 2.0 | | | | 1.9 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 2.0 | | | | | | | | | | | | | |
| | 39 | 18287 | 2.0 | | 1.5 | 1.9 | 1.6 | 1.7 | | | 2.0 | | 2.0 | 1.9 | 2.0 | |
| | 40 | 18288 | 2.0 | | 1.6 | 1.9 | 1.5 | 1.5 | | | | | 2.0 | | | |
| Vietnam | 41 | 18085 | 2.0 | 2.0 | 1.6 | | | 1.7 | 2.0 | 1.5 | 1.9 | | | 1.7 | | |
| | 42 | 18086 | 2.0 | | | | 1.7 | | | | | 2.0 | | | 2.0 | 2.0 |
| | 43 | 18127 | 2.0 | | | 1.9 | 1.8 | | 2.0 | | | 2.0 | | | 2.0 | |
| | 44 | 18128 | 2.0 | 2.0 | 1.5 | 1.9 | 1.5 | 1.8 | | 1.5 | 2.0 | 2.0 | 2.0 | 1.9 | | |
| | 45 | 18152 | 2.0 | | | 2.0 | 1.6 | | | 1.6 | | 2.0 | 2.0 | | | |
| **Region mean** | | | **2.0** | **2.0** | **1.6** | **1.9** | **1.7** | **1.6** | **2.0** | **1.4** | **2.0** | **2.0** | **2.0** | **1.8** | **2.0** | **2.0** |

**Appendix 1.12** (cont'd) Mean values for stem damage (*Stmhe*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 2.0 | | | 2.0 | 1.8 | | | | | | 2.0 | 1.8 | 2.0 | 2.0 |
| Egypt | 47 | 18122 | 2.0 | 1.9 | 1.6 | 2.0 | 1.9 | 1.8 | 2.0 | 1.5 | 2.0 | 2.0 | | 1.6 | | |
| | 48 | 18125 | 1.9 | 2.0 | 1.6 | | 1.9 | 1.8 | | 1.6 | 2.0 | 2.0 | 2.0 | 1.5 | | |
| | 49 | 18126 | 2.0 | | | | | | | | | 2.0 | | | 2.0 | 2.0 |
| Kenya | 50 | 18134 | 2.0 | 1.9 | 1.3 | 2.0 | 1.9 | 1.9 | 2.0 | 1.6 | 2.0 | 2.0 | | 1.8 | | |
| | 51 | 18135 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 52 | 18136 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 53 | 18137 | 2.0 | 2.0 | 1.5 | 2.0 | 1.7 | 1.9 | 2.0 | 1.8 | 2.0 | 2.0 | | 1.7 | | |
| | 54 | 18141 | 2.0 | | | | | | | | | | | | | |
| | 55 | 18142 | 2.0 | | | 2.0 | 1.9 | | | 1.5 | | | | | 2.0 | 2.0 |
| | 56 | 18143 | 2.0 | | | 1.9 | 1.6 | | | | | 2.0 | 2.0 | | | |
| | 57 | 18144 | 2.0 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 2.0 | | | | | | | | | | 2.0 | | 2.0 | 2.0 |
| **Region mean** | | | **2.0** | **1.9** | **1.5** | **2.0** | **1.8** | **1.9** | **2.0** | **1.6** | **2.0** | **2.0** | **2.0** | **1.7** | **2.0** | **2.0** |
| Puerto Rico | 59 | 18752 | 2.0 | | | | | | | | | | 2.0 | | 2.0 | 2.0 |
| **Overall mean** | | | **2.0** | **2.0** | **1.6** | **1.9** | **1.7** | **1.7** | **2.0** | **1.5** | **2.0** | **2.0** | **2.0** | **1.8** | **2.0** | **2.0** |
| | | RMS | 0.0042 | 0.0039 | 0.0349 | 0.0106 | 0.0891 | 0.0763 | 0.0007 | 0.0627 | 0.0044 | | 0.0003013 | 0.0177 | 0.0008 | 0.0062 |
| | | SED | 0.050 | 0.044 | 0.132 | 0.073 | 0.211 | 0.195 | 0.019 | 0.012 | 0.054 | 0.000 | 0.012 | 0.094 | 0.020 | 0.057 |
| | | Prov. | ns | ns | ns | * | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| | | Country | ns | ns | *** | ns | ns | ns | ns | ns | ns | ns | ns | *** | ns | ns |
| | | Region | ns | ns | * | ns | ns | ns | ns | ns | ns | ns | ns | *** | ns | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.13** Mean values for foliage damage (*Folhe*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 2.0 | 1.6 | 1.6 | 1.9 | 1.6 | 2.0 | 2.0 | 2.0 | 1.9 | 2.0 | | 1.0 | 2.0 | 2.0 |
| | 2 | 16166 | 2.0 | | | 1.9 | | | | | | 2.0 | 2.0 | | 2.0 | 1.9 |
| | 3 | 18008 | 2.0 | 1.8 | 1.9 | 1.9 | 1.9 | 2.0 | 1.7 | 2.0 | 1.9 | | | 1.0 | 2.0 | 2.0 |
| | 4 | 18378 | 1.8 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 1.9 | 1.5 | 1.8 | 1.8 | 1.7 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | 2.0 | |
| Fiji | 6 | 18270 | 2.0 | 1.5 | 1.5 | | 1.4 | 2.0 | | | 2.0 | | | | | |
| | 7 | 18271 | 1.8 | 1.6 | 1.8 | 1.7 | 1.6 | 2.0 | | | 1.8 | | | 1.0 | | |
| | 8 | 18272 | 1.8 | | | | | | | | | | 1.8 | | 2.0 | 2.0 |
| Guam | 9 | 18121 | 2.0 | 1.4 | 1.7 | 1.9 | 1.6 | 2.0 | 2.0 | 2.0 | | | 1.8 | 1.0 | 2.0 | 2.0 |
| Solomon | 10 | 18402 | 2.0 | | | | | | | | | | | | 2.0 | 2.0 |
| | 11 | 18403 | 2.0 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 2.0 | | | 1.8 | 1.4 | | | | | | 1.7 | 1.0 | 2.0 | |
| Tonga | 12a | 18040 | | | | 1.9 | 1.1 | | 2.0 | | | | | | | |
| **Region mean** | | | **1.9** | **1.6** | **1.7** | **1.9** | **1.5** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **1.8** | **1.0** | **2.0** | **2.0** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 2.0 | 2.0 | 2.0 | 1.8 | 1.5 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | | |
| | 14 | 18158 | 2.0 | 1.8 | 1.9 | 1.7 | 1.8 | 2.0 | 1.6 | 2.0 | 2.0 | 2.0 | | 1.0 | 2.0 | 2.0 |
| | 15 | 18160 | 2.0 | | | | | | | 2.0 | | 2.0 | | | | |
| | 16 | 18161 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 17 | 18244 | 2.0 | 1.8 | 2.0 | 1.5 | 1.8 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 | | |
| | 18 | 18348 | 1.8 | | | 1.7 | 1.7 | | | | | | | 1.0 | 1.8 | |
| | 19 | 18374 | 2.0 | | | | | | | | | | 1.9 | | | |
| | 20 | 18375 | 1.9 | | | | | | | | | | | | | |
| | 21 | 18376 | 2.0 | | | | | | | | | | | | | 2.0 |

**Appendix 1.13** (cont'd) Mean values for foliage damage (*Folhe*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 2.0 | 2.0 | 1.8 | 2.0 | 1.5 | 2.0 | | | 1.9 | 2.0 | | | 2.0 | |
| | 23 | 18154 | 2.0 | 1.9 | 1.9 | | 1.6 | 2.0 | 1.9 | 2.0 | 1.9 | 2.0 | 2.0 | 1.0 | | |
| | 24 | 18357 | 2.0 | | | | 1.7 | | | | | | | | | |
| Thailand | 25 | 18296 | 2.0 | | 1.9 | 1.9 | 1.5 | 2.0 | | | 1.9 | | 2.0 | 1.2 | | |
| | 26 | 18297 | 2.0 | | 2.0 | 1.9 | 1.8 | 2.0 | | | 2.0 | | | | 1.9 | 1.9 |
| | 27 | 18298 | 1.8 | 2.0 | 2.0 | 1.6 | 1.6 | 2.0 | | | | | 1.8 | 1.1 | | |
| | 28 | 18299 | 2.0 | 2.0 | | 1.6 | 1.4 | | | | | | 1.8 | | 2.0 | 2.0 |
| **Region mean** | | | **2.0** | **1.9** | **1.9** | **1.8** | **1.6** | **2.0** | **1.8** | **2.0** | **2.0** | **2.0** | **1.9** | **1.0** | **1.9** | **2.0** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 2.0 | 1.9 | 1.9 | 1.8 | 1.2 | 2.0 | | | 1.9 | | 2.0 | 1.0 | | |
| | 30 | 18268 | 2.0 | 2.0 | 2.0 | 1.8 | 1.9 | 2.0 | | | 2.0 | | | 1.0 | | |
| | 31 | 18586 | 1.9 | | | | | | | | | | | | 2.0 | |
| India | 32 | 18013 | 2.0 | 1.9 | 2.0 | 2.0 | 1.7 | 2.0 | 1.9 | 2.0 | 1.9 | 2.0 | | | | |
| | 33 | 18014 | 2.0 | 2.0 | 1.9 | 1.6 | 1.7 | 2.0 | | 2.0 | 1.8 | 2.0 | | 1.0 | 2.0 | 2.0 |
| | 34 | 18015 | 1.9 | | | 1.8 | 1.7 | | | 2.0 | | 2.0 | 2.0 | | 1.9 | 2.0 |
| | 35 | 18118 | 2.0 | 1.9 | 2.0 | 1.9 | 1.5 | 2.0 | 2.0 | | 1.9 | | | | | |
| | 36 | 18119 | 1.9 | 1.9 | 2.0 | 1.9 | 1.7 | 2.0 | | | 2.0 | 2.0 | 2.0 | 1.0 | 2.0 | |
| | 37 | 18120 | 2.0 | | | | 1.6 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 2.0 | | | | | | | | | | | | | |
| | 39 | 18287 | 2.0 | | 1.7 | 1.9 | 1.3 | 2.0 | | | 2.0 | | 2.0 | 1.0 | 2.0 | |
| | 40 | 18288 | 2.0 | | 1.9 | 1.5 | 1.3 | 2.0 | | | | | 2.0 | | | |
| Vietnam | 41 | 18085 | 2.0 | 2.0 | 1.9 | | | 2.0 | 1.9 | 2.0 | 2.0 | | | 1.0 | | |
| | 42 | 18086 | 2.0 | | | | 1.7 | | | | | 2.0 | | | 2.0 | 2.0 |
| | 43 | 18127 | 2.0 | | | 1.7 | 1.7 | | 1.9 | | | 2.0 | | | 2.0 | |
| | 44 | 18128 | 2.0 | 2.0 | 1.7 | 1.9 | 1.5 | 2.0 | | 2.0 | 1.9 | 2.0 | 2.0 | 1.0 | | |
| | 45 | 18152 | 2.0 | | | 1.7 | 1.3 | | | 2.0 | | 2.0 | 2.0 | | | |
| **Region mean** | | | **2.0** | **1.9** | **1.9** | **1.8** | **1.6** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **2.0** | **1.0** | **2.0** | **2.0** |

**Appendix 1.13** (cont'd) Mean values for foliage damage (*Folhe*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 2.0 | | | 1.9 | 1.7 | | | | | | 2.0 | 1.0 | 2.0 | 2.0 |
| Egypt | 47 | 18122 | 2.0 | 1.7 | 1.7 | 1.9 | 1.8 | 2.0 | 1.9 | 2.0 | 1.7 | 2.0 | | 1.0 | | |
| | 48 | 18125 | 1.6 | 1.9 | 1.7 | | 1.5 | 2.0 | | 2.0 | 1.9 | 2.0 | 1.9 | 1.0 | | |
| | 49 | 18126 | 1.7 | | | | | | | | | 2.0 | | | 2.0 | 2.0 |
| Kenya | 50 | 18134 | 2.0 | 1.5 | 1.8 | 2.0 | 1.8 | 2.0 | 2.0 | 2.0 | 1.8 | 2.0 | | 1.0 | | |
| | 51 | 18135 | 1.8 | | | | | | | | | 2.0 | | | | |
| | 52 | 18136 | 1.8 | | | | | | | | | 2.0 | | | | |
| | 53 | 18137 | 2.0 | 1.8 | 1.8 | 1.8 | 1.7 | 2.0 | 2.0 | 2.0 | 1.9 | 2.0 | | 1.0 | | |
| | 54 | 18141 | 2.0 | | | | | | | | | | | | | |
| | 55 | 18142 | 2.0 | | | 1.8 | 1.8 | | | 2.0 | | | | | 2.0 | 2.0 |
| | 56 | 18143 | 2.0 | | | 1.7 | 1.5 | | | | | 2.0 | 2.0 | | | |
| | 57 | 18144 | 1.8 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.8 | | | | | | | | | | 2.0 | | 2.0 | 2.0 |
| **Region mean** | | | **1.9** | **1.7** | **1.8** | **1.9** | **1.7** | **2.0** | **2.0** | **2.0** | **1.8** | **2.0** | **2.0** | **1.0** | **2.0** | **2.0** |
| Puerto Rico | 59 | 18752 | 2.0 | | | | | | | | | | 2.0 | | 2.0 | 2.0 |
| **Overall mean** | | | **1.9** | **1.8** | **1.8** | **1.8** | **1.6** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **1.9** | **1.0** | **2.0** | **2.0** |
| | | RMS | 0.0304 | 0.0397 | 0.0264 | 0.0317 | 0.1013 | 0.0001 | 0.0264 | 0.0001 | 0.0134 | | 0.0517 | 0.0033 | 0.0086 | 0.0025 |
| | | SED | 0.120 | 0.141 | 0.115 | 0.126 | 0.225 | 0.007 | 0.115 | 0.000 | 0.095 | 0.000 | 0.161 | 0.040 | 0.066 | 0.001 |
| | | Prov. | ns | ns | ns | ** | ns | ns | ns | ns | ns | ns | ns | ns | ns | ns |
| | | Country | ns | ns | ns | ns | ns | ns | * | ns | ns | ns | ns | *** | ns | ns |
| | | Region | * | *** | *** | * | ns | ns | * | ns | * | ns | ns | ns | ns | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 1.14** Mean values for flowering (*Flwre*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.1 | 1.0 | 1.3 | 1.0 | 1.0 | | 1.0 | 1.4 | 1.0 |
| | 2 | 16166 | 1.0 | | | 1.1 | | | | | | 1.0 | 1.0 | | 1.6 | 1.0 |
| | 3 | 18008 | 1.3 | 1.0 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 | 1.4 | 1.1 | | | 1.6 | 1.5 | 1.1 |
| | 4 | 18378 | 1.2 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 1.3 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.4 | 1.0 | 1.0 | 1.0 | 1.4 | 1.7 | |
| Fiji | 6 | 18270 | 1.1 | 1.0 | 1.0 | | 1.0 | 1.0 | | | 1.0 | | | | | |
| | 7 | 18271 | 1.2 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | | | 1.0 | | | 1.2 | | |
| | 8 | 18272 | 1.1 | | | | | | | | | | 1.0 | | 1.2 | 1.0 |
| Guam | 9 | 18121 | 1.2 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.0 | 1.4 | | | 1.0 | 1.5 | 1.3 | 1.0 |
| Solomon | 10 | 18402 | 1.0 | | | | | | | | | | | | 1.3 | 1.1 |
| | 11 | 18403 | 1.1 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 1.4 | | | 1.0 | 1.0 | | | | | | 1.0 | 1.2 | 1.1 | |
| Tonga | 12a | 18040 | | | | 1.1 | 1.1 | | 1.0 | | | | | | | |
| **Region mean** | | | **1.2** | **1.0** | **1.0** | **1.1** | **1.0** | **1.0** | **1.0** | **1.4** | **1.0** | **1.0** | **1.0** | **1.3** | **1.4** | **1.0** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 1.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | 1.1 | 1.0 | 1.0 | | 1.0 | | |
| | 14 | 18158 | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.4 | 1.0 | 1.0 | | 1.0 | 1.0 | 1.0 |
| | 15 | 18160 | 1.1 | | | | | | | 1.4 | | 1.0 | | | | |
| | 16 | 18161 | 1.4 | | | | | | | | | 1.0 | | | | |
| | 17 | 18244 | 1.2 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 | | 1.2 | 1.0 | 1.0 | 1.0 | 1.0 | | |
| | 18 | 18348 | 1.1 | | | 1.0 | 1.1 | | | | | | | 1.0 | 1.1 | |
| | 19 | 18374 | 1.0 | | | | | | | | | | 1.0 | | | |
| | 20 | 18375 | 1.1 | | | | | | | | | | | | | |
| | 21 | 18376 | 1.0 | | | | | | | | | | | | | 1.1 |

**Appendix 1.14** (cont'd) Mean values for flowering (*Flwre*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 1.5 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | 1.0 | 1.0 | | | 1.7 | |
| | 23 | 18154 | 1.4 | 1.0 | 1.0 | | 1.2 | 1.1 | 1.2 | 1.4 | 1.0 | 1.0 | 1.0 | 1.5 | | |
| | 24 | 18357 | 1.3 | | | | 1.0 | | | | | | 1.0 | | | |
| Thailand | 25 | 18296 | 1.0 | | 1.2 | 1.0 | 1.0 | 1.0 | | | 1.0 | | 1.0 | 1.0 | | |
| | 26 | 18297 | 1.2 | | 1.0 | 1.0 | 1.0 | 1.0 | | | 1.0 | | | | 1.3 | 1.1 |
| | 27 | 18298 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | | | | | 1.0 | 1.0 | | |
| | 28 | 18299 | 1.0 | 1.0 | | 1.0 | 1.0 | | | | | | 1.0 | | 1.1 | 1.2 |
| **Region mean** | | | **1.2** | **1.0** | **1.0** | **1.0** | **1.0** | **1.0** | **1.1** | **1.3** | **1.0** | | **1.0** | **1.1** | **1.2** | **1.1** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.3 | 1.0 | 1.1 | 1.0 | 1.0 | 1.1 | | | 1.0 | | 1.0 | 1.4 | | |
| | 30 | 18268 | 1.4 | 1.1 | 1.2 | 1.5 | 1.0 | 1.0 | | | 1.1 | | | 1.0 | | |
| | 31 | 18586 | 1.3 | | | | | | | | | | | | 1.4 | |
| India | 32 | 18013 | 1.4 | 1.0 | 1.1 | 1.1 | 1.0 | 1.0 | 1.1 | 1.6 | 1.0 | 1.0 | | | | |
| | 33 | 18014 | 1.4 | 1.0 | 1.1 | 1.2 | 1.0 | 1.1 | | 1.3 | 1.1 | 1.0 | | 1.6 | 1.7 | 1.1 |
| | 34 | 18015 | 1.2 | | | 1.0 | 1.0 | | | 1.5 | | 1.0 | 1.0 | | 1.6 | 1.0 |
| | 35 | 18118 | 1.6 | 1.2 | 1.4 | 1.1 | 1.1 | 1.1 | 1.2 | | 1.2 | | | | | |
| | 36 | 18119 | 1.7 | 1.1 | 1.2 | 1.0 | 1.1 | 1.0 | | | 1.0 | 1.0 | 1.0 | 1.7 | 1.6 | |
| | 37 | 18120 | 1.7 | | | | 1.0 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.3 | | | | | | | | | | | | | |
| | 39 | 18287 | 1.3 | | 1.1 | 1.1 | 1.0 | 1.2 | | | 1.0 | | 1.0 | 1.9 | 1.8 | |
| | 40 | 18288 | 1.3 | | 1.2 | 1.4 | 1.1 | 1.0 | | | | | 1.0 | | | |
| Vietnam | 41 | 18085 | 1.5 | 1.0 | 1.3 | | 1.3 | 1.1 | 1.2 | 1.6 | 1.0 | | | 1.8 | | |
| | 42 | 18086 | 1.4 | | | | | | | | | 1.0 | | | 1.9 | 1.0 |
| | 43 | 18127 | 1.5 | | | 1.2 | 1.2 | | 1.3 | | | 1.0 | | | 1.7 | |
| | 44 | 18128 | 1.4 | 1.0 | 1.0 | 1.3 | 1.0 | 1.0 | | 1.7 | 1.0 | 1.0 | 1.0 | 1.7 | | |
| | 45 | 18152 | 1.4 | | | 1.2 | 1.0 | | | 1.4 | | 1.0 | 1.0 | | | |
| **Region mean** | | | **1.4** | **1.1** | **1.2** | **1.2** | **1.1** | **1.1** | **1.2** | **1.5** | **1.0** | **1.0** | **1.0** | **1.6** | **1.7** | **1.0** |

**Appendix 1.14** (cont'd) Mean values for flowering (*Flwre*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 1.2 | | | 1.0 | 1.1 | | | | | | 1.0 | 1.4 | 1.4 | 1.0 |
| Egypt | 47 | 18122 | 1.2 | 1.0 | 1.0 | 1.1 | 1.1 | 1.0 | 1.0 | 1.3 | 1.0 | 1.0 | | 1.1 | | |
| | 48 | 18125 | 1.1 | 1.0 | 1.1 | | 1.1 | 1.0 | | 1.2 | 1.0 | 1.0 | 1.0 | 1.3 | | |
| | 49 | 18126 | 1.1 | | | | | | | | | 1.0 | | | 1.4 | 1.0 |
| Kenya | 50 | 18134 | 1.1 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.2 | 1.0 | 1.0 | | 1.1 | | |
| | 51 | 18135 | 1.2 | | | | | | | | | 1.0 | | | | |
| | 52 | 18136 | 1.1 | | | | | | | | | 1.0 | | | | |
| | 53 | 18137 | 1.3 | 1.0 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | | 1.1 | | |
| | 54 | 18141 | 1.3 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.2 | | | 1.0 | 1.1 | | | 1.0 | | | | | 1.2 | 1.3 |
| | 56 | 18143 | 1.2 | | | 1.1 | 1.0 | | | | | 1.0 | 1.0 | | | |
| | 57 | 18144 | 1.3 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 1.1 | | | | | | | | | | 1.0 | | 1.6 | 1.0 |
| **Region mean** | | | **1.2** | **1.0** | **1.0** | **1.0** | **1.1** | **1.0** | **1.0** | **1.2** | **1.0** | **1.0** | **1.0** | **1.2** | **1.4** | **1.1** |
| Puerto Rico | 59 | 18752 | 1.2 | | | | | | | | | | 1.0 | | 1.5 | 1.0 |
| **Overall mean** | | | **1.3** | **1.0** | **1.1** | **1.1** | **1.0** | **1.0** | **1.1** | **1.3** | **1.0** | **1.0** | **1.0** | **1.3** | **1.4** | **1.1** |
| | | RMS | 0.0411 | 0.0022 | 0.0139 | 0.0178 | 0.0190 | 0.0042 | 0.0259 | 0.0909 | 0.0068 | | 0.00019 | 0.0136 | 0.0283 | 0.0142 |
| | | SED | 0.140 | 0.034 | 0.083 | 0.002 | 0.098 | 0.094 | 0.114 | 0.017 | 0.067 | 0.005 | 0.010 | 0.147 | 0.178 | 0.084 |
| | | Prov. | ns | *** | ** | * | ns | ns | ns | ns | ns | ns | ns | *** | * | ns |
| | | Country | ** | ns | ns | *** | ns | ** | ns | * | ns | ns | ns | *** | *** | ** |
| | | Region | *** | *** | *** | ** | ns | ns | * | * | ns | ns | ** | *** | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant *P* 0.05; ** = significant *P* 0.01; *** = significant *P* 0.001.

**Appendix 1.15** Mean values for fruiting (*Frtre*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | | | | |
| Australia | 1 | 15958 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 1.7 | 2.0 | 1.9 | 2.0 | 2.0 | | 2.0 | 1.8 | 1.9 |
| | 2 | 16166 | 2.0 | | | 2.0 | | | | | | 2.0 | 2.0 | | 1.7 | 2.0 |
| | 3 | 18008 | 1.9 | 1.9 | 1.3 | 2.0 | 2.0 | 1.9 | 2.0 | 1.9 | 1.9 | | | 1.4 | 1.9 | 1.8 |
| | 4 | 18378 | 2.0 | | | | | | | | | | | | | |
| PNG | 5 | 18153 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 1.9 | 2.0 | 1.9 | 2.0 | 1.9 | 2.0 | 1.7 | 1.8 | |
| Fiji | 6 | 18270 | 1.9 | 1.9 | 1.0 | | 2.0 | 1.8 | | | 1.9 | | | | | |
| | 7 | 18271 | 1.9 | 2.0 | 1.1 | 2.0 | 2.0 | 2.0 | | | 2.0 | | | 1.8 | | |
| | 8 | 18272 | 1.9 | | | | | | | | | | 2.0 | | 1.7 | 1.9 |
| Guam | 9 | 18121 | 2.0 | 1.9 | 1.2 | 1.9 | 2.0 | 1.9 | 2.0 | 1.9 | | | 2.0 | 1.5 | 1.7 | 1.9 |
| Solomon | 10 | 18402 | 2.0 | | | | | | | | | | | | 1.9 | 1.9 |
| | 11 | 18403 | 2.0 | | | | | | | | | | | | | |
| Vanuatu | 12 | 18312 | 2.0 | | | 2.0 | 2.0 | | | | | | 2.0 | 1.8 | 1.9 | |
| Tonga | 12a | 18040 | | | | 2.0 | 2.0 | | 2.0 | | | | | | | |
| **Region mean** | | | **2.0** | **2.0** | **1.1** | **2.0** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **2.0** | **2.0** | **1.7** | **1.8** | **1.9** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | |
| | 14 | 18158 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 1.9 | 2.0 | | | 2.0 | 2.0 | 1.9 |
| | 15 | 18160 | 2.0 | | | | | | | 1.9 | | 2.0 | | | | |
| | 16 | 18161 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 17 | 18244 | 2.0 | 2.0 | 1.1 | 2.0 | 1.9 | 2.0 | | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | |
| | 18 | 18348 | 2.0 | | | 2.0 | 2.0 | | | | | | | 2.0 | 2.0 | |
| | 19 | 18374 | 2.0 | | | | | | | | | | 2.0 | | | |
| | 20 | 18375 | 2.0 | | | | | | | | | | | | | |
| | 21 | 18376 | 2.0 | | | | | | | | | | | | | 2.0 |

**Appendix 1.15** (cont'd) Mean values for fruiting (*Frtre*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| Philippines | 22 | 18117 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 1.9 | | | 2.0 | 2.0 | | | 1.6 | |
| | 23 | 18154 | 2.0 | 2.0 | 1.0 | | 1.9 | 1.6 | 2.0 | 1.9 | 2.0 | 1.9 | 2.0 | 1.6 | | |
| | 24 | 18357 | 2.0 | | | | 2.0 | | | | | | | | | |
| Thailand | 25 | 18296 | 2.0 | | 1.2 | 2.0 | 2.0 | 2.0 | | | 2.0 | | 2.0 | 2.0 | | |
| | 26 | 18297 | 2.0 | | 1.0 | 2.0 | 2.0 | 1.9 | | | 2.0 | | | | 2.0 | 1.8 |
| | 27 | 18298 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | | | | | 2.0 | 2.0 | | |
| | 28 | 18299 | 2.0 | 2.0 | | 2.0 | 2.0 | | | | | | 2.0 | | 2.0 | 1.9 |
| **Region mean** | | | **2.0** | **2.0** | **1.1** | **2.0** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **2.0** | **2.0** | **1.9** | **1.9** | **1.9** |
| *Introduced – Asia* | | | | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.9 | 2.0 | 1.1 | 1.7 | 2.0 | 1.8 | | | 2.0 | | 2.0 | 1.8 | | |
| | 30 | 18268 | 2.0 | 2.0 | 1.2 | 1.7 | 2.0 | 1.7 | | | | | | 1.6 | | |
| | 31 | 18586 | 1.9 | | | | | | | | | | | | 1.8 | |
| India | 32 | 18013 | 2.0 | 1.9 | 1.3 | 2.0 | 2.0 | 1.8 | 2.0 | 1.8 | 2.0 | 2.0 | | | | |
| | 33 | 18014 | 2.0 | 2.0 | 1.1 | 1.9 | 2.0 | 1.7 | | 1.9 | 2.0 | 2.0 | | 1.6 | 1.7 | 1.9 |
| | 34 | 18015 | 2.0 | | | 2.0 | 2.0 | | | 1.8 | | 1.9 | 2.0 | | 1.8 | 1.9 |
| | 35 | 18118 | 1.9 | 1.7 | 1.3 | 1.9 | 2.0 | 1.8 | 2.0 | | 2.0 | | | | | |
| | 36 | 18119 | 1.9 | 1.7 | 1.3 | 2.0 | 2.0 | 1.9 | | | 2.0 | 2.0 | 2.0 | 1.5 | 1.7 | |
| | 37 | 18120 | 1.7 | | | | 2.0 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | 1.9 | | | | | | | | | | | | | |
| | 39 | 18287 | 1.9 | | 1.6 | 1.9 | 2.0 | 1.8 | | | 2.0 | | 2.0 | 1.5 | 1.5 | |
| | 40 | 18288 | 1.9 | | 1.3 | 1.8 | 2.0 | 1.8 | | | | | 2.0 | | | |
| Vietnam | 41 | 18085 | 1.9 | 1.8 | 1.2 | | | 1.7 | 1.9 | 1.8 | 2.0 | | | 1.6 | | |
| | 42 | 18086 | 1.9 | | | | 1.9 | | | | | 2.0 | | | 1.6 | 1.9 |
| | 43 | 18127 | 2.0 | | | 1.9 | 1.9 | | 1.7 | | | 2.0 | | | 1.6 | |
| | 44 | 18128 | 1.9 | 1.9 | 1.1 | 1.9 | 2.0 | 1.7 | | 1.7 | 2.0 | 2.0 | 2.0 | 1.6 | | |
| | 45 | 18152 | 1.9 | | | 1.9 | 2.0 | | | 1.8 | | 2.0 | 2.0 | | | |
| **Region mean** | | | **1.9** | **1.9** | **1.3** | **1.9** | **2.0** | **1.8** | **1.9** | **1.8** | **2.0** | **2.0** | **2.0** | **1.6** | **1.7** | **1.9** |

**Appendix 1.15** (cont'd) Mean values for fruiting (*Frtre*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-01 | IPT-02 | IPT-03 | IPT-04 | IPT-05 | IPT-06 | IPT-07 | IPT-08 | IPT-09 | IPT-10 | IPT-11 | IPT-12 | IPT-13 | IPT-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 30mo | 24mo | 12mo | 30mo | 27mo | 26mo | 44mo | 32mo | 28mo | 48mo | 30mo | 26mo | 31mo | 30mo |
| *Introduced – Africa* | | | | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 2.0 | | | 2.0 | 1.9 | | | | | 2.0 | 2.0 | 1.7 | 1.8 | 1.9 |
| Egypt | 47 | 18122 | 2.0 | 2.0 | 1.1 | 2.0 | 2.0 | 1.9 | 2.0 | 1.9 | 2.0 | 2.0 | | 1.9 | | |
| | 48 | 18125 | 2.0 | 2.0 | 1.0 | | 1.9 | 1.9 | | 1.9 | 2.0 | 2.0 | 2.0 | 1.7 | | |
| | 49 | 18126 | 2.0 | | | | | | | | | 1.9 | | | 1.7 | 1.9 |
| Kenya | 50 | 18134 | 2.0 | 2.0 | 1.1 | 2.0 | 2.0 | 2.0 | 2.0 | 1.9 | 2.0 | 2.0 | | 2.0 | | |
| | 51 | 18135 | 1.9 | | | | | | | | | 2.0 | | | | |
| | 52 | 18136 | 2.0 | | | | | | | | | 2.0 | | | | |
| | 53 | 18137 | 2.0 | 2.0 | 1.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | | 1.9 | | |
| | 54 | 18141 | 1.9 | | | | | | | | | | | | | |
| | 55 | 18142 | 1.9 | | | 2.0 | 2.0 | | | 2.0 | | | | | 1.9 | 1.7 |
| | 56 | 18143 | 2.0 | | | 2.0 | 2.0 | | | | | 2.0 | 2.0 | | | |
| | 57 | 18144 | 2.0 | | | | | | | | | | | | | |
| Mauritius | 58 | 18565 | 2.0 | | | | | | | | | | 2.0 | | 1.8 | 1.9 |
| **Region mean** | | | **2.0** | **2.0** | **1.1** | **2.0** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **2.0** | **2.0** | **1.8** | **1.8** | **1.8** |
| Puerto Rico | 59 | 18752 | 2.0 | | | | | | | | | | 2.0 | | 1.8 | 2.0 |
| **Overall mean** | | | **2.0** | **1.9** | **1.1** | **1.9** | **2.0** | **1.9** | **2.0** | **1.9** | **2.0** | **2.0** | **2.0** | **1.8** | **1.8** | **1.9** |
| | | RMS | 0.0029 | 0.0034 | 0.0168 | 0.0102 | 0.0048 | 0.0122 | 0.0247 | 0.0139 | 0.0011 | | | 0.0098 | 0.0108 | 0.0276 |
| | | SED | 0.040 | | 0.003 | 0.035 | 0.049 | 0.078 | 0.111 | 0.003 | 0.028 | 0.005 | 0.000 | 0.070 | 0.073 | 0.118 |
| | | Prov. | *** | *** | * | ns | ns | * | ns | ns | ns | * | ns | *** | ns | ns |
| | | Country | * | *** | ** | ns | ns | *** | ns | * | ns | ** | ns | *** | *** | ns |
| | | Region | *** | *** | *** | *** | ns | ** | ns | ns | ns | ns | ns | *** | ** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 2.1** Mean values for survival (*Surv*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov. No. | CSIRO No. | IPT-15 | IPT-16 | IPT-17 | IPT-18 | IPT-19 | IPT-20 | IPT-21 | IPT-22 | IPT-23 | IPT-24 | IPT-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 12mo | 18mo | 36mo | 18mo | 47mo | 47mo | 24mo | 14mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | |
| Australia | 1 | 15958 | | 58 | 83 | 100 | 61 | 50 | | 69 | 100 | 98 | 17 |
| | 2 | 16166 | | 72 | | | 61 | 96 | | | 100 | | |
| | 3 | 18008 | 63 | 69 | 94 | 99 | | 63 | 63 | | | 100 | |
| | 4 | 18378 | | 56 | | | | | | | | | |
| PNG | 5 | 18153 | 25 | 61 | 100 | 100 | 67 | | 68 | 81 | 100 | 100 | 56 |
| Fiji | 6 | 18270 | | 31 | | 100 | | | 58 | | | | |
| | 7 | 18271 | | 22 | | 100 | | 54 | | | | | 32 |
| | 8 | 18272 | | 83 | | | 70 | | | | | | |
| Guam | 9 | 18121 | 88 | 33 | 100 | | 47 | 56 | 73 | | | 98 | 57 |
| Solomon | 10 | 18402 | | 50 | | | | | | | | | |
| | 11 | 18403 | | 58 | | | | | | | | | |
| Vanuatu | 12 | 18312 | 83 | 86 | | | 66 | | 75 | | | | 25 |
| Tonga | 12a | 18040 | | | | | | | | | | | 25 |
| **Region mean** | | | **64** | **57** | **94** | **100** | **62** | **64** | **67** | **75** | **100** | **99** | **36** |
| *Natural – Southeast Asia* | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | | 50 | | 100 | | | | | | | 39 |
| | 14 | 18158 | | 33 | | 100 | | | | | | 70 | 56 |
| | 15 | 18160 | | 42 | | | 61 | | | 77 | | | |
| | 16 | 18161 | | 39 | | | | | | | | | |
| | 17 | 18244 | | 50 | 100 | 100 | | 48 | 65 | 69 | 100 | | 39 |
| | 18 | 18348 | | 44 | | | 68 | | | | | | |
| | 19 | 18374 | | 81 | | | | | | | | | |
| | 20 | 18375 | | 50 | | | | | | | | | |
| | 21 | 18376 | | 6 | | | | | | | | | |

**Appendix 2.1** (cont'd) Mean values for survival (*Surv*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-15 | IPT-16 | IPT-17 | IPT-18 | IPT-19 | IPT-20 | IPT-21 | IPT-22 | IPT-23 | IPT-24 | IPT-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 12mo | 18mo | 36mo | 18mo | 47mo | 47mo | 24mo | 14mo |
| Philippines | 22 | 18117 | | | 94 | 99 | | | 73 | | | | |
| | 23 | 18154 | 83 | 53 | | 99 | 80 | | | | 100 | 98 | |
| | 24 | 18357 | | | | | | | | | | | |
| Thailand | 25 | 18296 | 36 | 69 | 94 | | 72 | | | 94 | | | 39 |
| | 26 | 18297 | 59 | 39 | | | | 85 | | | | | |
| | 27 | 18298 | 36 | 53 | | 100 | | | 71 | | | | 39 |
| | 28 | 18299 | | 56 | 94 | 100 | 63 | | | 77 | | | |
| **Region mean** | | | **53** | **47** | **96** | **100** | **69** | **67** | **70** | **79** | **100** | **84** | **42** |
| *Introduced – Asia* | | | | | | | | | | | | | |
| China | 29 | 18267 | 55 | 64 | | 100 | 82 | 85 | 70 | | 94 | | 41 |
| | 30 | 18268 | 67 | 83 | | 100 | 54 | 56 | | 88 | 100 | | |
| | 31 | 18586 | | | | | | 83 | | | | | |
| India | 32 | 18013 | 92 | 72 | | 100 | | | 76 | 69 | | 100 | 27 |
| | 33 | 18014 | 92 | 69 | 100 | 100 | | 69 | | | | | |
| | 34 | 18015 | | 78 | | | 71 | 71 | | | | | |
| | 35 | 18118 | 61 | 47 | | | | | 80 | 71 | | | 49 |
| | 36 | 18119 | 34 | 67 | 100 | 99 | | | | | | | |
| | 37 | 18120 | | 44 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | | 31 | | | | | | | | | |
| | 39 | 18287 | 83 | 56 | | | | | 78 | | | | 32 |
| | 40 | 18288 | 34 | 67 | | | | | | | | | |
| Vietnam | 41 | 18085 | 84 | 56 | | 99 | | | | | | 100 | 32 |
| | 42 | 18086 | | 53 | | | | | | | | | |
| | 43 | 18127 | | 58 | | | | | | | | 98 | |
| | 44 | 18128 | 100 | 44 | | 100 | 61 | | 90 | | 100 | | 35 |
| | 45 | 18152 | | 53 | | | 63 | | | 73 | | | |
| **Region mean** | | | **70** | **59** | **100** | **100** | **66** | **73** | **79** | **75** | **98** | **99** | **36** |

**Appendix 2.1** (cont'd) Mean values for survival (*Surv*) in international provenance trials of *Casuarina equisetifolia*.

| Country of origin | Prov. No. | CSIRO No. | IPT-15 | IPT-16 | IPT-17 | IPT-18 | IPT-19 | IPT-20 | IPT-21 | IPT-22 | IPT-23 | IPT-24 | IPT-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 12mo | 18mo | 36mo | 18mo | 47mo | 47mo | 24mo | 14mo |
| *Introduced – Africa* | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 86 | 28 | | | | 75 | | | | | |
| Egypt | 47 | 18122 | 25 | 58 | 89 | 99 | 70 | | | 75 | | 100 | |
| | 48 | 18125 | | 58 | | 100 | | | 85 | | 100 | 95 | 31 |
| | 49 | 18126 | | 47 | | | 69 | | | | 100 | 98 | |
| Kenya | 50 | 18134 | 84 | 72 | 86 | 100 | | | 78 | | | 100 | 36 |
| | 51 | 18135 | | 56 | | | 60 | 81 | | | | | |
| | 52 | 18136 | | 53 | | | 48 | | | | | | |
| | 53 | 18137 | 22 | 83 | | 100 | | | | | | 98 | 45 |
| | 54 | 18141 | | 44 | | | | | | | | | |
| | 55 | 18142 | | 78 | | | | | | | | | |
| | 56 | 18143 | | 58 | | | | | | | | | |
| | 57 | 18144 | | 89 | | | | | | 83 | | | |
| Mauritius | 58 | 18565 | | 17 | | | 72 | | | | 100 | | |
| **Region mean** | | | **54** | **57** | **88** | **100** | **64** | **78** | **82** | **79** | **100** | **98** | **37** |
| Puerto Rico | 59 | 18752 | | | | | | | | | | | |
| **Overall mean** | | | **63** | **55** | **95** | **100** | **65** | **70** | **74** | **77** | **100** | **96** | **38** |
| | | RMS | 611.000 | 503.600 | 61.180 | 0.521 | 0.028 | 405.300 | 182.500 | 543.200 | 7.716 | 22.640 | 220.100 |
| | | SED | 17.5 | 15.9 | 5.5 | 0.5 | 16.4 | 14.2 | 9.6 | 9.5 | 2.3 | 3.4 | 12.1 |
| | | Prov. | *** | *** | ns | ns | ns | * | ns | ns | ns | ns | ns |
| | | Country | *** | *** | ns | ns | ns | ns | ns | ns | ns | *** | * |
| | | Region | ns | * | * | ns | ns | ns | * | ns | ns | *** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 2.2** Mean values for height growth (*Ht*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov No. | CSIRO No. | IPT-15 | IPT-16 | IPT-17 | IPT-18 | IPT-19 | IPT-20 | IPT-21 | IPT-22 | IPT-23 | IPT-24 | IPT-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 12mo | 18mo | 36mo | 18mo | 47mo | 47mo | 24mo | 14mo |
| *Natural – Australia/Pacific* | | | | | | | | | | | | | |
| Australia | 1 | 15958 | | 8.2 | 0.8 | 3.0 | 2.1 | 6.9 | | 4.8 | 7.8 | 2.4 | 1.0 |
| | 2 | 16166 | | 9.7 | | | 1.8 | 9.0 | | | 7.2 | | |
| | 3 | 18008 | 2.6 | 8.6 | 1.1 | 3.8 | | 8.4 | 0.4 | | | 3.4 | |
| | 4 | 18378 | | 8.5 | | | | | | | | | |
| PNG | 5 | 18153 | 2.7 | 9.3 | 1.2 | 4.4 | 2.2 | | 0.6 | 7.0 | 9.2 | 3.2 | |
| Fiji | 6 | 18270 | | 8.1 | | 3.0 | | | 0.6 | | | | |
| | 7 | 18271 | | 7.8 | | 3.6 | | 7.1 | | | | | |
| | 8 | 18272 | | 7.4 | | | 1.9 | | | | | | |
| Guam | 9 | 18121 | 2.0 | 7.0 | 0.8 | | 2.2 | 5.9 | 0.5 | | | 2.7 | 1.6 |
| Solomon | 10 | 18402 | | 8.3 | | | | | | | | | |
| | 11 | 18403 | | 9.1 | | | | | | | | | |
| Vanuatu | 12 | 18312 | 2.3 | 9.5 | | | 2.2 | | 0.4 | | | | 1.5 |
| Tonga | 12a | 18040 | | | | | | | | | | | 1.0 |
| **Region mean** | | | 2.4 | 8.5 | 0.9 | 3.6 | 2.1 | 7.5 | 0.5 | 5.9 | 8.1 | 2.9 | 1.3 |
| *Natural – Southeast Asia* | | | | | | | | | | | | | |
| Malaysia | 13 | 18157 | | 8.8 | | 4.4 | | | | | | | 1.2 |
| | 14 | 18158 | | 9.3 | | 4.7 | | | | | | 3.5 | 2.0 |
| | 15 | 18160 | | 8.7 | | | 2.2 | | | 5.8 | | | |
| | 16 | 18161 | | 8.8 | | | | | | | | | |
| | 17 | 18244 | | 10.4 | 1.2 | 4.4 | | 8.7 | 0.5 | 6.6 | 8.8 | | 1.4 |
| | 18 | 18348 | | 8.2 | | | 2.0 | | | | | | |
| | 19 | 18374 | | 9.7 | | | | | | | | | |
| | 20 | 18375 | | 9.1 | | | | | | | | | |
| | 21 | 18376 | | 11.0 | | | | | | | | | |

**Appendix 2.2** (cont'd) Mean values for height growth (*Ht*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov No. | CSIRO No. | IPT-15 | IPT-16 | IPT-17 | IPT-18 | IPT-19 | IPT-20 | IPT-21 | IPT-22 | IPT-23 | IPT-24 | IPT-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 12mo | 18mo | 36mo | 18mo | 47mo | 47mo | 24mo | 14mo |
| Philippines | 22 | 18117 | | | 1.2 | 3.2 | | | 0.6 | | | | 2.1 |
| | 23 | 18154 | 2.4 | 8.5 | | 3.6 | 2.6 | | | | 9.0 | 3.7 | |
| | 24 | 18357 | | | | | | | | | | | |
| Thailand | 25 | 18296 | 2.3 | 9.4 | 1.2 | | 2.1 | | | 7.2 | | | 1.4 |
| | 26 | 18297 | 2.4 | 9.6 | | | | 8.8 | | | | | |
| | 27 | 18298 | 1.6 | 9.8 | | 4.3 | | | 0.7 | | | | 1.4 |
| | 28 | 18299 | | | 1.1 | 4.4 | 1.7 | | | 7.4 | | | |
| **Region mean** | | | 2.2 | 9.3 | 1.1 | 4.1 | 2.1 | 8.8 | 0.6 | 6.8 | 8.9 | 3.6 | 1.6 |
| *Introduced – Asia* | | | | | | | | | | | | | |
| China | 29 | 18267 | 1.7 | 8.8 | | 4.1 | 2.7 | 8.4 | 0.5 | | 10.1 | | 1.7 |
| | 30 | 18268 | 2.7 | 9.2 | 1.1 | 4.2 | 2.1 | 7.7 | | 6.9 | 9.5 | | |
| | 31 | 18586 | | | | | | 8.9 | | | | | |
| India | 32 | 18013 | 2.8 | 8.2 | | 3.6 | | | 0.5 | 6.6 | | 3.3 | 1.2 |
| | 33 | 18014 | 2.5 | 8.0 | 1.2 | 3.5 | | 8.0 | | | | | |
| | 34 | 18015 | | 8.7 | | | 2.2 | 7.7 | | | | | |
| | 35 | 18118 | 2.4 | 9.4 | | | | | 0.8 | 6.8 | | | 2.0 |
| | 36 | 18119 | 2.3 | 8.7 | 1.2 | 3.8 | | | | | | | |
| | 37 | 18120 | | 8.7 | | | | | | | | | |
| Sri Lanka | 38 | 18286 | | 9.6 | | | | | | | | | |
| | 39 | 18287 | 2.2 | 9.6 | | | | | 0.5 | | | | 1.4 |
| | 40 | 18288 | 2.3 | 9.7 | | | | | | | | | |
| Vietnam | 41 | 18085 | 2.9 | 9.1 | | 3.7 | | | | | | 3.3 | 1.3 |
| | 42 | 18086 | | 8.9 | | | | | | | | | |
| | 43 | 18127 | | 8.6 | | | | | | | | 3.3 | |
| | 44 | 18128 | 2.7 | 9.7 | | 4.0 | 2.3 | | 0.5 | | 9.8 | | 2.0 |
| | 45 | 18152 | | 7.9 | | | 2.3 | | | 6.9 | | | |
| **Region mean** | | | 2.4 | 8.9 | 1.2 | 3.8 | 2.3 | 8.1 | 0.6 | 6.8 | 9.8 | 3.3 | 1.6 |

**Appendix 2.2** (cont'd) Mean values for height growth (*Ht*) in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov No. | CSIRO No. | IPT-15 | IPT-16 | IPT-17 | IPT-18 | IPT-19 | IPT-20 | IPT-21 | IPT-22 | IPT-23 | IPT-24 | IPT-25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 12mo | 18mo | 36mo | 18mo | 47mo | 47mo | 24mo | 14mo |
| *Introduced – Africa* | | | | | | | | | | | | | |
| Benin | 46 | 18355 | 3.2 | 9.4 | | | | 8.5 | | | | | |
| Egypt | 47 | 18122 | 1.7 | 7.6 | | 3.0 | 2.1 | | | 5.3 | | 2.7 | |
| | 48 | 18125 | | 8.7 | | 2.7 | | | 0.6 | | 10.1 | 3.0 | 1.0 |
| | 49 | 18126 | | 7.2 | | | 2.3 | | | | 8.6 | 2.6 | |
| Kenya | 50 | 18134 | 1.8 | 9.3 | 0.9 | 2.8 | | | 0.6 | | | 1.9 | 1.6 |
| | 51 | 18135 | | 8.8 | | | 2.3 | 9.4 | | | | | |
| | 52 | 18136 | | 9.1 | | | 1.7 | | | | | | |
| | 53 | 18137 | 1.2 | 9.2 | | 2.6 | | | | | | 2.5 | 1.2 |
| | 54 | 18141 | | 8.8 | | | | | | | | | |
| | 55 | 18142 | | 8.8 | | | | | | | | | |
| | 56 | 18143 | | 7.0 | | | | | | | | | |
| | 57 | 18144 | | 8.8 | | | | | | 7.4 | | | |
| Mauritius | 58 | 18565 | | 8.5 | | | 2.1 | | | | 8.5 | | |
| **Region mean** | | | 2.0 | 8.6 | 0.9 | 2.8 | 2.1 | 8.9 | 0.6 | 6.3 | 9.1 | 2.6 | 1.3 |
| Puerto Rico | 59 | 18752 | | | | | | | | | | | |
| **Overall mean** | | | 2.3 | 8.8 | 1.0 | 3.7 | 2.1 | 8.1 | 0.6 | 6.5 | 9.0 | 3.0 | 1.5 |
| | | RMS | 0.2569 | 0.9596 | 0.0601 | 0.0616 | 0.1563 | 1.2820 | 0.0103 | 2.2280 | 0.5655 | 0.3952 | 0.1023 |
| | | SED | 0.36 | 0.69 | 0.17 | 0.18 | 0.28 | 0.80 | 0.07 | 0.61 | 0.61 | 0.44 | 0.26 |
| | | Prov. | * | ** | ns | *** | ns | ns | *** | ns | ns | ns | *** |
| | | Country | *** | *** | ns | *** | ns | * | ** | *** | * | ns | * |
| | | Region | * | *** | * | *** | ns | ** | ns | ns | *** | ** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.

**Appendix 2.3** Mean values for diameter at breast height ( *Dbh*) growth in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov No. | CSIRO No. | IPT-15 | IPT-16 | IPT-18 | IPT-19 | IPT-20 | IPT-22 | IPT-23 |
|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 18mo | 36mo | 47mo | 47mo |
| *Natural – Australia/Pacific* | | | | | | | | | |
| Australia | 1 | 15958 | | 5.5 | 1.2 | 0.8 | 4.0 | 2.3 | 3.0 |
| | 2 | 16166 | | 6.1 | | 0.8 | 5.5 | | 3.5 |
| | 3 | 18008 | 1.7 | 5.2 | 1.8 | | 5.1 | | |
| | 4 | 18378 | | 5.1 | | | | | |
| PNG | 5 | 18153 | 1.6 | 6.6 | 2.5 | 1.1 | | 3.9 | 4.5 |
| Fiji | 6 | 18270 | | 5.9 | 1.4 | | | | |
| | 7 | 18271 | | 4.9 | 1.7 | | 4.3 | | |
| | 8 | 18272 | | 4.8 | | 0.9 | | | |
| Guam | 9 | 18121 | 1.0 | 5.4 | | 1.0 | 3.6 | | |
| Solomon | 10 | 18402 | | 6.3 | | | | | |
| | 11 | 18403 | | 6.9 | | | | | |
| Vanuatu | 12 | 18312 | 1.7 | 6.9 | | 1.0 | | | |
| Tonga | 12a | 18040 | | | | | | | |
| **Region mean** | | | **1.5** | **5.8** | **1.7** | **0.9** | **4.5** | **3.1** | **3.7** |
| *Natural – Southeast Asia* | | | | | | | | | |
| Malaysia | 13 | 18157 | | 6.7 | 2.6 | | | | |
| | 14 | 18158 | | 7.4 | 2.7 | | | | |
| | 15 | 18160 | | 6.8 | | 1.0 | | 3.4 | |
| | 16 | 18161 | | 6.3 | | | | | |
| | 17 | 18244 | | 7.6 | 2.4 | | 5.4 | 3.6 | 4.0 |
| | 18 | 18348 | | 6.3 | | 0.8 | | | |
| | 19 | 18374 | | 6.8 | | | | | |
| | 20 | 18375 | | 6.3 | | | | | |
| | 21 | 18376 | | 9.2 | | | | | |

**Appendix 2.3** (cont'd) Mean values for diameter at breast height ( *Dbh*) growth in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov No. | CSIRO No. | IPT-15 | IPT-16 | IPT-18 | IPT-19 | IPT-20 | IPT-22 | IPT-23 |
|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 18mo | 36mo | 47mo | 47mo |
| Philippines | 22 | 18117 | | | 1.2 | | | | |
| | 23 | 18154 | 1.6 | 5.8 | 1.8 | 1.3 | | | 4.1 |
| | 24 | 18357 | | | | | | | |
| Thailand | 25 | 18296 | 1.2 | 6.6 | | 0.8 | | 4.0 | |
| | 26 | 18297 | 1.6 | 6.7 | | | 6.0 | | |
| | 27 | 18298 | 0.8 | 7.7 | 2.6 | | | | |
| | 28 | 18299 | | 7.8 | 2.6 | 0.6 | | 4.2 | |
| **Region mean** | | | **1.3** | **7.0** | **2.3** | **0.9** | **5.7** | **3.8** | **4.1** |
| *Introduced – Asia* | | | | | | | | | |
| China | 29 | 18267 | 0.9 | 5.8 | 2.2 | 1.3 | 5.5 | | 4.9 |
| | 30 | 18268 | 1.6 | 6.2 | 2.1 | 0.8 | 5.3 | 3.6 | 4.5 |
| | 31 | 18586 | | | | | 6.0 | | |
| India | 32 | 18013 | 1.9 | 6.1 | 2.0 | | | 3.7 | |
| | 33 | 18014 | 1.9 | 6.0 | 2.0 | | 5.6 | | |
| | 34 | 18015 | | 5.9 | | 1.0 | 4.5 | | |
| | 35 | 18118 | 1.9 | 7.0 | | | | 3.3 | |
| | 36 | 18119 | 1.6 | 6.3 | 2.1 | | | | |
| | 37 | 18120 | | | | | | | |
| Sri Lanka | 38 | 18286 | | 7.3 | | | | | |
| | 39 | 18287 | 1.4 | 6.5 | | | | | |
| | 40 | 18288 | 1.4 | 6.6 | | | | | |
| Vietnam | 41 | 18085 | 1.8 | 6.4 | 2.0 | | | | |
| | 42 | 18086 | | 5.7 | | | | | |
| | 43 | 18127 | | 6.1 | | | | | |
| | 44 | 18128 | 1.8 | 7.0 | 2.1 | 1.1 | | | 4.3 |
| | 45 | 18152 | | 5.3 | | 1.2 | | 3.7 | |
| **Region mean** | | | **1.6** | **6.3** | **2.1** | **1.1** | **5.4** | **3.6** | **4.5** |

**Appendix 2.3** (cont'd) Mean values for diameter at breast height ( *Dbh*) growth in international provenance trials of *Casuarina equisetifolia.*

| Country of origin | Prov No. | CSIRO No. | IPT-15 | IPT-16 | IPT-18 | IPT-19 | IPT-20 | IPT-22 | IPT-23 |
|---|---|---|---|---|---|---|---|---|---|
| | | | 26mo | 48mo | 12mo | 18mo | 36mo | 47mo | 47mo |
| *Introduced – Africa* | | | | | | | | | |
| Benin | 46 | 18355 | 2.2 | 7.2 | | | 5.6 | | |
| Egypt | 47 | 18122 | 1.0 | 4.6 | 1.4 | 0.9 | | 2.6 | |
| | 48 | 18125 | | 5.7 | 1.3 | | | | 4.8 |
| | 49 | 18126 | | 4.4 | | 0.8 | | | 3.8 |
| Kenya | 50 | 18134 | 1.0 | 6.2 | 1.4 | | | | |
| | 51 | 18135 | | 5.7 | | 1.0 | 5.3 | | |
| | 52 | 18136 | | 6.0 | | 0.7 | | | |
| | 53 | 18137 | 0.8 | 5.8 | 1.2 | | | | |
| | 54 | 18141 | | 5.9 | | | | | |
| | 55 | 18142 | | 5.8 | | | | | |
| | 56 | 18143 | | 5.0 | | | | | |
| | 57 | 18144 | | 5.6 | | | | 3.5 | |
| Mauritius | 58 | 18565 | | 6.3 | | 0.8 | | | 4.0 |
| **Region mean** | | | **1.2** | **5.7** | **1.3** | **0.9** | **5.4** | **3.0** | **4.2** |
| Puerto Rico | 59 | 18752 | | | | | | | |
| **Overall mean** | | | **1.5** | **6.2** | **1.9** | **0.9** | **5.1** | **3.4** | **4.1** |
| | | RMS | 0.1625 | 0.8011 | 0.0539 | 0.0689 | 0.5175 | 0.8857 | 0.2402 |
| | | SED | 0.29 | 0.63 | 0.16 | 0.19 | 0.51 | 0.38 | 0.40 |
| | | Prov. | ns | ** | ** | ns | * | ns | ns |
| | | Country | *** | *** | *** | ns | * | *** | * |
| | | Region | * | *** | *** | * | *** | ** | ns |

Note: RMS = residual mean square; SED = standard error of differences; Prov. = provenances; ns = not significant; * = significant $P$ 0.05; ** = significant $P$ 0.01; *** = significant $P$ 0.001.