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EFFECTS OF FERTILIZER APPLICATION AND SPACINGS ON GROWTH PERFORMANCES OF SOME *ACACIAS*

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ABSTRACT

This paper was a part of the study on growth/yield at Sri Thong Experiment Station, Thai-Japan Project (Sakaerat) and Huai Tha Experiment Station to study effects of fertilizer application and spacings on growth performances (height and diameter) of *A. auriculaeformis, A. aulacocarpa, A. crassicarpa* and *A. leptocarpa*. However, only 2 species were selected to plant at each experimental site according to their better growth performances in the ACIAR species trials in 1985, 1986 and 1987 in Thailand.

Effect of the fertilizer application on height and diameter growths was minimal and not consistant. There was no significant differences in the fertilizer application on height and diameter growths at all sites and in all species at 12 and 24 months, except at Sai Thong where only the fertilizer application was significantly different in both height and DBH growths of *A. auriculaeformis* at 12 monts. However, the differences disappeared at 30 months.

There was no significant difference in spacings on height and diameter growths at all experimental sites and in all species at 12 months, on height and diameter growths at Sakaerat at 24 monts, and on height at Huai Tha at 24 months and at Sai Thong at 30 months. However, the spacings indicated significant differences in DBH of *A. auriculaeformis* and *A. crassicarpa* at Sai Thong at 30 months and in DGL of *A. aulacocarpa* and *A. leptocarpa* at Huai Tha at 24 months. Species tested at both sites had larger diameters in 2 x 4 spacing than in other spacings.

No interaction between fertilizer application and spacings was significantly observed at 12 and 24 or 30 months at all sites and in all species.

INTRODUCTION

According to the series of the ACIAR species trials in 1985, 1986 and 1987 in Thailand, some acacias showed promising growth performances at particular trial sites. However, the trial plots were too small (*i.e.* 64m^2) to determine rates of biomass production and total accumulation. The ACIAR authority suggested that several kinds of growth and yield experiments need to be established for those species to gather information for their future development. The Royal Forest Department, Thailand agreed to the suggestion and conducted the experiments in 1998 as planned by the ACIAR authority.

This paper was extracted from the growth/yield experiments conducted at 3 experiment stations in order to study effects of fertilizer application and spacings on growth performances of selected acacias at early stage of development. It was expected that the immediate results gained from the study

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will be beneficial to further planting of the species in Thailand.

MATERIAL AND METHODS

The experiments were conducted at Sai Thong Experiment Station, Thai-Japan Project (Sakaerat) and Huai Tha Experiment Station, with 2 of selected Acacia species at each experimental site as shown in Table 1. Climatic and soil details of the experimental sites were described in Table 2.

Split plot techniques in RBD with 2 replicates was employed for the experiments at all experimental sites. Fertilizer application and spacings were main-plots and sub-plots respectively. The fertilizer application was consisted of the fertilized and the non-fertilized levels. 100 g of N: P : K = 15:15:15 formula were applied only once at first year into 2 pits, 25-30 cm from each planted seedling in the N-S direction, about 2 months after outplanting. There were 3 levels of spacings, 2 x 1.5, 2 x 2 and 2 x 4 m. Details of the spacing factor were shown in Table 3.

Seed for all experiments were given by the CSIRO Australian Seed Centre in Canberra the ACIAR. Seedlot numbers were 16106 (*A. auriculaeformis*), 16112 (*A. aulacocarpa*), 13683 (*A. crassicarpa*) and 16110 (*A. leptocarpa*).

Seedlings derived from the seeds were prepared at nurseries nearby respective experimental sites, almost at the same time. Polyethylene bags filled with normal nursery soil were used to grow the seedlings. No rhizobium innoculation was made.

Prior to outplanting, the experimental sites were selected for a uniform soil condition, cleared and disc-ploughed twice in crass-directions. Plot divisions and staking were undertaken according to the statistical designs.

Weed competition in experimental areas was kept to a minimum by frequent application of slash-weeding. Frequency of wood control was on an as-required basis.

Twenty eight inner trees of each sub-plot were measured for height and diameters. The diameters were DBH (diameter at breast height) and DGL (diamter at ground level). In this paper, the DGL was presented only when the DBH was not available. The measurement was made at 12 month interval; however, the measurement at 24 months at Sai Thong was extended to 30 months due to unexpected problems.

RESULTS

Average heights and DBHs or DGLs of trees in all treatments at all sites were given in Table 4. The ANOVA (Analysis of Variance) of growth performances at each experimental site was seperately made. No comparison between growth performances at different ages was

Table 1. Experimental species at different experimental sites in Thailand.

No	Experimental sites	*A.auriculaeformis*	*A.crassicarpa*	*A. aulacocarpa*	*A. leptocarpa*
1	Sai Thong Planting Experiment Sation, Prachuab Khiri Khan Province	0	0	-	-
2	Thai-Japan Project (Sakaerat), Nakorn Ratchasima Province	0	-	0	0
3	Huai Tha Experiment Station, Srisaket Province	-	-	0	-

Table 2. Climatic and soil details

Experimental sites	Lat.	Long.	Alt.	Rainfall	Temperature (°C)			Soil
	(N)	(E)	(m)	(mm)	Max.	Min.	Ave.	information
Sai Thong Planting Experiment Sation, Prachuab Khiri Khan Province	11 25	99 27	50	1,500	34.1	20.2	27.2	Red yellow podzolic; sand, loamy sand, sandy clay loam; pH 4.9
Thai-Japan Project (Sakaerat), Nakorn Ratchasima Province	14 13	104 27	130	1,300	31.6	22.9	27.3	low humic grey; sandy loam; pH 4.4-5.4
Huai Tha Experiment Station, Srisaket Province	14 13	101 55	550	1,200	31	20.7	25.9	Red yellow podzolic; loam, clay loam; pH 4.9-5.2

Table 3. Details of spacings

Spacing (m)		Sub-plot	Area	Trees/ha
In row	Between row	Dimension (m x m)	(m^2)	
2	1.5	10.5 x 12	147	3,330
2	2	14 x 14	196	2,500
2	4	14 x 28	392	1,250

Note : 1. Row oriented N-S
2. Each sub-plot is consisted of total 8 x 8 trees (36 measurement trees and 28 trees in a single row buffer) and 2 m apart.

Table 4. Average heights and DBHs or DGLs of the experiment at all experiment sites

Site	Species	Age	Spacing	Average growth performance					
				Height (m)		DBH (cm)		DGL (cm)	
				Non-fer.	Fer.	Non-fer.	Fer.	Non-fer.	Fer.
1	AUR	12	2 x 1.5	2.01	3.49	1.00	2.55	-	-
			2 x 2	1.83	3.61	0.90	2.80	-	-
			2. x 4	1.89	3.53	0.95	2.70	-	-
		30	2 x 1.5	7.38	9.49	5.90	7.20	-	-
			2 x 2	7.02	9.84	5.95	7.80	-	-
			2. x 4	7.04	9.99	6.80	9.15	-	-
	CRA	12	2 x 1.5	2.69	4.08	1.50	3.20	-	-
			2 x 2	2.85	4.22	1.65	3.30	-	-
			2. x 4	2.61	3.76	1.60	3.20	-	-
		30	2 x 1.5	10.10	11.47	7.55	8.45	-	-
			2 x 2	11.20	11.86	7.60	9.15	-	-
			2. x 4	10.60	11.83	9.90	10.75	-	-
2	AUL	12	2 x 1.5	2.03	2.41	-	-	3.55	4.15
			2 x 2	1.78	2.29	-	-	3.20	4.25
			2. x 4	2.02	2.31	-	-	4.25	4.60
		24	2 x 1.5	3.74	4.48	-	-	6.15	7.00
			2 x 2	3.39	4.44	-	-	6.10	7.50
			2. x 4	3.84	4.15	-	-	7.80	8.70
	LEP	12	2 x 1.5	2.79	2.83	-	-	4.05	4.10
			2 x 2	2.84	2.97	-	-	4.15	4.55
			2. x 4	2.83	2.79	-	-	4.40	4.50
		24	2 x 1.5	4.70	4.93	-	-	7.35	7.75
			2 x 2	4.58	5.09	-	-	7.55	8.45
			2. x 4	4.69	4.78	-	-	8.60	9.00
3	AUR	12	2 x 1.5	2.98	3.02	2.50	2.60	-	-
			2 x 2	3.15	2.90	2.60	2.40	-	-
			2. x 4	3.26	3.08	2.55	2.75	-	-
		24	2 x 1.5	6.24	6.12	6.25	5.75	-	-
			2 x 2	6.31	6.09	5.55	6.45	-	-
			2. x 4	6.41	6.32	5.55	5.40	-	-
	AUL	12	2 x 1.5	2.90	3.45	2.10	2.95	-	-
			2 x 2	3.11	3.31	2.40	2.80	-	-
			2. x 4	2.94	3.29	2.40	2.80	-	-
		24	2 x 1.5	6.30	6.73	6.25	5.75	-	-
			2 x 2	6.36	6.74	5.55	6.45	-	-
			2. x 4	5.89	6.42	5.55	5.40	-	-

Notes: 1. Site 1 = Sai Thong, Site 2 = Huai Tha, Site 3 = Sakaerat
2. AUR = *A. auriculaeformis*, CRA = *A. crassicarpa*, AUL = *A. aulacocarpa*, LEP = *A. leptocarpa*

calculated.

According to the ANOVA analysis, there was no significant difference in blocks at all sites.

Sai Thong Experimental Station

A. auriculaeformis

According to the ANOVA analysis, there was no interaction between the fertilizer application and spacings on heights and DBHs at 12 months and 30 months. Only significant differences in the fertilizer application on heights ($p < 0.05$) and DBHs were found out at 12 monhts ($p < 0.05$). However, the differences disappeared at 30 months. At 30 months, only spacings showed significant difference in DBHs ($p < 0.05$).

The best average height (3.61 m) and diameter (2.80 cm) at 12 months were found out in 2 x 2 m spacing with fertilizer application. However, at 30 months the best height (9.99 m) and diameter (9.15 cm) appeared in 2 x 4 m spacing with fertilizer application, respectively.

A. crassiparpa

According to the ANOVA analysis, no interaction between fertilizer application and spcaing on heights and DBHs at 12 and 30 months was observed. There was no significant differences in both fertilizer application and spacings on herights and idameters at 12 months. However, only spacings were significantly different in DBHs at 30 months ($p < 0.05$).

The best height (4.22 m) and diameter (3.30 cm) were at 2 x 2 m spacing with fertilizer application at 12 months. At 30 months, the best height (11.86 m) and diameter (10.75 cm) were observed in 2 x 2 m spacing with fertilizer application and 2 x 4 m spacing with fertilizer application, respectively.

Thai-Japan Project (Sakaerat)

A. auriculaeformis

According to the ANOVA analysis, no indication of interaction between fertilizer application and spacings was found out at 12 and 24 months. There was no significant effect on fertilizer application and spacings in heights and DBHs at both ages either.

The best height (3.26 m) was found out in 2 x 4 m spacing without fertilizer application and the best diameter (2.75 cm) was at the same spacing but with fertilizer application, at 12 months. The best height (6.41 m) and diameter (6.45 cm) at 24 months were observed in 2 x 4 m spacing without fertilizer application and in 2 x 2 m spacing with fertilizer application, respectively.

A. aulacocarpa

Due to the ANOVA analysis, the interaction and significant effects of

fertilizer application and spacings were none at both ages, like *A. auriculae-formis*.

Huai Tha Experimental Station

A. aulacocarpa

According to the ANOVA analysis, none of the interaction and significant effect of fertilizer application and spacings was evident. Only significant difference in spacings on DGL was observed at 24 months ($p < 0.05$).

The best height (2.31 m) and DGL (4.60 cm) were found out in 2 x 4 m spacing with fertilizer application at 12 months. At 24 months, the best height (5.09 m) and DGL (9.00 cm) were observed in 2.15 m spacing with fertilizer application and in 2 x 4 m spacing with fertilizer application, respectively.

A. leptocarpa

Same evidence of *A. aulacocarpa* was happened with *A. leptocarpa* at both ages.

The best height (2.97 m) and DGL (4.55 cm) were found out in 2 x 2 m spacing with fertilizer application at 12 months whereas the best height (5.09 m) and DGL (9.00 cm) occured in 2 x 2 m spacing with fertilizer application and in 2 x 4 m spacing with fertilizer application.

DISCUSSION AND CONCLUSION

Selection of the experimental sites

According to the ANOVA, there was no significant differences in blocks at all sites. This indicated that the experimental sites were properly selected.

Effect of fertilizer application on height and diameter growths

In general, effects of fertilizer application on height and diameter growths at all sites in the experiment at 12 and 24 or 30 months was minimal and not consistent, except at Sai Thong where fertilizer application showed significant effect on height and DBH of *A. auriculaeformis* at 12 months. However, the effect disappeared at 30 months. Usually, acacias should respond well to fertilizer application. *A. mangium* and *A. auriculaeformis* gave large responses to P fertilizer and somtimes K fertilizer in acidic soil (Dart *et al.*, 1991) and on less fertile *Imperata* sites, 120 g of a 1 : 1 mixture of TPS (Triple Superphosphate) and NPK blue (12 : 5 : 14 + TE) was suggested to apply to *A. mangium* plantation to gain diameter growth (Mead and Miller, 1991). The main reasons why the species test gave less response to the fertilizer applied may be due to the results at Sai Thong with *A. auriculaeformis* at 12 and 30 months, attributed to low amount of the fertilizer and only one application at first year. It is likely that in this experiment the fertilizer applied was not adequate to promote growth perfor-

mances of the acacias tested. Loss of the fertilizer applied by a low soil pH, leaching and consumption by weeds or grasses may involve in the fertilizer inadequacy. It is expected that yearly fertilizer application could extedn thd significant effect in successive years to some extent.

Effect of spacings on height and diameter growths

Results of the experiments revealed that spacings had no significant effect on height and diameter growths at 12 months at all sites and in all species. This evidence was that the trees were still small and had no competition in growths. However, spacings started showing significnat effect at 24 or 30 months, especially with species of larger diameters such as *A. auriculaeformis* and *A. crassicarpa* at Sai Thong and *A. aulacocarpa* and *A. leptocarpa* at Huai Tha. It is expected that the above significant effect in spacings will continue in successive years. There was no significant effect in spacings occurring at Sakaerat since diameter growth of the tree was still small in comparison with those of other sites.

Interaction between fertilizer application and spacings

According to the ANOVA, there was no interaction between ferilizer application and spacings at all sites and ages. The evidence was pertinent to the expectation when the experiments had been statistically designed and the split plot techniques were employed.

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