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Effect of Some Seed Pretreatments on Emergence of *Acacia senegal* (L.)

[1]*Saikou E. Sanyang,* [2]*B.H. Kabura and* [3]*Wen-Chi Huang*

[1]Department of Tropical Agriculture and International Cooperation,
National Pingtung University of Science and Technology, Taiwan 912
[2]Department of Crop Science, Faculty of Agriculture, University of Maiduguri, Nigeria
[3]Graduate Institute of Agribusiness Management, National Pingtung University of Science and Technology

Abstract: An experiment was carried out to study the effect of some seed pre-treatments on emergence of *Acacia senegal* (L). The pre-treatments were water at ambient temperature and simmering hot water. The seeds were subjected to the various pre-treatments for 5, 10, 20, 40, 80, 160, 320 and 640 minutes. The treatments were arranged in a Randomized Complete Block Design (RCBD), replicated three times. Seeds pre-treated with hot water for 10 minutes had the shortest time to germinate (6 days after sowing); shortest time to 50% emergence (7 days after sowing) and the shortest time to last observed emergence (11 days after sowing). Seeds pre-treated with hot water for 10 minutes also produced the highest percentage emergence of 71%. Based on the results of this study, pre-treatment of *Acacia senegal* seeds with hot water for 10 minutes before sowing in the nursery is encouraged.

Key words: *Acacia senegal* · nursery · seed pre-treatment · seed emergence

INTRODUCTION

Arabic gum is the dried exudates obtained from the stems and branches of *Acacia senegal* (L.) or related species [1, 2]. It is a natural gum harvested from the exterior of *Acacia* trees in the form of dry, hard nodules up to 50 mm in diameter and ranging from almost colorless to brown, internationally traded Arabic gum comes from *Acacia senegal.* The term Arabic gum or gum acacia cannot be taken as implying a particular botanical source. In some cases, the so-called Arabic gum may not even have been collected from *Acacia* spp, but might have originated from Combretum, Albezia or other genera [3]. Thus, in Nigeria, Arabic gum is classified into grade 1 (*Acacia senegal*), grade 2 *(Acacia seyal)* and grade 3 (Combretum and other sources). In Zimbabwe, Arabic gum is derived from *A. karroo* [1]. Although there are over 1,100 *Acacia* species worldwide, *Acacia senegal* and A. seyal remain the most commercially exploited species. The Arabic gum-yielding acacias grow in semi-arid areas. The vast majority of Arabic gum entering international trade originates from the gum belt of sub-Saharan Africa, extending from the Northern parts of West Africa eastwards, to Sudan and Ethiopia. [4]. Arabic gum is widely found in the Sahelian and Sudano zones of Africa altitude 11°30 north and above. It is wide spread in the dry savannas of the tropical Africa and extends to the Red Sea and eastern India. It is a spiny tree five to six meters tall with a flagrant creamy white flowers-borne in spikes 5-10cm long. Arabic gum is mainly obtained from wild and semi-cultivated trees in Sudan where it grows in areas with a rainfall as low as 100-150mm per annum [5, 6].

The distribution of *Acacia* in Borno State and other northern fringes of the country are basically influenced by the edaphically and environmental factors in addition to their characteristic for survival under adverse environments. It is therefore important to consider the extent of drought in the environment before embarking on large scale production especially when the objective is for Arabic gum production [7]. A distinct short seasonal rainfall 3-4 months and a prolonged dry season of 8-9 months yield greater exudates. Areas with prolonged rainfall are unsuitable because gum tapping is best done during the dry season [8].

In Borno State the most common method of breaking the dormancy of Arabic gum seed is by use of hot water pre-treatment kept in containers or in pots [7]. Use of ambient water for seed pre-treatment has not been reported in Borno State. The seed coat of Arabic gum is hard which causes poor and delay emergency unless pre-

Corresponding Author: Dr. Saikou E. Sanyang, Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Taiwan 912

treatment takes place. Therefore, the objectives of this study were to evaluate the effect of different seed pre-treatments on emergence of Arabic gum seeds and to make comparison between the pre-treatments in order to provide the best Arabic gum seed pre-treatment for farmers.

Production: Arabic gum is the main product. *A. senegal* produces some 90 % of the gum sold in the world market. Annual world commercial production varies from 20,000 to 60, 000 tons per annum, averaging 40,000, of which 80 % of the world trade comes from the Republic of Sudan, particularly in the Kordofan province; but this has decreased and other countries are developing their own production, as it is free market system [19]. Production varies widely and the average may be of the order of 100 g per tree and up to 250 g / tree / annum in the best managed orchards of Kordofan.

Description: Bush or small tree usually 2-6m tall occasionally reaching 10m under optimal condition frequently forming thicket. It has a short stem, usually low branches with many upright twigs, the crown eventually flattened, umbrella-shaped. Bark pale brown to pale grey, smooth in young individuals, brown scaly on the older parts, slash mottled red and white, prickles up to 0.5 cm long, the centre one sharply curved, the other two more or less straight and directed forward [10, 11]. Arabic gum has small bi-pinnate leaves, greenish-grey, with 3-6 pairs of pinnulae having 10-20 pairs of leaflets each. Leaflets grey-green, 3-8 x 1-2 mm. Flowers very fragrant, creamy white (red in bud), usually appearing before the leaves in pedunculate spikes 3-10 cm long either solitary or 2-3 together. Pods 7-10 cm long x 2 cm wide, flat and thin, papery, attenuated at both ends, containing 3-6 flat, round, light-brown to brown-greenish seeds. Both tap roots and lateral roots are very developed; the latter may spread many meters from the tree, particularly in sandy terrain. The tree is deciduous; litter its leaves in the month of November in the Republic of Sudan [12, 13].

Economic value Arabic gum: Arabic gum is used extensively in pharmaceutical preparations, inks, pottery pigments, water colors, wax polishes and liquid gum. It is used for dressing fabrics, giving luster to silk and crepe. It is used for thickening colors and mordant in calico-printing [14, 15].

Confectionery: Arabic gum has been used widely in the confectionery industry, where in most cases it has two important functions: (a) to retard sugar crystallization and (b) to emulsify the fat and keep it evenly distributed through out the product. For prevention of sugar crystallization, Arabic gum finds its greatest application in confections such as jujubes and pastilles in which sugar content is high and moisture is low. With these products, the technique of incorporating the flavors is extremely important. Usually, the Arabic gum is dissolved in water and the solution is filtered, mixed with sugar and boiled. The flavor is added with a minimum of stirring to prevent formation of bubbles or opaque spots. The second function, as a fat emulsifier, is essential in keeping fat distributed uniformly throughout an utilizable, greasy film. This property makes Arabic gum extremely useful as an emulsifying agent in caramels and toffees. It is therefore used as emulsifier in caramels and toffees, flavors [16].

Flavors: The emulsification properties of Arabic gum are utilized in various liquid flavor emulsions. Many citrus oils and other beverage flavor emulsions utilize the emulsification properties of the gum. When used as a flavor fixative, the superior film forming ability of the Arabic gum makes it ideal for protecting the flavor from oxidation, evaporation and absorption of moisture from the air [17]. It is equally used as a foam stabilizer and agent to promote cohesion of foam to glass.

Pharmaceuticals: Arabic gum suspending and stabilizing properties are use to suspend insoluble drugs and to prevent the precipitation of heavy metals. Its emulsifying property is used for calamine, magnesia and kaolin liquid petrolatum and cod liver emulsions. Many cough drops and syrups utilize Arabic gum because of its demulcent of soothing characteristics. Arabic gum is used as an adhesive and binder for pharmaceutical tablets as well as in their coating [18].

Bakery: Arabic gum is widely used in the baking industry for its low water absorption properties. It is cold water soluble and has impressive adhesive properties for use in glazes and toppings. The ability of the gum to stabilize foam is used in the manufacturing of drinks. The gum is also used to clarify wine and fix tanning that is use for making beverages [1-19].

Ink/industrial application: Arabic gum is an important constituent of many special purpose inks. Water color and quick drying inks utilize the suspending and binding properties of Arabic gum. Arabic gum is

also used by tannery and textile industries. The textile industries use the gum in fabric sizing and stiffening, as a binder for textile printing, in laundry as water proofing emulsions, starches, as thickening agent for silk and acetate rayon printing. In paper industries, it is used in the production of high quality paper with glossy appearance. It is also used in the plastic industry as stabilizer in polymeric emulsion and polymerizations. Other uses include manufacture of paints, adhesives, carbon paper, pottery glazes, matches, fireworks and insecticide [10, 11].

Environmental protection and soil improvement:

- The plant fixes nitrogen into the soil
- It reduces desertification
- It enhances soil moisture conservation
- It reduces soil erosion

Any meaningful a forestation program of Sudan and Sahel (semiarid) zones should prominently feature the use of Arabic gum plant in view of *its numerous advantages* [7].

Arabic gum plant as fodder: Gum Arabic plant has very palatable leaves that are readily consumed by livestock-goat, sheep, cattle and even chickens when the leaves are young and tender. Herdsmen who perhaps, do not know about the values of Arabic gum plant usually cut down the plants for their livestock to browse. This act has contributed immensely in reducing the population of Arabic gum [20]. The Gum Arabic gum tree has lots of economic potentials or diverse functions when properly harnessed can go a long way in the socio-economic development of farmers. In terms of sustainable agricultural development programs it can also serve as environmental protection, soil conservation and mitigating drought and desertification prone regions.

MATERIALS AND METHODS

Experimental site: The site selected was suitable for nursery bed preparation with adequate water supply, protected from animals and direct supply of sunshine. The nursery was well located under the shade of eucalyptus tree with easy access to routine monitoring and evaluation. The experiment was conducted from January 14th to February 28th, 2002 during the dry season at the Faculty of Agriculture, behind the Agro-vet library, University of Maiduguri. During the experiment the average temperature ranges from 20-25°C and the relatively humidity was 10%. The materials used for the experiment were seeds obtained from Borno State Agricultural Development program (BOSADP), Maiduguri, polythene bags, beaker 500ml, soil mixture 2:1 ratio, electric kettle and watering can.

Experimental design and layout: There were two types of seed pre-treatments on *Acacia senegal* (L) and a control (no pre-treatment). These were (i) water at ambient temperature and (ii) simmering hot water.

Water at ambient temperature: In this treatment a sample of 60 seeds were selected and poured into 500ml beaker containing water (leaving about 3cm space to the brim of the beaker) at ambient temperature and kept for 5, 10, 20, 40, 80, 160, 320 and 640 minutes after which the seeds were removed basing on time allocation. For water treatments at ambient temperature the experiment was set at 11.55am and seeds were removed from the ambient water at 12.00, 12.05, 12:15, 12:35, 1:15, 2:35, 5:15 and 10:35 pm to achieve the respective pre-treatments of 5, 10, 20, 40, 80, 160, 320 and 640 minutes, respectively.

Hot water treatment: For the water treatment same sample of 60 seeds were also selected and poured into a plastic bowl containing 5 liters of water at boiling point to simmering. For the hot water treatment, the experiment was set at 12:05pm and seed were removed from the simmering hot water at 12:10, 12:15, 12:25, 12:45, 1:25, 2:45, 5:25 and 10:45pm to achieve seed pre-treatment time of 5, 10, 20, 40, 80, 160, 320 and 640 minutes,respectively. The seeds were picked out of the container based on their time allocation and sown in a drill of soil mixture (inside poly bags) of 3 cm length at a depth of 1cm after the respective pre-treatments. Two seeds were sown per poly bag, giving a total of 20 seeds per row per treatment and there were 10 poly bags in each treatment.

Irrigation: This is the adequate supply of water to the young seedlings at the right time and frequency. The supply of adequate water was essential and important because the experiment was conducted in the dry season. Arabic gum seeds may not need any irrigation process in the rainy season due to high moisture content of the soil. Prior to the sowing operation the poly bags were fully watered in order to keep the moisture content of the soil. The seedlings were supplied with water on a daily basis for a period of one month.

Weed control: Weed control was carried out by hand pulling throughout the period of the experiment so that the seedlings could be free from weeds, as weeds compete with plants for air, light, nutrients, space and water. Arabic gum is very sensitive to weeds, particularly at the early stages after transplanting. Therefore necessary to ensure timely weeding so that vigor and growth of the young plants would be not inhibited.

Test parameters: The experiment was based on two parameters and includes: (i) time to first observed emergence (in days) from the time of sowing. The seeds that emerged from the rows of the treatment were considered as the first to observed germination time for that treatment, (ii) time to 50% emergence (in days); this refers to the time when up to 50% of the seeds sown in a treatment (row) emerged (iii) percentage of seed emergence with time (in days); this refers to the percentage emergence attained with progress of time from sowing in each treatment., (iv) time to last emergence (in days); this refers to the time seed emergence. The figures obtained were added and divided by 3 to have the mean of the time to first emergence, time to 50% emergence, percentage seed emergence with time and last emergence (in days). This process was done through close monitoring both mornings and evenings during the time of the experiment.

RESULTS

Time to first observed emergence: Seeds pre-treated with water at ambient temperature for 160 to 640 minutes starts to emerged 7 days after sowing while for seeds without any pre-treatment and seeds received 5-20 minutes of ambient water took 9 days to start emergence (Table 1). However, the seeds pre-treated or soaked for a longer period of time absorbed more water to break the seed dormancy for imbibitions to take place at a faster rate. For seeds with 160 to 640 minutes emerged 7 days after sowing than seeds with 5-20minutes treatments.

Seeds that received hot water for 10 minutes started to show emergence 6 days after sowing while seeds pre-treated with hot water for 20-80 minutes took 7 days to start emergence. The seeds treated with hot water for ten minutes emerged 6 days after sowing because the hot water makes the imbibition's to occur quickly (Table 1).

Generally, seeds pre-treated with hot water for 10 minutes emerged as the fastest that is, it took 6 days to start emergence; followed by 20, 40 and 80 minutes for hot water pre-treated seeds and seeds pre-treated with water at ambient temperature for 160-640 minutes. For treatment in water at ambient temperature, seeds pre-treated for 40-80 minutes followed by hot water pre-treatment at 160-320 minutes' took 8 days for seed emergence to take place after sowing (Table 1). Seeds pre-treated with water at ambient temperature for 8 to 20 minutes or with hot water for 5 and 640 minutes and no pre-treatment (control) started to emerge 9 days after sowing.

Table 1: Effect of some pre-treatments on seed emergence of *Acacia senegal* (L)

Type of seed pre-treatments	Average time to first observed emergence (DAS)	Average time to 50% emergence (DAS)	Average time to last emergence (DAS)
Control	9	17	20
Water at ambient			
temp. 5mins	9	15	17
"10mins	9	13	16
"20mins	9	14	15
"40mins	8	13	16
"80mins	8	12	15
"160mins	7	12	14
"320mins	7	12	15
"640mins	7	12	14
Hot water			
5mins	9	12	14
"10mins	6	7	11
"20mins	7	8	10
"40mins	7	9	11
"80mins	7	8	11
"160mins	8	12	14
"320mins	8	13	16
"640mins	9	14	17

Time to 50% emergence: Water at ambient temperature, seeds pre-treated for 80 to 640 minutes scored 50% by 12 days after sowing and seeds pre-treated for 10 and 40 minutes attained 50% emergence 13 days after sowing; but seeds without any pre-treatment (control) took 17 days to attained 50% emergence (Table 1). For hot water, seeds pre-treated for 10 minutes scored 50% seed emergence by 7 days after sowing while seeds pre-treated for 20 and 80 minutes took 8 days to attained 50% emergence. Seeds pre-treated with hot water for 80 minutes took 11 days to attained 50% emergence while for control treatment took 17 days to attain 50% emergence (Table 1). In general seeds pre-treated with hot water for 10 minutes were the first to attain 50% emergence, followed by 20, 40 and 80 minutes hot water pre-treated seeds.

Table 2: Percentage seed emergence with time (in days)

Type of seed	Days after sowing														
pre-treatments	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Control	0	0	0	15.0	20.3	24.6	28.0	32.3	36.6	38.8	34.0	51.0	54.0	56.7	58.3
Water at ambient	0	0	0	20.0	26.0	30.0	33.0	36.2	44.5	53.0	53.0	54.1			
Temperature 5mins															
" 10mins	0	0	0	22.1	28.4	36.7	45.0	54.2	55.0	57.0	59.1				
" 20mins	0	0	0	25.1	35.4	45.2	49.2	49.2	52.0	54.2					
" 40mins	0	0	23.2	28.0	32.1	38.1	45.0	51.2	53.1	55.0	58.9				
" 80mins	0	0	26.1	35.0	43.0	48.0	53.2	54.0	57.0	60.1					
" 160mins	0	30.0	35.1	38.1	43.8	48.0	50.0	53.0	53.0						
" 320mins	0	35.0	42.1	46.4	48.1	49.0	52.0	54.1	55.0	58.4					
" 640mins	0	37.1	40.1	45.0	45.0	47.0	49.1	53.0	55.0	59.2					
Hot water 5mins	0	0	0	44.0	47.0	49.1	51.0	54.2	57.2						
" 10mins	48.7	57.0	59.3	64.8	68.5	71.0									
" 20mins	0	46.5	54.1	57.2	64.0										
" 40mins	0	44.1	48.1	52.1	55.0	60.2									
" 80mins	0	45.5	51.2	55.4	55.2	58.3									
" 160mins	0	0	25.6	33.3	40.0	47.0	51.0	52.4	56.1						
" 320mins	0	0	24.0	30.0	36.0	42.7	47.1	53.0	55.1	58.2	60.0				
" 640mins	0	0	0	26.0	32.0	38.1	45.0	48.0	53.0	57.0	59.3	62.5			

Time to last observed emergence: For water at ambient temperature, seeds pre-treated at 160 and 640 minutes attained their last emergence 14 days after sowing. Seeds pre-treated at 20 and 80 minutes attained their last emergence 15 days after sowing while for seeds with no pre-treatment attained last emergence 20 days after sowing (Table 1). Hot water seeds pre-treated at 20 minutes took 10 days to last emergence while seeds pre-treated at 10, 40 and 80 minutes took 11 days to last emergence (Table 1).

In general, hot water seeds pre-treated at 20 minutes attained last emergence 10 days after sowing followed by seeds pre-treated with hot water for 10, 40 and 80 minutes which attained last emergence 11 days after sowing.

Final percentage emergence with time: Seeds pre-treated for 5 minutes with water at ambient temperature had 20.0% at the time it was first observed and attained a maximum of 54% emergence throughout the period of the experiment. Seeds pre-treated for 80 minutes with water at ambient temperature had 25.1% at the start of observation and attained maximum emergence of 60.1% throughout the period of the experiment.

Seeds that received no pre-treatment had 15.0% at the start of emergence produced maximum germination of 58.3% throughout the period of the experiment (Table 2). Seeds that received hot water pre-treated for 10 minutes attained emergence of 48.7% at the beginning of emergence and attained highest percentage emergence of 71.0 at the end of the experiment. Seeds pre-treated for 20 minutes with hot water had 46.5% at the start of emergence and scored 64.0% germination towards the end of the experiment. Seeds pre-treated for 640 minutes with hot water had 26% and registered maximum percentage of 62.5% (Table 2).

DISCUSSION

A successful field emergence is vital for crop production from seeds and maximum yields are often very dependent on successful establishment of the optimum plant population. Uniform emergence in time, of seedlings in the field is also important for crop uniformity [5, 7]. *Acacia senegal* seed takes a long period of time to finish emergence due to the problem of seed dormancy [1]. This is evident from the results of the present study, seeds that were not given treatment took longer time to start emergence; and the period was up to 20 days after sowing to finish emergence. In the present study seeds given pre-treatment, particularly simmering hot water for 10 minutes emerged within 6 days after sowing and reached final emergence within 11 days and gave high final percentage emergence 11days after sowing. Such results were also reported [21] where seeds of Arabic gum performed very well when treated with hot water at 80°C for 10-40 minutes.

The positive effect of the seed pre-treatment with hot water for 10 minutes made the seed coat to become adequately softened to absorb enough water for imbibition. Seeds that stayed longer than 10 minutes in simmering hot water might have their embryo weakened. This is evident from the results of the present study where seeds pre-treated with simmering hot water for 640 minutes delayed seed emergence and took long period of time to finish emergence. The final percentage emergence from this treatment was also relatively low. Seeds pre-treated with simmering hot water for 5 minutes did not perform well as the seeds pre-treated with simmering hot water because the period of exposure was relatively short as a result the seed coat were not softened adequately [22]. The treatment of Arabic gum seeds by soaking in water at room temperature for 12-24 hours is often helpful [16]. In a similar experiments [21] stated that the seeds of Arabic gum were often treated with hot water before planting to achieve better emergence. Who also reported that, seeds covered with hot water treatment and left for 12-18 hours gave good emergence. According to Stanton and Young, [9] also indicate that dipping in boiling water made many hard seeds of Arabic gum to be permeable. In general, seeds pre-treated with hot water for 10 minutes gave the highest percentage emergence of 71.0%, followed by seeds treated in hot water for 20 minutes attained 64% emergence.

In conclusion, from the results of the study, essentially *Acacia senegal* seed pre-treatment using simmering hot water for 10 minutes appeared more promising because it started emergence faster, finished emergence faster and gave the highest final percentage emergence.

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REFERENCES

1. Anon 2004. Non-wood forest products for rural income and sustainable forestry-exudates gums 2,. Arabic gum, Gum Talha and other Acacia Gums.
2. FAO 1990. Arabic gum FAO Food and Nutrition. Food and Agriculture Organisation of the United Nations, Rome, 49: 735-737.
3. Barbier, E.B., 2000. The economic linkages between rural poverty and land degradation: some evidence from Africa, Agriculture, Ecosystems and Environment, 82: 355-370.
4. Cossalter, C., 1987. Introducing Australian acacias in dry, tropical Africa. In: Turnball, J.W. (Ed.). pp: 118-122.
5. Okoro, C., 2002. Arabic gum Production and Marketing in Nigeria. The NESG Agricultural Summit, pp: 60-63.
6. Omer, S.A., 1989. Some Aspects of Socio-economic and Environmental Change in Simsim Area. The case of Sudanese-Canadian project.
7. Odo, P.E. and P.E. Oleghe, 1988. The production and management of gum arabic in the Sudan and Sahelian zones of Borno State. Nigeria. Journal of Arid Agriculture, 1: 254-266.
8. Randev, H.S., 1986. Irrigated forest nursery practices Sahel-Sudan and Northern Guinea zones. Savanna Region, Nigeria.
9. Stanton, M. and T. Young, 1999. "Thorny Relationships." Natural History, 108 (9): 28-31.
10. Ayensu, E.S., 1978. Medicinal plants of West Africa. Reference publication. Inc. Algonac, MI, pp: 282.
11. Armstrong, W.P., 1999. "The Unforgettable Acacias." Zoonooz, 71 (8): 28-31.
12. Umalker, C.V., S. Begum and K.M.A. Nehemiah, 1976. Inhibitory effect of *Acacia nilotica* extracts on pectolytic enzyme production by some pathogenic fungi, Indian phytopath publication: 1977, 29 (4): 469-470.
13. Walker, B.H., 1980. A review of browse and its role in livestock production in Southern Africa. In: LeHouerou, H.N. (Ed), Browse in Africa. International livestock center for Africa, Addis Ababa, Ethiopia, pp: 7-24.
14. Fakoya, E.O., D.K. Ojo and O.B Oyesla, 2002. Catergorization of farmers in relation to use of sustainable land management practices in Ondo Sate. ASSET Journal Series A, 2: 29-36.
15. Hazell, P.B.R. and P.D. Norton, 1986. Mathematical Programming for Economic Analysis in Agriculture. Maximilian Publication. New York.

16. Pingali, A.A. and T.K. Biswanger, 1984. Sustainable production systems in arid savanna zones. Journal of Development studies, 45: 58.
17. Spore Magazine. 1990. CTA-Bimonthly report No.25. Technical Centre for Agricultural and Rural Cooperation (CTA Publication).
18. Hagos, M., G. Samuelsson, L. Kenne and B.M. Modawi. 1987. Isolation of smooth muscle relaxing 1, 3-diaryl-propan-2-ol derivatives from *Acacia tortilis*. Planta Medica, 53: 27-31.
19. Ayoub, S.M.H., 1983. Aglicidal properties of *Acacia nilotica*. (I). Fitoterapia, 53 (5): 175-178.
20. Pande, M.B., P.M. Talpada, J.S. Patel and P.C. Shukla, 1981. Note on nutritive value of babul (*Acacia nilotica L.*) seeds (extracted). In: Indian Journal of Animal Science, 51 (1): 107-108.
21. Edwin, H.L., 1992. Man and plants. International Learning Systems Corporation Limited.
22. Tame, T., 1992. Acacias of Southeast Australia. Kangaroo Press, Kenthurst, Australia.