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PERFORMANCES OF ACACIA SPECIES IN THAILAND

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บทคัดย่อ

การทดลองปลูกไม้สกุลอาเคเซียในประเทศไทย ซึ่งกรมป่าไม้ดำเนินการโดยได้รับความร่วมมือจากศูนย์วิจัยเกษตรระหว่างประเทศของออสเตรเลีย (ACIAR) ตั้งแต่ปี พ.ศ. 2528 ในพื้นที่ทดลอง 6 แห่ง จำนวนชนิดไม้ 12 ชนิด 23 ถิ่นกำเนิด ผลการศึกษาหลังการปลูกได้ 36 เดือน ปรากฏว่า การเจริญเติบโตของไม้แต่ละชนิดและถิ่นกำเนิดมีความแตกต่างทางสถิติอย่างมีนัยสำคัญยิ่ง พันธุ์ไม้ *Acacia crassicarpa, Acacia auriculiformis* และ *Acacia aulacocarpa* ที่มีถิ่นกำเนิดจาก Papua New Guinea เจริญเติบโตได้ดีทุกแห่ง A. aulacocarpa ที่มีถิ่นกำเนิดจาก Queensland, *Acacia cincinnata, Acacia shirleyi, Acacia melanoxylon* และ *Acacia polystachya* เจริญเติบโตค่อนข้างช้า การรอดตายของพันธุ์ไม้แต่ละชนิดแตกต่างกันอย่างมีนัยสำคัญยิ่ง ยกเว้น พื้นที่ทดลองที่ศรีสะเกษ ไม่มีความแตกต่างทางสถิติ ซึ่งพันธุ์ไม้ทุกชนิดมีการรอดตายสูง ส่วนที่จันทบุรี และประจวบคีรีขันธ์ การรอดตายค่อนข้างต่ำ A. auriculiformis, A. aulacocarpa และ A. crassicarpa เป็นพันธุ์ไม้ที่มีการรอดตายสูงทุกพื้นที่ทดลอง

ABSTRACT

Twelve Australian Acacia species were introduced in field trials in Thailand. These feild trials were established in 1985 as a collaborative research work between the Royal Forest Department (RFD) of Thailand and the Australian Centre for International Agricultural Research (ACIAR) of Australia.

A total of 23 seedlots of 12 Acacia species were planted in six trial sites throughout Thailand. The result in growth performance of these Acacias at 36 month after planting showed a very significant difference between species and seedlots. The best three species were *Acacia crassicarpa, Acacia auriculiformis, and Acacia aulacocarpa* all from Papua New Guinea which exhibited good growth performance at almost every trial sites. On the other hand, *A. aulacocarpa* from Queensland, *A. cincinnata, A. shirleyi, A. melanoxylon, and A. polystachya* were the slowest growing Acacia species in all trial sites.

Survival percentage between species also showed significant difference within site except at Sisaket which showed the best survival percentage in all species. Trial sites at Chantaburi and Prachuap Kiri Khan had the overall lowest survival percentage. However, *A. auriculiformis* showed the best survival percentage at all site followed by *A. aulacocarpa* and *A. crassicarpa*

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INTRODUCTION

In Thailand, the forest area in 1961 was 273,000 km^2 or 53% of the country total area of 513,100 km^2. It decreased to 156,000 km^2 or 30% in 1982. Thailand has a population about 55 million people and 80% of them live in rural areas where wood is the main source of energy for cooking and heating. Rapid deforestation has resulted in shortage of fuelwood and construction timber and soil erosion in many places. One measure to alleviate these problems is to establish forest plantations with tree species that are fast growing, nitrogen fixing and capable of surviving in grossly disturbed habitats.

Acacia auriculiformis has been used as plantation species with notable success througout Thailand. However, there are many other Australian Acacias which have never been tried but may be better adapted. Following the establishment of the Australian Center for Internatinal Agricultural Research (ACIAR), a project on Australian Hard woods for Fuelwood and Agroforestry was set up in 1985 as a collaborative effort between the Royal Forest Department (RFD) and ACIAR. Twenty-three Acacia seedlots comprising 12 species (1-4 provenances each), along with some other Australian species, have been introduced and planted in a series of species/ provenance trials at six different locations (Figure 1.) the previous assessment of this field trials at 6, 12 and 24 months after planting have been reported (Pinyopusarerk and Puriyakorn 1986, Pinyopusarerk and Boland 1987, Puriyakorn, Pinyopusarerk, and Luangviriyasaeng 1988). This paper reports growth and survial of the acacia 36 months after field establishment.

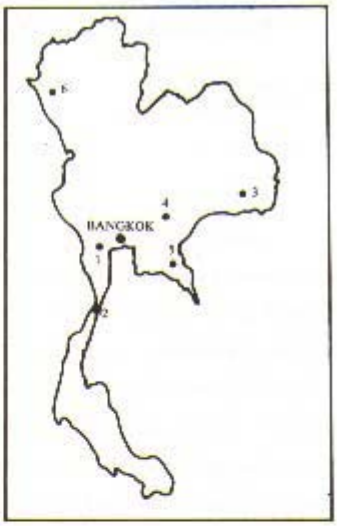

Figure 1. Location of the 1985 aciar project sites in Thailand 1 : Ratchaburi, 2 : Sai thong, 3 : Huai Tha, 4 : Sakaerat, 5 : Kho Soidao, 6 : Huai Bong.

METERIALS AND METHODS

The trials were established at six locations selected to represent a range of climatic and geographie conditions in Thailand as detailed in Table 1. Seed for all plantings was supplied by The Common wealth Scientific and Industrial Research Organization (CSIRO), Australian tree Seed Center in Canberra. Details of Seedlots are given in Table 2. The number seedlots at each site varied but most seedlots were planted at four to six sites. Seedlings raised from these seedlots were grown in nurseries near each planting site. No innoculation with microorganisms was made.

Prior to the rainy season the trial sites were cleared, burned and disc-ploughed twice in cross directions. Herbicide (Roundup at 1:100 in aqueous solution) was sprayed over each planting spot two to three weeks before planting. The trials were laid out in a ran-

Table 1. Climatic and site Details for Australian tree species trials in Thailand

Study Site	Lat. (N)	Long. (E)	Alt. (m)	Rainfall (mm)	Temperature (C) Max	Min	Ave	Soil Information
1. Ratchaburi Experiment Station, Ratchaburi	12 35	99 50	90	800	30.8	23.5	29.3	Red yellow lateritic, sandy loam ; pH 4.9–5.2
2. Sai Thong Experiment Station Prachuap Khiri Khan	11 25	99 25	50	1,500	34.3	20.2	27.2	Red yellow podzolic ; sand, loamy sand, sandy clay loam ; pH 4.9
3. Hau Tin Experiment Sation, Si Sa Ket	14 53	104 37	150	1,200	31.6	22.9	27.3	low humic grey ; sandy loam ; pH 4.4–5.4
4. Sakarat Thai-Japan Project Nakorn Ratchasima	14 12	101 55	550	1,200	31	20.7	25.9	Red yellow podzolic ; loam, clay loam ; pH 4.9–5.2
5. Khao Sa Duo Seed Orchard Chanthaburi	13 9	102 15	200	1,300	32.6	21.4	27	Grey podzolic ; sandy loam, sandy clay loam ; pH 6.2
6. Ban Bong Experiment Station Chiang Mai	18 15	98 25	580	1,000	29.8	14.2	24	Lateritic ; loamy sand, sandy loam ; pH 5.5–5.6

Table 2. Origin Data for Australian seedlots used in the field trials in 1985

Species	Abbreviation of species	CSIRO seedlot number	No. of parent tree in collection	Location	Lat. S		Long. E		Alt. (m)
1985 Planting									
Acacia aulacocarpa	ACACUL	13608	6	Kerau PNG	8	32	144	45	60
aulacocarpa	ACACUL	13609	5	Orima River PNG	8	48	142	9	20
aulacocarpa	ACACUL	13896	8	Cairvale QLD	16	40	145	18	400
aulacocarpa	ACACUL	13897	10	Julatten Area QLD	16	35	145	25	410
auriculiformis	ACAAUR	13654	17	Balamuk PNG	8	54	141	15	18
auriculiformis	ACAAUR	13686	10	Inkwa PNG	8	41	141	29	35
auriculiformis	ACAAUR	13854	200	Openpelli NT	12	20	133	4	50
auriculiformis	ACAAUR	13881	4	Springvale Holding QLD	15	50	144	55	500
cincinnata	ACACIN	13884	5	Shotted QLD	16	57	145	38	440
crassicarpa	ACACRA	13650	21	Wemenzer PNG	8	51	141	26	30
crassicarpa	ACACRA	13651	10	Mata PNG	8	40	141	45	90
crassicarpa	ACACRA	13652	15	Worer Wipim PNG	8	49	141	8	20
crassicarpa	ACACRA	13653	5	Shotted La QLD	16	52	145	38	440
difficilis	ACADIF	14623	41	Daly Waters NT	16	21	133	22	230
flavescens	ACAFLA	14132	9	Mt Molloy QLD	16	40	145	18	440
holosericea	ACAHOL	14660	28	Turkey Creek Wa	17	4	128	12	400
leptocarpa	ACALEP	13633	1	Staroze Holding QLD	14	16	144	26	2
leptocarpa	ACALEP	13691	4	Worer Wipim PNG	8	52	143	3	30
mangium	ACAMAN	13621	9	Pira, Ceram INDONESIA	3	4	128	12	150
mangium	ACAMAN	13846	75	7 km SSE of Mossman QLD	16	31	145	24	60
melanoxylon	ACAMEL	14176	10	Acharot QLD	17	17	145	26	1,000
polystachya	ACAPOL	13871	4	Bridle QLD	16	58	145	37	480
shirleyi	ACASHI	14622	10	Daly Waters NT	16	19	133	23	255

domized complete block design with three replicates. Each treatment comprised 25 trees arranged in a plot of 5×5 trees at a 2×2 m. spacing. Field planting took place during June-August 1985 at each site. Seedlings were approximately 6 months old from germination to out planting. Following cultivation, 50g of a complete fertilizer (15-15-15) was given once to each plant one month after planting and at the beginning of the rainy season in the second year. Weed competition in the trial areas was kept to a minimum by frequent application of slash-weeding or chemical spraying. Frequeney of weed control was based on as-required basis.

All trees were measured for height growth, diameter at breast hight (dbh), and survival, every 6 month after planting until 3 years. Analysis of variance were made for plot-mean data at each planting site, and F-test used to test the significance of differences between seedlot means. For survival, arcsin transformations was applied before analysis. Duncann's new multiple range test procedure (Duncan, 1955 outlined in Steel and Torrie, 1981) was used to test the significance of differences between seedlot means.

RESULT AND DISCUSSION

Height Growth

Analysis of data (Table 3) indicated that there was significant differences in height growth between seedlots of the same species and between trial sites. Species that showed the best height growth in all experimental sites except Chantaburi and Huai Bong was *A. crassicarpa* which had the height growth of 14.8, 10.2, 9.7, and 8.6m at Sai Thong, Sisaket, Sakaerat, and Ratchaburi respectively.

The second best species in height growth were *A. auriculiformis*, *A. difficils* (which was planted only at Ratchaburi and Sai Thong), *A. aulacocarpa*, *A. leptocarpa*, *a holosericea*, and *A. mangium*. However, in Chantaburi and Huai Bong trial sites, most Acacia species had poor performance in height growth except *A. aulacocarpa* (seedlot 13688) and *A. auriculiformis* (seedlot 13861) which showed acceptable height growth of 6.5 and 5.2m respectively.

The least height growth of Acacia species in these trials were *A. cincinnata*, *A. aulacocarpa* (seedlot 13866, 13877) *A. shirleyi*, *A. melamoxylon*, and *A. polystachya*

Comparison of height growth data at 6, 12, and 24 months after planting showed a consistent trend in height growth of all species. Those species which grew vigorously at the early stage of field trial were still growing very well.

Diameter Growth

Diameter growth of Acacia species also showed significant differences within species and between trial sites (Table 4). The general trend of diameter growth followed closely with height growth. At 36 months after planting, *A. crassicarpa* produced the best diameter growth in all trial sites except Chantaburi and Huai Bong which *A. auriculiformis* Seedlot 13854 and 13861 was the best respectively. The second best species in diameter growth were *A. auriculiformis* (seedlot 13684, 13686), *A. difficilis*, *A. leptocarpa*, *A. aulacocarpa* (seedlot 13688, 13689), *A. mangium*, and *A. holosericea*.

Acacia species which showed the least diameter growth in almost all trial sites were

Table 3. Mean height growth (m) of 36-month-old **Acacia** species and provenance trials in Thailand.

Acacia	Seedlot	Ratchaburi	Saithong	Sisaket	Sakaerat	Chanthaburi	Huai Bong
aulacocarpa	13688	6.4 cd	11.4 cdef	8.2 bcd	6.9 de	6.5 a	3.2 e
	13689	6.4 cd	11.3 def	8.4 be	8.0 b	5.4 abc	3.8 b
	13866	4.9 ef	6.3 ijk	5.0 fg	4.8 hi	3.5 de	2.7 cd
	13877	4.9 ef	7.1 higk	4.3 gh	5.4 gh	2.5 e	1.8 ef
auriculiformis	13854	5.6 def	11.8 cde	9.1 abc	7.8 bc	6.3 ab	4.8 a
	13861	6.0 de	11.7 cde	8.9 abc	8.2 b	6.3 ab	5.2 a
	13684	7.3 bc	12.3 cd	9.0 abc	8.5 b	6.2 ab	4.1 b
	13686	7.5 abc	12.4 cd	–	–	–	–
cincinnata	13864	4.6 f	7.7 ghi	4.3 gh	6.9 de	2.8 e	–
crassicarpa	13863	5.8 def	10.5 ef	9.5 ab	7.1 cd	–	–
	13681	8.0 ab	12.8 bc	9.5 ab	9.3 a	–	3.8 b
	13683	8.7 a	14.8 a	10.2 a	9.7 a	4.8 abcd	–
	13680	8.7 a	13.9 ab	9.2 abc	–	4.7 bcd	–
difficilis	14623	8.0 ab	8.6 g	–	–	–	–
flavescens	14175	5.8 def	8.4 gh	5.0 fg	4.6 ig	2.3 e	–
holosericea	14660	7.7 ab	8.8 g	5.8 ef	6.5 def	4.6 bcd	3.9 b
leptocarpa	13653	6.8 bcd	10.2 f	7.8 cd	6.3 ef	4.7 bcd	2.6 d
	13691	7.5 abc	11.7 cde	8.8 bc	–	3.8 ced	2.2 de
mangium	13621	6.1 cd	7.4 ghij	5.4 fg	3.5 kl	3.4 de	1.3 g
	13846	7.2 bc	8.7 g	6.8 de	5.9 fg	3.8 cde	–
melanoxylon	14176	–	5.9 f	–	2.3 m	–	1.6 fg
polystachya	13871	3.4 f	6.1 jk	3.4 h	3.0 lm	2.4 e	1.4 fg
shirleyi	14622	6.2 cd	–	5.3 fg	3.9 gk	–	–
Grand mean		6.5	10.0	7.2	6.3	4.4	3.0
F-test (seed lots)		13.73***	38.12***	24.893***	78.725***	7.441***	69.504***

*** indicate significance at the 0.1% level. Mean followed by the same letter are not significantly different ($p < 0.05$) by Duncan's Multiple Range Test.

Table 4. Mean dbh (cm) of 36 – month – old Acacia species and provenance trials in Thailand.

Acacia	Seedlot	Ratchaburi	Saithong	Sisaket	Sakaerat	Chanthaburi	Huai Bong
aulacocarpa	13688	6.8 bcde	10.1 efg	6.8 cd	6.5 cde	5.9 ab	2.6 e
	13689	6.6 bcdef	11.3 def	6.8 cd	7.3 bcd	5.3 abc	3.4 cb
	13866	5.1 gh	5.1 j	4.4 ef	5.2 g	2.3 de	1.4 fg
	13877	5.5 efgh	5.9 j	3.2 fg	5.8 efg	1.8 e	1.2 fg
auriculiformis	13854	5.5 efgh	9.8 fg	8.6 abc	8.0 ab	6.8 a	4.7 ab
	13861	5.4 fgh	9.0 gh	7.8 bc	7.4 bc	5.7 abc	5.3 a
	13684	6.9 abcde	12.0 cd	8.1 abc	8.6 a	6.1 ab	4.4 b
	13686	7.8 ab	11.5 de	–	–	–	–
cincinnata	13864	4.4 hi	5.8 j	3.8 fg	7.2 bcd	2.3 de	–
crassicarpa	13863	6.3 bcdefg	9.9 fg	9.5 ab	6.4 def	–	–
	13681	8.2 a	13.2 bc	9.9 a	7.7 ab	–	4.1 bc
	13683	8.3 a	14.9 a	9.3 ab	8.7 a	4.8 bcd	–
	13680	8.2 a	13.4 b	9.4 ab	–	4.0 bcd	–
difficilis	14623	7.3 abcd	7.6 hi	–	–	–	–
flavescens	14175	5.7 efgh	7.6 hi	4.9 ef	3.7 h	1.5 e	–
holosericea	14660	6.0 defg	6.2 ij	4.9 ef	5.2 g	3.0 de	2.8 de
leptocarpa	13653	6.0 defg	9.0 gh	8.3 abc	5.4 fg	3.9 bcd	1.9 f
	13691	6.5 bcdefg	9.5 g	7.4 cd	–	2.6 de	1.6 f
mangium	13621	6.2 cdefg	5.6 j	4.7 ef	2.7 i	2.2 e	0.8 g
	13846	7.6 abc	8.8 gh	5.9 de	5.8 efg	3.4 cde	–
melanoxylon	14176	–	4.7 j	–	1.2 j	–	0.6 g
polystachya	13871	3.5 i	4.9 j	2.1 g	2.2 i	1.8 e	0.7 g
shirleyi	14622	6.1 cdefg	–	4.5 ef	2.0 ij	–	–
Grand mean		6.4	8.9	6.5	5.6	3.7	2.5
F – test (seed lots)		7.763***	40.809***	18.555***	56.725***	6.415***	42.332***

*** indicate significance at the 0.1% level. Mean followed by the same letter are not significantly different ($p < 0.05$) by Duncan's Multiple Range Test.

Table 5. Mean survival (arcsin % tranformation) of 36 month-old Acacia species and provenance trials in Thailand.

Acacia	Seedlot	Ratchaburi	Saithong	Sisaket	Sakaerat	Chanthuburi	Huai Bong
aulacocarpa	13688	62.5 abcdefgh	80.7 abcd	82.3	81.1 ab	53.3 cde	66.9 bcd
	13689	66.0 abcdefg	57.8 def	86.2	74.4 abc	50.9 def	66.5 bcd
	13866	86.2 a	77.8 abcd	86.2	58.7 cde	49.4 def	69.9 bc
	13877	44.7 hi	47.0 fg	82.3	77.8 ab	33.3 f	51.0 e
auriculiformis	13854	82.1 ab	90 a	90.0	90.0 a	86.2 ab	86.2 a
	13861	78.3 abc	84.5 abc	90.0	90.0 a	90.0 a	90 a
	13684	76.7 abc	86.2 cd	90.0	90.0 a	43.0 ef	76.7 ab
	13686	69.6 abcdef	57.8 def	–	–	–	–
cincinnata	13864	24.3 i	50.4 efg	73.9	67.6 bcd	42.7 ef	–
crassicarpa	13863	50.2 defgh	73.7 abcdc	82.3	76.7 ab	–	–
	13681	–	63.4 bcdef	77.3	71.1 bc	–	41.5 e
	13683	71.5 abcde	64.0 bcdef	84.5	75.7 ab	51.7 def	–
	13680	84.5 ab	86.3 ab	84.5	–	42.3 ef	–
difficilis	14623	73.0 abcd	65.9 bcdef	–	–	–	–
flavescens	14175	61.1 bcdefgh	45.1 fg	86.2	48.2 ef	43.8 ef	–
holosericea	14660	73.9 abcd	–	43.7	67.9 bcd	67.5 cd	23.1 f
leptocarpa	13653	80.7 abc	66.8 abcdef	78.5	73.4 abc	71.5 bc	44.6 e
	13691	48.1 efgh	61.54 cdef	86.2	–	63.3 cd	55.7 cde
mangium	13621	46.1 fghi	52.4 ef	75.4	55.7 de	36.0 ef	18.3 f
	13846	57.4 cdefgh	71.8 abcde	82.3	76.5 ab	54.8 cde	–
melanoxylon	14176	–	29.4 g	–	43.8 ef	–	23.4 f
polystachya	13871	86.2 a	66.7 abcdef	80.7	69.6 bcd	66.6 cd	53.2 de
shirleyi	14622	40.0 hi	–	80.7	35.5 f	–	–
Grand mean		65.5	65.534	83.12	69.7	55.7	54.8
F-test (seed lots)		5.634***	4.729***	1.219^{NS}	9.976***	8.272***	26.435***

*** indicate significance at the 0.1% level. NS indicates not significant at the 5% level. Mean followed by the same letter are not significantly different ($p < 0.05$) by Duncan's Multiple Range Test.

A. melanoxylon, *A. polystachya*, *A. shirleyi*, and *A. cincinnata*. However, *A. cincinnata* still showed satisfactory diameter growth at Sakaerat trial site.

Comparison of diameter growth data at 6, 12, and 24 months after planting also showed the same trend as in height growth; those which grew vigorously at the early stage of field trial were still producing the best diameter growth.

Survival

Analysis of survival data (Table 5) indicated that there was significant difference between species in almost all trial sites, except at Sisaket which showed no significant different between species. Species that showed the best survival was *A. auriculiformis* (seedlot 13861). The second bests in survival were *A. aulacocarpa* and *A. crassicarpa* while the lowest survival were *A. melanoxylon* and *A. shirleyi*.

CONCLUSION

Growth performance of exotic Acacias (12 species, 23 seedlots) which were planted in RFD-ACIAR field trial plots in trial sites in Thailand at age 36 month showed a marked different in all growth parameters observed. Furthermore, difference in growth between seedlots of the same species was also highly significance statistically. *Acacia crassicarpa* (seedlot 13683) was the best species which exhibited impressive growth performance in all trial sites. The second bests were *A. auriculiformis* (seedlot 13688) and *A. aulacocarpa* (seedlot 13689) from Papua New Guinea.

Species which showed satisfactory growth performance were *A. difficilis* (seedlot 14623), *A. leptocarpa* (seedlot 13653, 13691), *A. holosericea* (seedlot 14660), and *A. mangium* (seedlot 13846) from North Queensland. The lowest in growth performance were *A. shirleyi* (seedlot 14622), *A. melanoxylon* (seedlot 14176), *A. polystachya* (seedlot 13871), *A. aulacocarpa* (seedlot 13866, 13877) form Queensland, and *A. cincinnata* (seedlot 13864).

As for overall survival percentage, *A. auriculiformis* (all seedlots) was the best species in all trial sites, followed by *A. crassicarpa*, and *A. aulacocarpa*. However, survival of all Acacia species in Sisaket showed high survival with no significant difference statistically. But in Chantaburi and Huai Bong sites, the survival percentage were the lowest compared to all sites.

The result of RFD-ACIAR field trials on Acacia species indicated that the use of Acacia species in forest plantation should be considered carefully on site conditions, species, and seedlots so that maximum growth and yield could be ensured. Miss-matched of species and seedlots to the prevailing site conditions will certainly produce poor plantation that can not cover the cost of establishment.

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REFERENCES

Pinyopusarerk, K. and Puriyakorn, B. 1986. Acacia species and provenance trials in Thailand. Paper presented to an International Workshop on the Role of Australian Acacia in Developing Countries. 4-7 August. 1986. Gympie, Queensland, Australia.

Pinyopusarerk, K. and Boland, D. J. 1987. Assessment of early growth of some Australian acacia and casuarina species in field trials in Thailand. Paper presented to a Workshop on the Contribution of Bilolgical Nitrogen Fixation to Plant Production 3-7 August 1987. Bogon, Indonesia.

Puriyakorn, B; Pinyopusarerk. K. and Luangviriyasaeng. V. 1988. Assessment of Early Growth of Australian Tree Species Trials in Thailand. Paper presented to the Fourth seminar on Silviculture 18-22 January 1988. Pattaya, Thailand.

Steel, R. G. and Torrie, J.H. 1981. Principles and Procedures of Statistic. Mc Graw-Hill Book Company, Singapore, 633 pp.

Wasuwanich, P. 1990. Phenological Investigation of Australian Tree Species in field Trials in Thailand. A report to the Australian International Development Bureau. Division of Silviculture, Royal Forest Department, Bangkok 10900, Thailand, 82 p.