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Variation in Growth Traits and Survival of Acacia Mearnsii Provenances in Bako, Western Oromia Regional State, Ethiopia

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Abstract
An experimental study was carried out at Bako Agricultural research Center, Western, Oromia Regional state, Ethiopia. The purpose of the study was to evaluate the variation existing in different twelves (12) provenances of *Acacia mearnsii* and then to select the best seed sources/ provenance that suits with Bako site conditions. The twelve provenances of *Acacia mearnsii* namely George Town, Tasmania, N of Bemboka, New South Wales, Bawley PT, New South Wales, Tantanoola, South Australia, East Lorne, Victoria, Wonboyn Lake, New South Wales, You Yangs, Victoria, N Bungendore, New South Wales, Mt. Gladstone, New South Wales, (R)B'hill Res Kyneton, Victoria, Bodalla, New South Wales and Gloucester, New South Wales obtained from Australian used in the study. The saplings were monitored for survival rates and growth performances by measuring root collar diameters and heights. There was non-significant difference in survival among the species investigated (P>0.05). Survival percent were varies from 87.96 to 100, across the species provenance, but at the end of the experimental study (62 months after planting) the survival varied significantly (p<0.001). Non-Significant differences in height growth (P>0.05) and diameter growth were also observed. Among tree provenance greatest height (8.13 m) was recorded for the Wonboyn Lake, New South Wales (17934) followed by the N of Bemboka, New South Wales (16635) and root collar diameter (RCD) (3.01 cm) were recorded (R)B'hill Res Kyneton, Victoria (18979) followed by the Gloucester, New South Wales (18626). Lowest height (6.90 m) was recorded for (R)B'hill Res Kyneton, Victoria (18979) and root collar diameter (RCD) (2.25 cm) was recorded for Wonboyn Lake, New South Wales (17934) provenance. Statistical analysis showed that there were non-significant (p>0.05) differences in mean diameter at different age of after planting of between provenances. The provenance of Tantanoola, South Australia (17927) performed highly in diameter at breast height (DBH) (8.09 cm) followed by Nof Bemboka, New South Wales (16635) and N Bungendore, New South Wales (18975). We recommend for the due to its superior growth and survival with the following provenance Tantanoola, South Australia (17927), N of Bemboka, New South Wales (16635) and N Bungendore, New South Wales (18975) are recommended for Bako area and other localities with similar agro-ecology.
Keywords: provenances; Acacia mearnsii; Survival percent; growth performances; root collar diameter; diameter at breast height

INTRODUCTION

Multipurpose trees do have enormous potential for alleviating many of the severe agricultural problems (such as land degradation, growing shortages of wood for fuel and timber, scarcity of dry season animal fodder, etc.) that beset different nations of the world today. This calls for the urgency of increasing tree planting of the right species at the right place for the right purpose. Because wood products from these plantations can compensate for the reduced supply from the disappearing natural forest.

A. mearnsii, commonly known as black wattle, is one of such important multipurpose tree of Australian origin having a wide range of adaptation, and now introduced elsewhere. In Ethiopia, it performs well in different agro-ecological zones (Azene, 1993; Hedberg and Edwards, 1989). *A. mearnsii* is a fast growing , nitrogen fixing tree species adapted to a wide range of sites from the temperate and subtropical lowlands to tropical highlands (Doran and Turnbull, 1997), and the best candidate for woodlot and boundary planting (Azene, 1993). It is a large shrub or small tree, typically in the height range of 6-10 m but at times reaching 20 m. Open grown specimens are freely branched from near ground level and with a crooked main stem. In forest stands the stem is usually straighter and may be dominant (Doran and Turnbull, 1997). Black wattle is the most important sources of commercial tannins used in treating hides and skins. The use of *A. mearnsii* tannin in waterproof wood adhesives for the production of reconstituted wood is expanding. In addition, this species is useful for firewood, charcoal, poles, bee forage, soil conservation/biological nitrogen fixation, ornamental and wind break. (Doran and Turnbull, 1997; Fichtl and Admasu, 1994; Azene, 1993; Hedberg and Edwards, 1989).

Generally, different trees respond differently to different environments (Rocheleau *et al,* 1988). Because every tree species has its own range of biotic and abiotic factors in which it performs with its maximum capacity (FAO, 1974; Evans, 1992), and different sites may also have different qualities. Thus, whenever one plans to plant a tree species in any form, he has to match the species with the site condition. From ten different tree species included in the screening trial at Bako, *Acacia mearnsii* De Wild (1925) was the most vigorous in height growth and root collar diameter showing promising performance under Bako site conditions (Abebe *et al*, 2000).

But choosing the right species is not an end in itself. After selecting a species for planting purpose, it is equally important to select the best provenance (Albrecht, 1993) in order to exploit the diversity that could exist within that species.

Many trees grow naturally over a range of sites and locations, and are widely distributed. This wide separation and often isolation of stands may have led to genetically different populations within one species, and these different provenances often perform differently when tested together on one site. The differences between provenances of the same species may differ only in their ability to adapt specific environmental conditions.

Provenance is important consideration because most trees exhibit considerable intra-specific genetic variation, and, therefore, it is essential to get the best provenance for your particular planting purpose (Jaenicke, 1999). Therefore, this study was initiated to exploit the genetic diversity that could exist within this important species and select the best performing provenance before launching a large scale plantation or introducing the species into the farming system. Thus the objective of this study was to evaluate the variation existing in different provenances of *Acacia mearnsii* and then to select the best seed sources/ provenance that suits with Bako site conditions.

MATERIALS AND METHODS

Description of the study area

The trial was conducted at Bako Agricultural Research Center 9^{o}07' N latitude and 37^{o}05' E longitude (Figure 1). The area is mid-altitude, sub-humid tropical climate with unimodal rainfall pattern (Figure 2), experiencing an average annual rainfall of 1270 mm and an average annual temperature of 20^{o}C (maximum - 27^{o}C and minimum - 13^{o}C). The altitude at the Bako Meteorological station is about 1650 m above sea level. The soil is dominantly reddish brown Nitosol, with a pH of 5-6, and clay dominated in texture (Legesse *et al*, 1987).

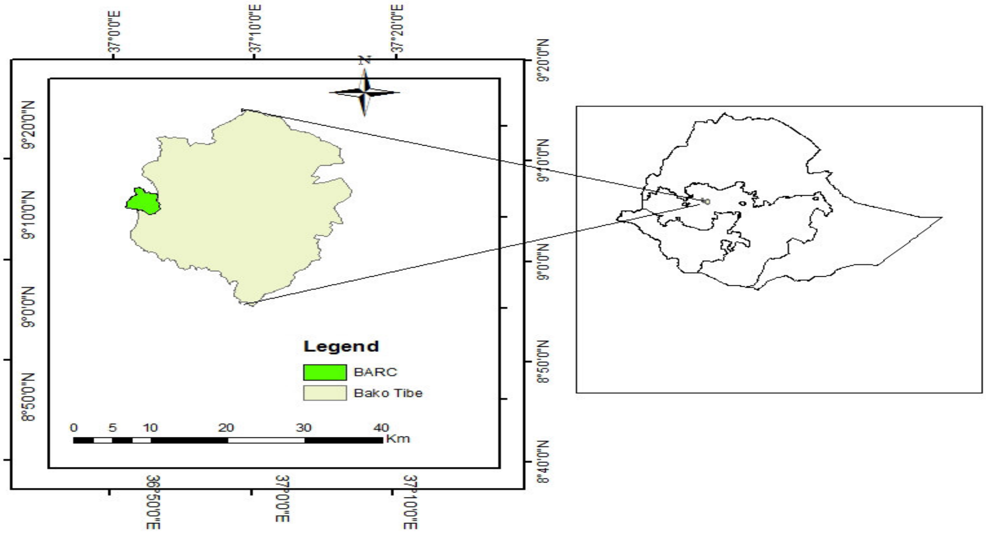

Figure 1.**Location of the study area.**

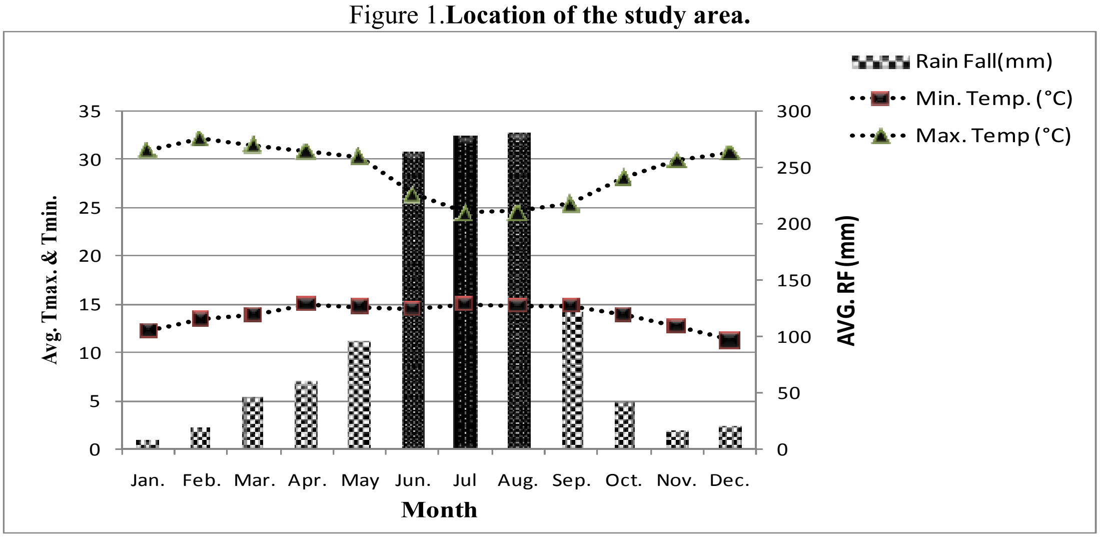

Figure 2:-**Mean monthly rainfall (RF), maximum and minimum temperature (Temp.) of the study area during the five years trial period (2002-2007)**

Experimental design, data collection and analysis

Seedlings were raised in Bako tree nursery, and were planted in a randomized complete block design (RCBD), (two replications with a total of 49 trees per plot at 1 m x 1m spacing). The spacing between plots and blocks was 2 and 4 m, respectively. Survival counts were conducted 7, 10 and 62 months after planting while root collar diameter (RCD) and height of the inner plants were measured five years after planting. Growth and survival data from each trial were subjected to analysis of variance and Tukey's Honestly Significant Difference (HSD) Test was used to compare means of treatments tests to enable comparisons of tree species provenance using SAS V9.0.

Ten different provenances of *A. mearnsii* and 2 provenances of *A. irrorata ssp*. i*rrorata* were obtained from Australian Tree Seed Centre will be used.

Table 1. **Details of the Acacia seed source used for the study.**

Provenance code	Number of parent trees	Locality	Latitude	Longitude	Altitude, m
15326	18	George Town, Tasmania	41° 07'	146° 52'	60
16635	14	N of Bemboka, New South Wales	36° 32'	149° 35'	300
16974	8	Bawley PT, New South Wales	35° 31'	150° 24'	20
17927	30	Tantanoola, South Australia	37° 41'	140° 28'	30
17930	15	East Lorne, Victoria	38° 28'	144° 02'	70
17934	7	Wonboyn Lake, New South Wales	37° 17'	149 ° 54'	30
18256	245	You Yangs, Victoria	37° 57'	144° 25'	100
18975	50	N Bungendore, New South Wales	35° 11'	149° 32'	760
18977	70	Mt. Gladstone, New South Wales	36° 15'	149° 05'	1000
18979	18	(R)B'hill Res Kyneton, Victoria	37° 12'	144° 29'	520
18619	8	Bodalla, New South Wales	36° 08'	150° 02'	20
18626	20	Gloucester, New South Wales	31° 59'	151° 47'	650

RESULT AND DISCUSSION

Survival, RCD, Height, and Diameter at breast height (DBH) of *Acacia mearnsii* provenances.

Survival, diameter and tree height are important indicators of adaptability and performance evaluation in the evaluation of species and provenances (Ræbild 2002). Although the primary purpose of provenance evaluation was the early performance of provenances in terms of survival, root collar diameter and height were evaluated to select the best performing provenance for the establishment of plantations in the Bako, western Oromia.

Survivals

Survival 7 and 10 months after planting ranged from 87.96%–100%, the lowest survival was for the Tantanoola, South Australia (17927) provenance and the highest for Gloucester, New South Wales (18626) provenance (Fig. 3), But at the end of the experimental study (62 months after planting) the survival varied significantly (p<.001) between provenances (Table 4). This could be explained by the genetic and environmental variability of the species (Ross 1979).

Table 2. **ANOVA of Survivals of provenances of Acacia mearnsii.**

Provenance code	Survival %		
	at 7 months	at 10 months	at 62 months
15326	98.00a	93.87a	76.00ab
16635	98.00a	96.94a	90.00a
16974	100.00a	98.98a	94.00a
17927	88.00a	87.96a	74.00ab
17930	96.00a	92.90a	74.00ab
17934	100.00a	98.98a	94.00a
18256	98.00a	93.87a	92.00a
18975	98.00a	94.89a	80.00ab
18977	98.00a	96.93a	84.00a
18979	100.00a	98.98a	90.00a
18619	98.00a	98.00a	62.00b
18626	100.00a	100a	92.00a
P-value	0.314	0.292	<.001

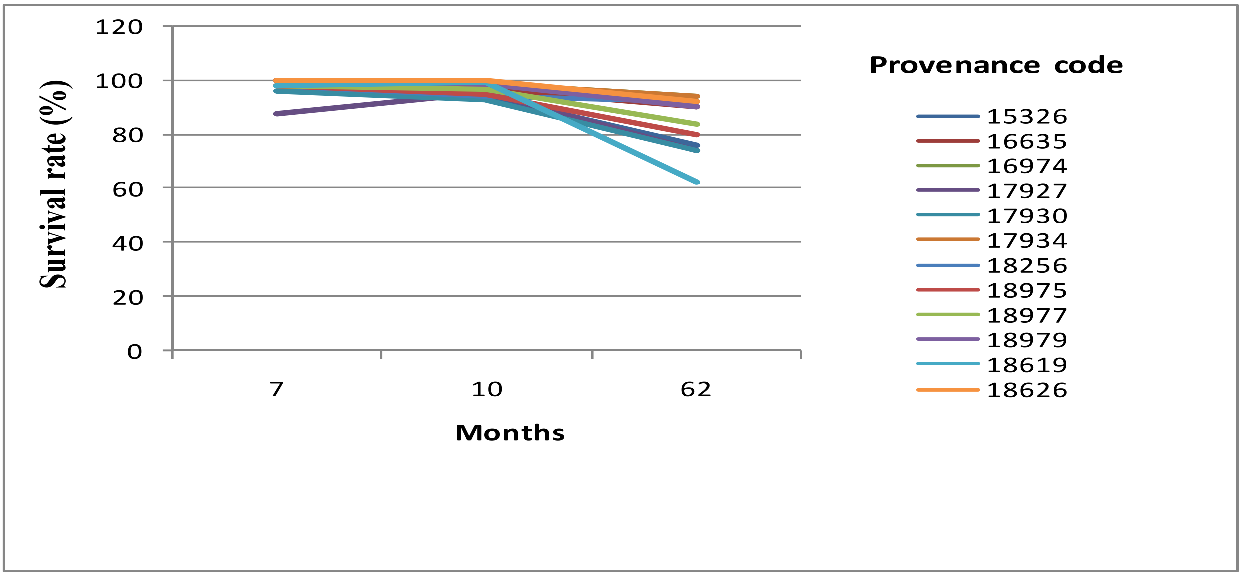

Figure 3: **Survival (%) trends of those planted Acacia mearnsii provenances.**

Height and root collar diameter (RCD)

Tree heights and root collar diameters were highly variable among the provenances tested. Non -significant differences were observed between provenances in tree height (p>0.05) (Table 5) and root collar diameter (p>0.05) (Table 6). Greatest height (8.13 m) was recorded for the Wonboyn Lake, New South Wales (17934) followed by the N of Bemboka, New South Wales (16635) and RCD (3.01 cm) were recorded (R)B'hill Res Kyneton, Victoria (18979) followed by the Gloucester, New South Wales (18626). Lowest height (6.90 m) was recorded for (R)B'hill Res Kyneton, Victoria (18979) and RCD (2.25 cm) was recorded for Wonboyn Lake, New South Wales (17934) provenance (Table 6). The height and diameter growth of the species at the trial site indicate its suitability for small and large scale plantation.

Table 3. **ANOVA of Height of provenances of Acacia mearnsii.**

Provenance	Height (m)					
	at 1 month	at 3 months	at 6 months	at 10 months	at 25 months	at 32 months
15326	0.58a	0.89b	1.32bcd	2.34a	6.05a	7.40a
16635	0.66a	1.16ab	1.94a	2.18a	6.87a	8.03a
16974	0.60a	1.09ab	1.45abcd	2.16a	6.18a	7.20a
17927	0.57a	1.05ab	1.70abcd	2.37a	6.32a	7.80a
17930	0.67a	1.06ab	1.63abcd	2.15a	6.23a	7.27a
17934	0.66a	1.11ab	1.6abcd1	1.91a	6.44a	8.13a
18256	0.63a	0.90b	1.22d	2.25a	5.67a	7.00a
18975	0.74a	1.24a	1.87ab	2.16a	6.27a	7.63a
18977	0.59a	1.06ab	1.58abcd	2.24a	6.00a	7.73a
18979	0.71a	1.22a	1.80abc	2.60a	6.16a	6.90a
18619	0.69a	1.16ab	1.51abcd	2.63a	6.63a	7.80a
18626	0.61a	0.98ab	1.28cd	2.59a	5.99a	7.49a
P-value	0.766	0.014	0.005	0.800	0.949	0.643

Table 4. **ANOVA of root collar diameter (RCD) of provenances of Acacia mearnsii.**

Provenance	RCD (cm)			
	at 1 month	at 3 months	at 6 months	at 10 months
15326	0.56a	1.22abc	1.73b	2.65a
16635	0.62a	1.59ab	2.50a	2.51a
16974	0.62a	1.41abc	1.89ab	2.56a
17927	0.64a	1.48abc	2.40ab	2.73a
17930	0.60a	1.45abc	2.16ab	2.73a
17934	0.61a	1.36abc	2.04ab	2.25a
18256	0.59a	1.20bc	1.78ab	2.54a
18975	0.61a	1.60a	2.33ab	2.50a
18977	0.53a	1.33abc	1.98ab	2.49a
18979	0.74a	1.42abc	2.16ab	3.01a
18619	0.75a	1.21abc	1.8ab3	2.61a
18626	0.57a	1.13c	1.77ab	2.97a
P-value	0.626	0.006	0.014	0.803

Diameter at breast height (DBH) of *Acacia mearnsii* provenances

Statistical analysis showed that there were non-significant (p>0.05) differences in mean diameter at different age of after planting of between provenances (Table 5). The provenance of Tantanoola, South Australia (17927) performed highly in DBH (8.09 cm) followed by Nof Bemboka, New South Wales (16635) and N Bungendore, New South Wales (18975). (Table 5)

Table 5. **ANOVA of diameter at breast height (DBH) of provenances of *Acacia mearnsii.***

Provenance	DBH (cm)				
	at 25 months	at 32 months	at 42 months	at 57 months	at 62 months
15326	3.68a	4.32a	4.63a	5.15a	5.38b
16635	4.63a	5.06a	6.19a	7.05a	7.80ab
16974	3.56a	4.13a	6.20a	5.70a	6.50ab
17927	4.40a	4.83a	6.29a	7.45a	8.09a
17930	4.21a	4.85a	5.69a	6.50a	7.00ab
17934	3.85a	4.49a	5.48a	6.50a	7.09ab
18256	3.66a	4.22a	4.83a	5.45a	6.48ab
18975	4.17a	4.81a	6.13a	6.95a	7.42ab
18977	3.82a	4.17a	5.43a	6.00a	6.50ab
18979	4.03a	4.24a	5.40a	6.15a	6.98ab
18619	4.47a	5.20a	6.25a	6.40a	7.34ab
18626	3.31a	3.84a	4.92a	5.70a	6.62ab
P-value	0.557	0.057	0.074	0.123	0.080

CONCLUSIONS AND RECOMMENDATION

Evaluation of 12 provenances of *A. mearnsii* has been going on at Bako Agricultural Research Center since July 2002. Data on growth and survival has been collected to assess the difference in the adaptability of the various provenances to Bako site condition. Results of the analysis of variance showed that there is no significant difference in height and diameter growth of the different provenances at various ages. Besides, the survival percentage which is the measure of early adaptability did not vary significantly among the various provenances. Accordingly, based on the diameter at breast height after 62 months after establishment and height after 32 months planting, *A. mearnsii* with the following provenance Tantanoola, South Australia (17927), N of Bemboka, New South Wales (16635) and N Bungendore, New South Wales (18975) are recommended for Bako area and other localities with similar agro-ecology.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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