International Journal of Plant Research 2015, 5(5): 97-102
DOI: 10.5923/j.plant.20150505.01

Senna singueana Seed Viability and Root Suckering Capacity in Morogoro, Tanzania

Nduwayezu J. B.[1,2,3]

[1]Sokoine University of Agriculture (SUA), Chuo Kikuu, Morogoro, Tanzania
[2]Institute of Scientific and Technological Research (IRST), Butare, Rwanda
[3]African Forest Forum (AFF), Nairobi, Kenya

Abstract Two studies were carried out during the 1996-1998 period to evaluate the effect of the applied pre-treatments (i.e. soaking seeds in cold water and direct seed sowing without pre-soaking in water) on *Senna singueana* seed germination rate and to assess the suckering capacity of this valuable indigenous shrub (i.e. fertilizer source). Thirteen seed testing dates (after 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 months of seed storage) were involved in this study, and at each date, the number of seeds that germinate daily (i.e. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 days) was recorded and used to estimate the germination rate. Four sets of 100 seedlings raised in 10 cm x 15 cm polythene tubes and root-pruned 3 times (at 4, 5 and 6 months after seed sowing) were involved in the study on suckering ability of *Senna singueana*. The number of root suckers and subsequent survivors (percentage of success) were used to estimate both the root suckering capacity (%) and survival rate (%). *Senna singueana* is a lesser-known indigenous shrub found to be successfully propagating by both seeds and root suckers from young seedlings. The seeds of this species have a maximum germination rate of 80% with a viability period of up to one year but after 3 months it drops rapidly to less than 2% at 12 months of storage. No seed pre-treatment is required for optimum germination. In order to ensure a high germination rate (> 70%) the seeds of *Senna singueana* should not be stored for periods in excess of 3 months. *Senna singueana* seedlings sucker readily (with the survival rate of new root suckers ranging between 78-84%.) and the suckering capacity increases with the plant (root) size (r = 0.7183). The optimum size which maximizes suckering has not, however, been established. Research is urgently required to determine this including the ascertainment of whether suckering potential is confined to the tape roots alone or spread evenly to the lateral roots.

Keywords Senna singueana, Seed germination, Seedling, Pruning, Root suckers, Fertilizer source

1. Introduction

Senna singueana is an indigenous shrub with high agroforestry potentials (i.e. fertilizer source) belonging to the *Caesalpinioideae* sub-family, *Fabaceae* family of the super family *Leguminoseae* [1, 2, 3].

The success of tree planting in agroforestry systems with the intention of improving soil fertility in smallholder farms has largely been attributed to the quality of the planting stock [4]. *Senna singueana* and other agroforestry trees and shrubs can be propagated either sexually (using seeds) or asexually (using vegetative materials). While considerable data are available on seed viability and propagation techniques of different multipurpose trees and shrubs [5], the published information on how to conserve the germplasm of *Senna singueana* is generally lacking. Propagating forest trees and agroforestry species by seeds was reported to be associated with inefficiency of use mainly caused by physical, chemical, morphological/ physiological and mechanical dormancy problems (i.e. difficulties in seed germination) [6-10] and rapid loss of viability [5]. Pre-treating seeds of a number of tree/shrub species with the aim of breaking the seed dormancy using a variety of methods generally enhanced the germination rate [6, 11-17, 5, 18, 10], but the degree of enhancement or response to the pre-treatment methods depended upon the type of tree and shrub species involved probably due to the high genetic variations between different plant species. A wide range of studies have demonstrated some advantages associated with tree propagation using vegetative materials as compared with the sexual propagation method [19, 20, 21, 10] and the importance of vegetative propagation in a number of plant species [22, 7, 5, 10] but the potential of *Senna singueana* to propagate vegetatively either through root suckers or using other vegetative materials has not yet been studied. Various studies on vegetative propagation of different plants have clearly demonstrated the superiority of plant species propagation using root suckers over other sexual and asexual methods [23-27]. The success of root suckers, however, can strongly be influenced by the plant biological, environmental and climatic conditions [28, 29, 30, 5, 31]. Knowledge about

* Corresponding author:
jbuwayezu@yahoo.co.uk (Nduwayezu J. B.)
Published online at http://journal.sapub.org/plant

Senna singueana flowering pattern, seed germination and seed viability longevity may help the resource poor farmers with the provision of the germplasm of this valuable indigenous species for improved crop production. The main objective of the present study was, therefore, to determine the seed viability longevity and root suckering capacity of *Senna singueana* (source of fertilizer for smallholder farmers) with the intention of improving soil fertility and crop productivity in smallholder farms.

2. Materials and Methods

2.1. Study Sites Description

These two studies were carried out at Kitete Village (37°8'E and 6°30'S; 375 m a.s.l) which lies within the Mkata plain in Kilosa District and Sokoine University of Agriculture (latitude: 5°40'S; longitude: 37°39'E; altitude: 525 m above the sea level) located at 3.0 km from the centre of Morogoro Municipality, which is about 200 km west of Dar es Salaam in Morogoro, Tanzania.

2.2. Experimental Procedures

2.2.1. *Senna singueana* Seed Germination

The seeds of *Senna singueana* used in the plant propagation studies (propagation by root suckers and seeds) were collected from the local trees within the Kitete Village and from the Sokoine University of Agriculture Horticultural Unit during the December 1996 and November 1997 periods respectively.

The seed storage and germination experiments were established in November 1997 in a completely randomized block design of 2 treatments (seed pre-treatment methods), 4 replications and 13 seed testing dates (after 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 months of seed storage). The two treatments involved were soaking *Senna singueana* seeds in cold water and direct seed sowing without pre-soaking in water.

Immediately after *Senna singueana* seed collection and processing, some seeds were tested for their germination rate (i.e. seed germination test at 0 month after seed collection). A duplicate of the remaining seeds was packed in two clean and dry cotton bags. One seed lot was stored for a period of one year (12 months) in a dry, clean and insect free place at Kitete Village and the other lot was stored for the same period under similar conditions in the Forest Biology Laboratory at Sokoine University of Agriculture. The subsequent seed germination tests out of the stored seed lots were carried out every after 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 months of storage by taking 100 seeds of *Senna singueana* (25 seeds per replicate) and germinating them in sand. The number of seeds that germinate daily (i.e. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12 days) was recorded. At the end of seed germination period (day-12), the germination rate (%) per each seed storage period for each seed lot was calculated as follows:

$$\text{Seed germination (\%)} = \text{Seeds germinated/total seeds} \times 100 \quad (1)$$

2.2.2. *Senna singueana* Vegetative Propagation by Root Suckers

A 7-months study on *Senna singueana* seedling root suckering ability was carried out in both Kitete Village and Sokoine University of Agriculture nurseries during the December 1996- June 1997 period. The experiment was laid out in a completely randomized block design of 4 sets of healthy seedlings, 4 replications and 3 seedling pruning periods (4, 5 and 6 months after seed sowing). Four sets or observation units (U) of 100 seedlings each (i.e. seedlings raised in 10 cm x 15 cm polythene tubes) were initially arranged in the replication blocks of Compartment A (Figure 1). Polythene tubes containing 100 seedlings were randomly distributed in each block of each compartment. Compartments B and C were initially empty while waiting for root pruned seedlings from Compartment A.

At 4 months after seed sowing, *Senna singueana* seedlings with an average height of 9.4 cm and root collar diameter of 1.2 mm were root-pruned by passing a sharp knife below the polythene tubes thus leaving the parts of the seedling tape roots that had grown into the soil below the tubes. The cut ends of such root parts (root stumps) could easily be seen sticking out on the ground surface. The sets of root pruned seedlings in each observation unit (block), were subsequently shifted to their respective blocks in Compartment B. Both Compartment A (with root stumps) and Compartment B (with root pruned seedlings) continued being watered routinely. At the age of 5 months (i.e. 1 month after the first root pruning), the seedlings in Compartment B were again root pruned and the pruned seedlings were again shifted to their respective observation units in Compartment C, and Compartment A (with root stumps) was assessed for root suckering. At 6 months after seed sowing, the parent seedlings in C were pruned for the last time and disposed while the root stumps in Compartment B were assessed for root suckering. At 7 months root suckering was assessed in Compartment C (with root stumps). After each removal of the pruned seedlings from one compartment to another, the compartment with root stumps was routinely irrigated (i.e. twice a day) until the new root suckers appeared. After these root suckers had grown to attain 2-5 leaves they were counted and transferred into polythene tubes containing a well-balanced soil mixture for survival rate monitoring. Based on the number of root suckers and subsequent survivors, both the root suckering capacity (%) and survival rate (%) were estimated.

3. Results and Discussions

3.1. *Senna singueana* Seed Germination and Optimum Storage Period

It is apparent from Figure 2 that, initially, the *Senna*

singueana seed germination rate decreased gradually from an average maximum rate of 80% to 70% during the first 3 months of seed storage. After 3 months of storage however, a marked decline in germination rate (i.e. from 70% to less than 2% at 12 months of seed storage) was recorded. No statistical significant (P=0.05) differences in terms of germination rate were observed between the two *Senna singueana* seed pre-treatment methods (Table 1).

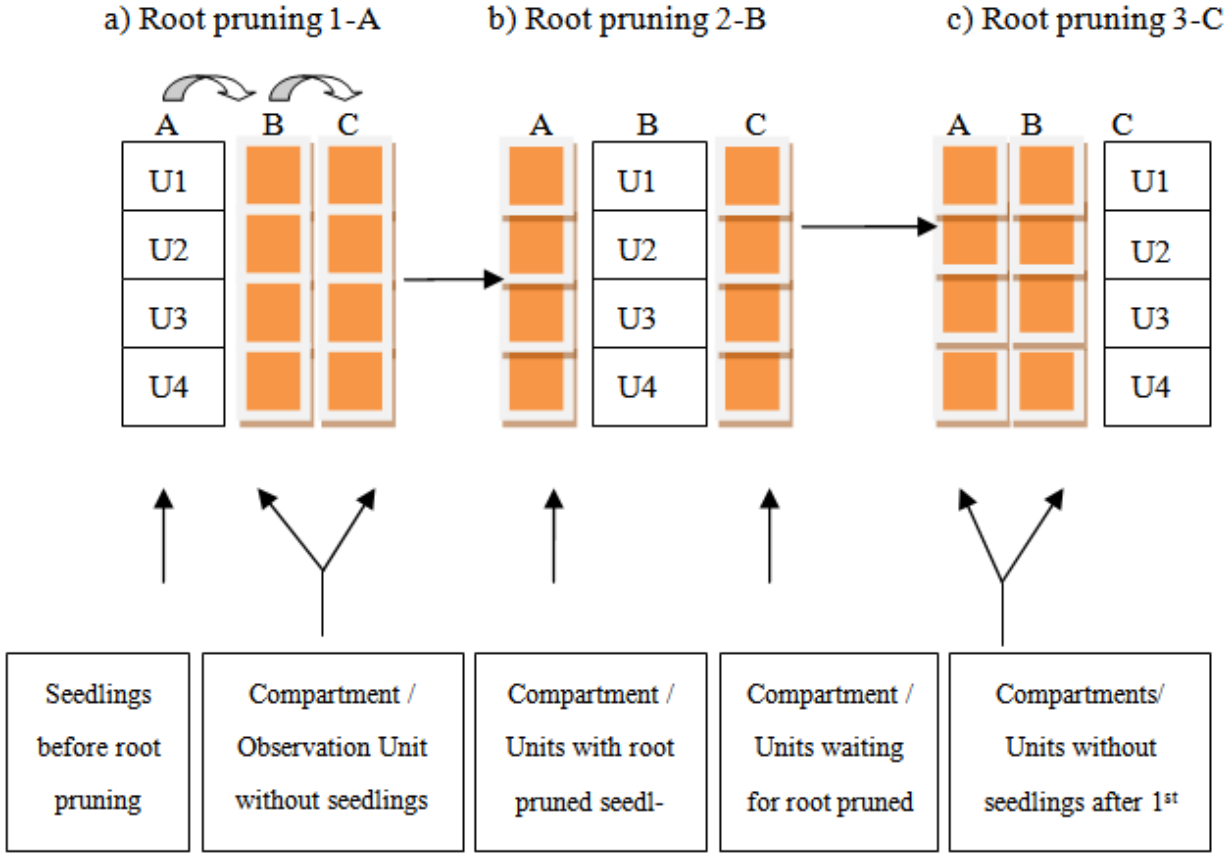

Figure 1. Schematic representation of *Senna singueana* seedling transfers from one observation unit (U) of each Compartment to another unit after root pruning

Table 1. Effect of *Senna singueana* seed pre-treatment on its germination rate in Morogoro, Tanzania

Storage period (months)	*Senna singueana* seed pre-treatment methods and seed germination rate (%)		Mean difference $D = X_1 - X_2$	Deviation from the mean d = D - Mean D	Squared deviation d^2
	Seed soaking in cold water	Direct sowing without seed soaking in water			
0	79.5	80.5	1.0	0.03	0.001
1	76.8	79.5	2.7	1.73	2.993
2	75.8	74.3	1.5	0.53	0.281
3	69.8	70.3	0.5	-0.47	0.221
4	56.8	55.3	1.5	0.53	0.281
5	42.0	41.5	0.5	-0.47	0.221
6	30.0	30.0	0.0	-0.97	0.941
9	20.3	19.8	0.5	-0.47	0.221
12	2.30	1.80	0.5	-0.47	0.221
Total	453.3	453.0	8.7		5.381
Mean	50.4	50.3	0.97		
t-calculated t-tabulated (t0.05, 8 df)	3.540 2.306	t-calculated > t-tabulated : Reject Ho; 0.010 < P < 0.005			

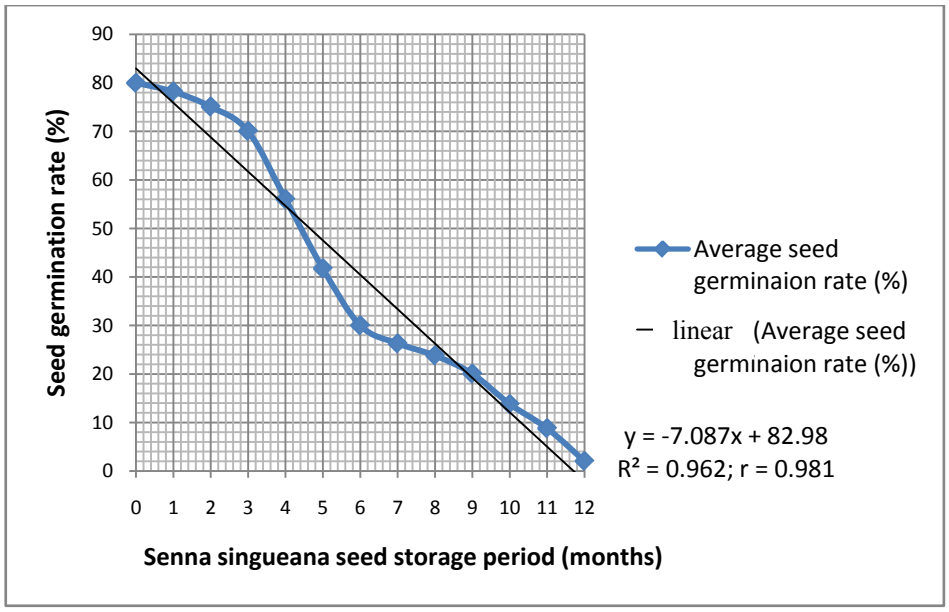

Figure 2. *Senna singueana* seed germination rate at different storage periods (1997-1998) in Morogoro, Tanzania

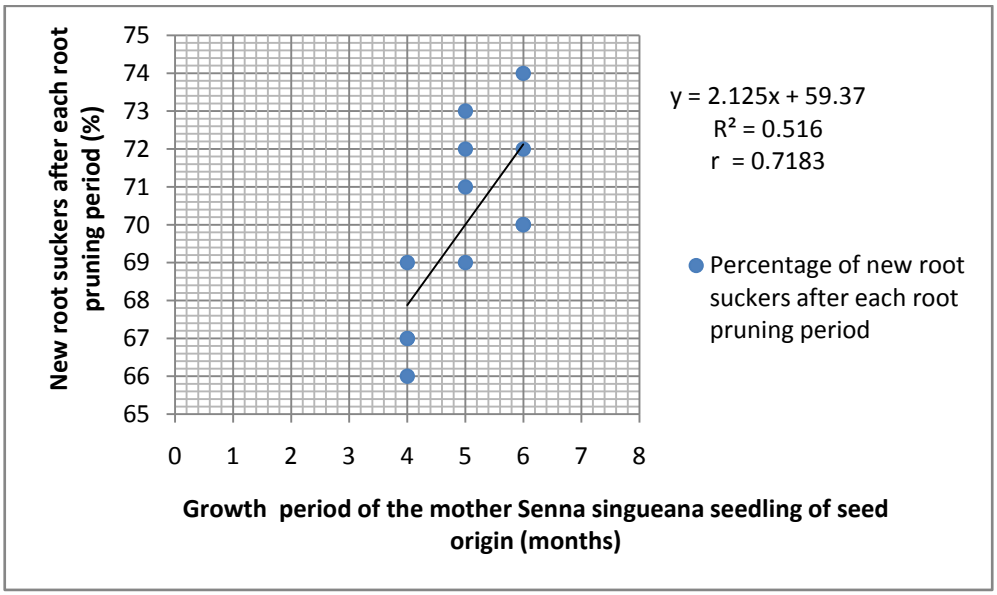

Figure 3. Relationships between the overall mean of new *Senna singueana* root suckers and growth period of their mother seedlings of seed origin

The results show that although the seeds of *Senna singueana* can be stored at room temperature for up to one year if kept dry and insect free, the germination rate drops rapidly with time (Table 1 and Figure 2). These findings are in line with the earlier reports indicating that seeds of some members of *Ceasalpinioideae* sub-family, in which *Senna singueana* belongs, loose viability rapidly while few others can be stored for over one year if kept dry and insect free [5]. Other studies suggested that under ideal conditions, the *Senna singueana* seeds germinate within 8-10 days with an average germination rate of 78% and remain viable for at least 3 years [32, 33] which is also in conformity with the findings from this study. The insignificant effect of the applied pre-treatments on seed germination rate (Table 1) implies that the small-scale farmers can simply propagate *Senna singueana* using seeds without resorting to the pre-treatments which are needed for seeds of a number of tree/shrub species [34, 15, 35, 8, 10]. This is indeed a significant finding especially for the resource poor farmers.

3.2. *Senna singueana* Growth and Root Suckering Capacity

As shown in Figure 3, *Senna singueana* was successfully propagated through root suckers but the suckering ability of its roots increased with increasing size or growth period of the parent seedlings. It was also observed that the survival rate of the new seedlings or root suckers ranged between 78-84%.

The continued increase in *Senna singueana* root suckering rate and vigor in direct proportion with the size of the parent seedlings (Figure 3) implies that their maximum suckering capacity had not yet been attained. The increasing ability of

Senna singueana seedlings to produce suckers with the increasing sizes of seedling rootstocks can probably be attributed to the fibrous root systems that develop around rootstocks as evidenced by the high root growth capacities observed after root pruning activity in the present study. These observations are in agreement with earlier reports suggesting that the dense fibrous root systems of seedlings ensured a rapid creation of contact with soil moisture and nutrients [4]. Based on the observed rapid loss of seed viability and high root suckering successes, however, vegetative propagation through root suckering is promising as a useful means of propagating *Senna singueana* plants in the future. The importance of root suckering as a vegetative propagation method has, also, been confirmed by various researchers for other tree/shrub species [36, 23, 24, 25, 27, 26] and is a main natural regeneration method for many important tropical broad-leaved tree species. Based on the existing literature on tree/shrub propagation using root suckers and from the findings of the present study, it is obvious that the use of seedlings is the simplest and easiest way of conserving the germplasm of *Senna singueana* and possibly other agroforestry trees and shrubs by the resource poor farmers.

4. Conclusions and Recommendations

- *Senna singueana* is a lesser-known indigenous shrub found to be successfully propagating by both seeds and root suckers from young seedlings.
- The seeds of this species have a maximum germination rate of 80% with a viability period of up to one year but after 3 months it drops rapidly to less than 2% at 12 months of storage.
- No seed pre-treatment is required for optimum germination.
- In order to ensure a high germination rate (> 70%) the seeds of *Senna singueana* should not be stored for periods in excess of 3 months.
- *Senna singueana* seedlings sucker readily and the suckering capacity increases with the plant (root) size. The optimum size which maximizes suckering has not, however, been established. Research is urgently required to determine this including the ascertainment of whether suckering potential is confined to the tape roots alone or spread evenly to the lateral roots.

ACKNOWLEDGEMENTS

The author acknowledges with thanks the financial support from the Canadian International Development Research Centre (IDRC) and also wish to express his most sincere gratitude and appreciation to Sokoine University of Agriculture for her facilities and to all those people who in one way or another have contributed to the success of these studies.

REFERENCES

[1] Brenan, J.P.M., 1967, Leguminosae, sub-family caesalpinioideae, In: Flora of tropical east africa (Edited by Milne Redhead, E. and Polhill, R.M), Royal Botanic Garden, Kew, England, pp 230.

[2] Ruffo, C.K., Chilongola, S.B. and Mabula, C.K., 1996, Catalogue of Lushoto herbarium-Tanzania, Tjep Tryk Copenhagen Denmark, pp 467.

[3] Nduwayezu, J.B., Ruffo, C.K., Minani, V, Munyaneza, E. and Nshutiyayesu, S., 2009, Know some useful trees and shrubs for agricultural and pastoral communities of Rwanda, Institute of Scientific and Technological Research (IRST) - Rwanda, pp 264.

[4] Chamshama, S.A.O., 1984, Establishment techniques for Eucalyptus species: effects of nursery treatments, site preparation and fertilization on survival and growth, PhD Thesis, University of Dar es Salaam, pp 171.

[5] Mbuya, L.P., Msanga, H.P., Ruffo, C.K., Birnie, A and Tegnas, B., 1994, Useful trees and shrubs of Tanzania: identification, propagation and management for agricultural and pastoral communities, SIDA/RSCU Nairobi, pp 525.

[6] Nwoboshi, L.C., 1982, Tropical silviculture. Principles and techniques, Ibadan University Press, pp 333.

[7] Lulandala, L.L.L., 1985, Intercropping Leucaena leucocephala with maize and beans, PhD Thesis, SUA, pp 254.

[8] Duangpatra, J., 1991, Environmental factors affecting germination, In: Proceedings on standard germination tests, (Edited by ASEAN-Canada Forest Tree Seed Centre), 14-18 January 1991, Sarbuni, Thailand, pp 20-24.

[9] Bewler, J.D and Black, M., 1994, Seeds: physiology of development and germination, Plenum Press, New York, pp 445.

[10] Mwang'ingo, P.L. 1997, Propagation of Parinari curatellifolia Planch. Ex Benth and Uapaca kirkiana Muell. Arg by seeds and stem cuttings, MSc. Dissertation, SUA, Tanzania, pp 85.

[11] Chamshama, S.A.O. and Downs, R.J., 1984, Germination characteristics of Acacia tortilis Hayne, Journal of Tanzania Association of Foresters, 5, 29-39.

[12] Willan, R.L., 1986, A guide to forest seed handling, FAO Forestry Paper 20/2/FAO, Rome, pp 379.

[13] Mugasha, A.G. and Msanga, H.P., 1987, Maesopsis eminii seedcoat impermeability is not the cause of sporadic germination and prolonged seed germination, Forest Ecology and Management, 22, 301-305.

[14] Maithan, G.P., Bahuguna, V.K and Sook, O.P., 1989, Fruit maturing and interrelated effects of temperature and container on longevity of neem (Azadirachta indica) seeds.

[15] Sadhu, R.N and Kaul, V., 1989, Seedcoat dormancy in Robinia pseudo-acacia, Indian Forester, 121, 59-62.

[16] Msanga, H.P and Kalaghe, A.G., 1992, Germination of Wild

medlar (Vangueria infausta) following manual seedcoat scarification and Indole Acetic Acid treatment, In: Proceedings of the IUFRO Symposium on Trees problems, with special reference to Africa, (Edited by Some, L.M and De-kam, M), 23-28 November 1992, Ouagadougo, pp 170-305.

[17] Tietema, T., Eldbjorg, M and Schroten, J., 1992, Seed germination of indigenous trees in Botswana, African Centre for Technology Studies, Nairobi, Kenya and Forestry Association of Botswana, Gaborone, Botswana, pp 106.

[18] Sudhir, M., Sonali, J., Sunil, P., Meshram, S., Joshi, S and Pande, S., 1995, Microbial technology for biomass production in barren land, Agropedology, 5, 83-90.

[19] Krishnamoorthy, H.N., 1981, Plant growth substances, Tata McGraw-Hill, New Delhi, pp 214.

[20] Hartmann, H.T and Kester, D.E., 1989, Plant propagation: principles and practices, Prentice-Hall, Englewood cliffs, N.J., USA, pp 727.

[21] Kantari, M., 1993, Vegetative propagation of Hopea odorata by cuttings: a low cost technology, Technical publication n°. 16, ASEAN- Canada Forest Tree Seed Centre Project, Muak-lek, Saraburi, Thailand, pp 7.

[22] Mahlstede, J.P and Haber, E.S., 1957, Plant propagation, John Willey & Sons, Inc., London, pp 413.

[23] Hussain, A.M.M and Ponnuswamy, P.K., 1982, An innovation in the vegetative propagation of sandal (Snatalum album Linn.), Indian Journal of Forestry, 5, 1-7.

[24] Gassama, Y.K and Duhoux, E., 1987, Micropropagation of adult trees of Acacia albida (Leguminosae), Les arbres fixateurs d'azote- l'amérioration biologique de la fertilité du sol, Actes des seminaires, 17-25 mars, Dakar, Sénégal, pp 216-224.

[25] Kuldeep, S., Kapur, S.K., Sarin, Y.K and Singh, K., 1993, Domestication of Sapium sebiferum under Jammu conditions, Indian Forester, 119, 36-42.

[26] Byun-Kwang OK, Park-HyunSoon, Lee-SungKyu, 1995, Effect of position of explants on rooting rate and root development of Prunus serrulata var. spontanea Wilson, Research Report of the Forest Genetics Research Institute Kyonggido, 31, 106-11.

[27] Harrington, F., Douglas, G.C. and McNamara, J., 1994, Production of root suckers, and crown buds for culture initiation, Advances in Horticultural Science, 8, 11-14.

[28] Karschon, R., 1976, Clonal growth patterns of Acacia albida Del., Bulletin International Group for the study of Mimosoideae, 4, 28-30.

[29] Behrens, V and Merchior, G.H., 1978, Improving the method of vegetative propagation of aspen and aspen hybrids by softwoog cuttings from young root suckers, Holzzucht, 32, 3-4.

[30] Awashi, A.K., 1986, Sucker regeneration and sprouting in Diospyros melanoxylon Roxb, Journal of Tropical Forestry, 2, 66-68.

[31] Bespalov, V.P and Os'-kina, N.V., 1995, Regeneration of Ulmus pumila var.arborea by root suckers in arid conditions. Lesovedenie 2, 60-69.

[32] Orwa, C., Mutua, A., Kindt, R., Jamnadass, R., and Antony, S., 2009, Agroforestry database: a tree reference and selection selection guide version 4.0, http://www.worldagroforestry.org/ sites/treedbs/treedatabases.asp or http://www.worldagroforestry.org/treedb/AFTPDFS/Senna_singueana.PDF, Retrieved on September 19, 2015.

[33] Prota, 2015, *Senna singueana*- Protabase record, http://database.prota.org/PROTAhtml/Senna%20singueana.En.htm, Retrieved on September 15, 2015, 13:39:26 GMT

[34] Maghembe, J.A and Msanga, H.P., 1988, Effect of physical scarification and giberellic acid treatment in germination of Trichilia emetica, International Tree Crop Journal 5, 163-177.

[35] Onyekwelu, S.S., 1990, Germination studies in Tetrapleura tetraptera, International Tree Crop Journal, 6, 59-66.

[36] Hussain, A.M.M and Ponnuswamy, P.K., 1980, Propagation of Casuarina junghuhniana by planting shoots and root suckers, Indian Forester, 106, 298-299.