Journal of Research in Forestry, Wildlife & Environment Vol. 11(4) December, 2019
E-mail: jrfwe2019@gmail.com; jfewr@yahoo.com
http://www.ajol.info/index.php/jrfwe

ISBN: 2141 – 1778
Adelani and Suleiman, 2019

EFFECT OF WATER TEMPERATURES AND SEED WEIGHTS ON THE GERMINATION OF BLACK PLUM (*VITEX DONIANA* SWEET) SEEDS

***Adelani, D.O. and Suleiman, R.**

Federal College of Forestry Mechanisation, P.M.B 2273, Afaka, Kaduna State, Nigeria
***Correspondence author**: *adelani.olusegun@yahoo.com;* 07038953146

ABSTRACT

Vitex doniana is an underexploited indigenous tree species with enormous potentials. Investigation was conducted in Federal College of Forestry Mechanization, Afaka, Kaduna during dry season of 2018 to overcome problems associated with germination of Vitex doniana seeds. Effect of temperatures of water (27, 56, 73 and 96 ^{o}C) and seed weights (3.3, 1.4 and 1.2 g) on the germination of V. doniana was laid down in a split-plot experimental design with five replications. Interaction of temperatures of water and seed weights significantly (P<0.05) enhanced the germination of V. doniana seeds. A significant germination percentage of 46.67 % was recorded in seeds soaked in 56 ^{o}C water. Germination percentage among the seed weights were not significantly (P<0.05) different. The least mean germination time of 12 days was recorded in 1.2 g seeds soaked in 73 ^{o}C water for 45 minutes. A significant germination percentage value of 80 % was recorded in 3.3 g seeds soaked in 96 ^{o}C water. Soaking of 3.3 g seeds in 96 ^{o}C water enhanced the germination of V. doniana. The study therefore recommends soaking of 3.3 g seeds in 96 ^{o}C water for 45 minutes.

Key words: Temperature of water, Seed weights, Germination, Indigenous fruit tree species.

INTRODUCTION

The local people tend to make use of edible fruits, vegetables and medicine from tree/shrubs and herbs of forest and compounds to meet their day to day needs (Erhabor and Oboho, 2017). Erhabor and Oboho (2017) stated that different indigenous species produce fruits and other edible products and nutrient supplements at different times of the year to complement the staple foods such as grains, tubers and pulses that are the buck of their diets. Okafor (2010) reported that wild fruits, nuts, seeds, vegetables and other classes of edible forest products contributed enormously to overcome or ameliorate prevailing food problems of rural dwellers in developing countries.

There are around 3000 species of wild fruits in Africa representing enormous important and largely untapped natural resources (Pye-Smith 2010). *Vitex doniana* is one of such indigenous fruit tree species of immense potentials. *Vitex doniana* is called Black plum; Dinya; Ucha koro and Oori-nla in English, Hausa, Igbo and Yoruba respectively (Orwa *et al.*, 2009). The blackish pulp of the matured fruits is sweet and edible, and is eaten fresh. This pulp also serves in jam preparation. A beverage is made from the fruit juice, whereas boiled fruits are the basis for an alcoholic liquor and wine (Ky, 2008).

Hounkpèvi *et al.* (2018) stated that its leaves are used as fodder for livestock and the young leaves as leafy vegetables in sauces preparation. The blackish pulp of its ripened fruits is edible and used in preparation of some sweet drinks (Hounkpèvi *et al.*, 2018). The *V. doniana* is an important indigenous fruit or leafy vegetable in Africa (Burkill, 2000; Maundu *et al.*, 2009) for food, medicine and other purposes (Dadjo *et al.*, 2012). In traditional medicine *V. doniana* have several applications (Ladeji *et al.*, 2005; Ky, 2008; Padmalatha *et al.*, 2009). For instance the leaf, the bark, dried and fresh fruit serve as ingredients in many preparations to treat or heal diseases including conjunctivitis, headache, stiffness, measles, rash, fever, chicken pox, hemiplegia, respiratory diseases, ankylostomiasis, rachitis, gastro-intestinal disorders,

jaundice, kidney troubles, leprosy, liver diseases, bleeding after childbirth and diarrhoea (Achigan-Dako *et al.*, 2014).

The species has proved difficult to germinate from fresh seeds while existing trees are aging. The *V. doniana* seeds present a combination of physical (PY) and physiological dormancy (PD), based on classification by Baskin and Baskin (2004) and Silveira (2013). However, little is known about dormancy breaking requirements and no reliable technique is available yet. Germination trials usually produce low success rates (Ky, 2008). Various pre- treatments reported by Yarou (2007) lead to only 20 % germination when seeds are involved. Imbibition tests revealed that *V. doniana* seeds are physically dormant (N'Danikou *et al.*, 2014) but different treatments tested so far resulted in germination rates below 60 % after six months (Mapongmetsem, 2006; Ky, 2008; Ahoton *et al.*, 2011). Ahoton *et al.* (2011) and Chamshama *et al.* (2001) have respectively reached 58 % and 61 % (the highest rates reported so far) when stones are broken with physical shock prior to sowing.

To propagate more of this species for biodiversity conservation, dormancy associated with the seeds of this species need to be overcome. Developing ex - situ conservation programme for any forest tree species requires sound and broad based knowledge of the species silvicultural requirements (Oni, 2013). Little information is available on the effect of temperatures of water and seed weights on the germination of *V. doniana* seeds. Seeds of the same tree species, with different seed weights need to be pre-treated differently. Seed weights and seed sizes are directly proportional (Adelani *et al.*, 2013). Ajiboye *et al.* (2016) stated that a lot of attributes including seed sizes affect the germination of seeds and growth of seedlings, in many of the tropical tree species especially leguminosae tree species of the savanna. Seed weight has been reported to be a very important factor in the evaluation of seed germination and seedling vigour (Adetiloye, 2005).

De *et al.* (2003) reported that the use of large seed in wheat proved much better for germinability and productivity than medium and small size seeds. Upadhaya *et al.* (2007) in *Prunus jenkinsii* stated that seedlings from heavy seeds survived maximally and had greater height number of leaves, leaf area and dry matter yield than seedlings from intermediate and light weight seeds. In order to ascertain appropriate temperature of water for treatment of particular seed weight, investigation was conducted into effect of temperatures of water and seed weights on the germination of *V. doniana*.

MATERIALS AND METHODS

Study Area

The research was conducted in the screen house of the Federal College of Forestry Mechanization, Afaka, Kaduna. The college is located in the Northern Guinea Savannah Ecological zones of Nigeria. It is situated in Igabi Local Government Area of Kaduna State, Nigeria. It lies between Latitude 10^o 35' and 10^o 34' and Longitude 7^o 21'and 7^o 20' (Adelani, 2015). The mean annual rainfall is approximately 1000 mm. The vegetation is open woodland with tall broad leaved trees (Otegbeye *et al.*, 2001).

Fruit collection and seed extraction

The fruits of *V.doniana* were sourced from mother tree from Buruku forest in Kaduna State. The seeds were extracted from the fruits and air dried for thirty minutes. The viability of the randomly selected seed samples was assessed using the cutting method (Schmidt, 2000). The river sand used for the experiment was collected from the floor of the college dam, sieved through 2 mm sieve and then sterilized in the laboratory oven at 160 ^{o}C for 24 hours. The polythene pots used was 20 x 10 x 10 cm^3 in dimension and filled with the sterilized river sand and arranged in the screen house.

Effect of different water temperatures and seed weights on the germination of *V.doniana* seeds

The experiment of the effect of different water temperatures and seed weights on the germination of *V. doniana* seeds was laid down in a split-plot experimental design with five replications. Seeds were soaked in different water temperatures for forty-five (45) minutes. Four different water temperatures regime (27, 50, 73 and 96 ^{o}C) and three seed weights (1.2, 1.4 and 3.3 g) constituted the main and sub-plot treatments respectively. The water at room temperature (27 ^{o}C) served as the control. The sum of one hundred and twenty seeds was used for the experiment.

Two seeds represented a replicate. The weight of the samples of seeds was determined by weighing the seeds on Mettler Top Loading Weighing Balance (Model-Mettler PM 11-K). The ten (10) seeds of different weights 1.2, 1.4 and 3.3 g were soaked in 27, 50, 73 and 96 ^{o}C water. The seeds were removed, washed and air dried. Ten (10) seeds each of different seed weight were planted in 4 cm depth of sterilized river sand and 70 mL of water per seed was administered daily.

Data analysis

The germination count data collected on the effect of the different water temperatures and seed weights were converted to percentage germination. Germination percentage was calculated as suggested by Cicek and Tilki (2007). Germination percentage was subjected to two-way analysis of variance (ANOVA) using SAS (2003) software. Comparisons of significant means were accomplished using Fischer's Least Significant Difference (LSD) at 5% level of significance.

RESULTS

Effect of temperatures of water and seed weights on the germination of *Vitex doniana* seeds

The result of the effect of temperatures of water and seed weights on the germination of *V. doniana* seeds is presented in Table 1. A significant germination percentage of 46.67 % was recorded in seeds soaked in 56 ^{o}C water. Germination percentages among the seed weight treated were not significantly (P<0.05) different.

Interactive effect of temperatures of water and seed weights on the germination of *V. doniana* seeds

The result of interactive effect temperatures of water and seed weights on the germination of *V. doniana* seeds is presented in Table 2. A significant germination percentage value of 80 % was recorded in 3.3 g seeds soaked in 96 ^{o}C water.

Table 1: Effect of temperatures of water and seed weights on the germination of *V. doniana* seeds

Temp (^{o}C)	Effect of Temperature on germ		S W(g)	Effect of Seed Weight on germ	
	% germ	MGT (day)		% germ	MGT(day)
27	13.30^{a}	13.30^{a}	---	---	---
56	46.67^{a}	46.67^{a}	3.3	35.00^{a}	35.00^{a}
73	26.67^{a}	26.67^{a}	1.4	25.00^{a}	25.00^{a}
96	40.00^{a}	40.00^{a}	1.2	35.00^{a}	35.00^{a}
SE	19.44	19.44	SE	18.48	18.48

**Means on the same column having different superscripts are significantly different (P<0.05) vertically*

Key : Temp- Temperature, % germ- Percentage germination, SW- Seed weight, MGT- Mean germination time

Table 2: Interactive effect of temperatures of water and seed weights on the germination of *V. doniana* seeds

Temperature (^{o}C)	Seed Weight (g)		
	3.3	1.4	1.2
27	0.00^{a}	0.00^{a}	40.00^{a}
56	60.00^{a}	40.00^{a}	40.00^{a}
73	0.00^{b}	60.00^{a}	20.00^{ab}
96	80.00^{a}	0.00^{b}	40.00^{a}
SE	18.75	18.75	18.75

**Means on the same row having different superscripts are significantly different (P<0.05) horizontally*

Interactive effect of temperatures of water and seed weights on the mean germination time of *V. doniana* seeds

The result of the interactive effect of temperatures of water and seed weights on mean germination time of *V. doniana* seeds is presented in Table 3. The mean germination time among the treatments were not significantly (P<0.05) different. The least mean germination time of 12 days was recorded in 3.3 and 1.4 g seeds not soaked. The least mean germination time of 12 days was recorded in 1.2 g seeds soaked in 73 ^{o}C water for 45 minutes.

Table 3: Interactive effect of temperatures of water and seed weights on the mean germination time of *V. doniana* seeds

Temperature (^{o}C)	Seed Weight (g)		
	3.3	**1.4**	**1.2**
27	12.00^{a}	12.00^{a}	20.00^{a}
56	32.00^{a}	24.00^{a}	24.00^{a}
73	0.00^{a}	36.00^{a}	12.00^{a}
96	0.00^{a}	24.00^{b}	16.00^{a}
SE	18.75	18.75	18.75

*Means on the same row having different superscripts are significantly different (P<0.05) horizontally

DISCUSSION

It could be inferred that 56 ^{o}C is average, moderate and appropriate temperature of water for breaking the dormancy of *V. doniana* seeds. Appropriate temperature for seed germination varies within and between species. Similar observations have been reported by investigators such as Mackay *et al.* (2001) (*Lupinus arboreus*)., Tigabu and Oden (2001) (*Abizia species*)., Aydin and Uzuu. (2001) (*Trifolium meneghinianum*)., Rincon-Rosales *et al.* (2003) (*Acacia angustissima).*, Agboola *et al.* (2006) (*Tithonia diversifolia*) and Wang *et al.* (2006) (*Kraschenninnikovia lanata*)., Afrasyab and Reza (2007) (*Ferula gummosa*)., Truong and Hans (2007) (*Sesbania sesban*)., Michael *et al.*, (2008) (*Terminalia sericea*)., Nour-El-Din (2010) (*Balanites aegyptiaca*)., Okunomo (2010) (*Tetrapleura tetraptera*)., Amira and Mohammed (2013) (*Cassia fistula*)., Sikiratu, (2014) (*Acacia senegalensis*)., Adelani *et al.* (2014) (*Tamarindus indica*) and Adelani, (2015) (*Sesbania sesban*). It can be inferred that soaking the seeds in appropriate temperature softened the seed coat to absorb water for imbibition that resulted in germination. This is in line with the reports of Oboho and Ogana (2012). Germination percentages among the seed weights treated were not different. The result of this trial is contrary to those of Ajiboye (2016) and Ibeawuchi *et al.* (2012) who recorded highest germination percentage in large seeds. They attributed the excellent performance of large seeds to the presence of large food reserves that gave energy for higher germination percentage. The excellent performance of heaviest seeds in the presence of highest temperature of water can be attributable to the availability of the compatibility between heaviest seeds and highest temperature of water, which help to degrade the seed coat without damaging the embryo and equally enhanced germination. This is in consonance with the reports of Adelani *et al.* (2013) and Adelani *et al.* (2018).

The least mean germination time of 12 days recorded in small seeds revealed that small seeds germinated faster compared to other treated seed weight. Similar observation has been reported by Ajiboye *et al.* (2016).

CONCLUSION

Investigation conducted into effect of temperatures of water and seed weights on germination of *V. doniana* seeds revealed that highest germination of seeds was recorded when soaked in 56 ^{o}C water. To have maximum germination percentage, 3.3 g *V. doniana* seeds need to be soaked in 96 ^{o}C water for 45 minutes. The least mean germination time was recorded in 1.2 g seeds soaked in 73 ^{o}C water for 45 minutes. Seedlings of high vigour were obtained by adopting appropriate temperature of water for pre-

sowing treatment and selecting the best seed weight of this indigenous priority species for biodiversity conservation. Breaking the dormancy of the appropriate seed weight will enhance robust germplasm conservation programmes.

REFERENCES

Achigan-dako, E.G., N'Danikou, S., Tchokponhoue, D.A., Komlan, F. A., Larwanou, M., Vodouhe, R.S and Ahanchede, A. (2014). Sustainable use and conservation of *Vitex doniana* Sweet: unlocking the propagation ability using stem cuttings. *Journal of Agriculture and Environment for International Development*, JAIED,108(1):43-62. Doi.10.12895/jaeid.2014.195

Adelani, D.O., Oyekola, A. A and Suleiman, R. A. (2013). Effects of some pre-treatments on the germination of tamarind (*Tamarindus indica* L) seeds. *Forests and Forest Products Journal*, 6:18-24.

Adelani,D.O., Oyekola, A.A., Hezekiah, I and Sodimu, A.I. (2014). Assessment of some factors for the germination of tamarind (*Tamarindus indica* L). *Forests and Forest Products: Key to Sustainable livelihood*. In: Adedire, M.O; Onyekwelu, J.C; Oke, D.O; Adekunle, V. A. J; Jayeola, O.A and Oladoye, A.O (Eds). *Proceedings of the 4th Biennial National Conference of the Forests and Forest Products Society*, PP611-616.

Adelani, D.O. (2015). Effect of hydro-priming and potassium nitrate priming on the germination of *Balanites aegyptiaca* L. *Applied Tropical Agriculture* 20 (2): 17-23.

Adelani, D.O., Amos, O.S and Ojo, O.S. (2018). Effects of some pre-germination treatments and seed weights on the germination of *Zizyphus mauritiana* Lam seeds. *Journal of Sustainable Environmental Management* 10: 218-234.

Adetiloye, P.O. (2005). Effect of seed weight, seed drying and seed soaking on germination and seedling vigour in bell pepper (*Capsicum annum* L) ASSET SERIES A 5(1):31-34.

Afrasyab, R.G and Reza, T.A. (2007). Methods for dormancy breaking and germination of galbanum seeds (*Ferula gummosa*) . *Asian Journal of Plant Sciences*, 6 (4):611-616.

Agboola, D.A., Idowu, W.F and Kadiri, M. (2006). Seed germination and seedling growth of the Mexican sunflower, *Tithonia diversifolia* (Compositae) in Nigeria, Africa. *Revista de Biologia Tropical*, 54(2): 1-9.

Ahoton, L. E., Adjakpa, J. B., Gouda, M., Daînou, O and Akpo, E. (2011). Effet des traite ments de semences du prunier des savanes (*Vitex doniana* Sweet) sur la regeneration et la croissance des plantules. *Annales des Sciences Agronomiques*, 15: 21-35.

Ajiboye, A.A., Fawibe, O.O and Agboola, D.A. (2016). Tropical forest tree species: Germination, seedling growth and economic importance. Advances in Biological science. Adedire, C.O and Fagbenro, O.A (eds). Artsmostfare prints, Ibadan, Nigeria. Pp 315

Amira, Sh. S and Mohamed, S.A. (2013). Effects of sulphuric acid and hot water pre-treatments on seed germination and seedling growth of *Cassia fistula L. American-Eurasian Journal of Agriculture and Environmental Science*, 13(11): 07-15

Aydin, I and Uzun, F. (2001). The effects of some application on germination rate of Gelemen clover seeds gathered from natural vegetation in Samsun. *Pakistan Journal of Biological Sciences*, 4:181-183

Baskin, J. M and Baskin, C.C. (2004). A classification system for seed dormancy. *Seed Science Research*, 14: 1-16.

Burkill, H.M. (2000). *The Useful Plants of West Tropical Africa*, second ed., Volume 5,

Families S–Z, Addenda. Royal Botanic Gardens, Kew, Richmond, United Kingdom.pp 686.

Chamshama S.A.O., Mugasha A.G., Mgangamundo M.A., Gerald V., Msanga H.P. (2001). Effect of seed size and sowing depth on germination of *Vitex doniana* and *Vitex mombassae* seeds. *Tanzania Journal of Forestry and Nature Conservation* 74: 1–15.

Cicek, E and Tilki, F. (2007).Seed size effects on germination, survival and seedling growth of *Castanea sativa* Mill. *Journal of Biological Sciences,* 7 (2): 438-441.

Dadjo, C., Assogbadjo, A. E., Fandohan, B., Kakaï R.G., Chakeredza, S., Houehanou, T. D., Damme, P. V and Sinsin, B. (2012). Uses and management of black plum (*Vitex doniana* Sweet) in Southern Benin. *Fruits* 67(4): 239-248.

De, B. K. Mandal, A.K. and Basu, R.N. (2003) Seed invigoration treatments on different seed size of Wheat (*Triticum aestivum* L.) for improved storability and field performance. *Seed Science and Technology* 31: 379-388.

Erhabor, T.A and Oboho, E.G. (2017). Agroforestry and its importance in the dietary diversity of Nigeria. *Harnessing the Uniqueness of Forests for Sustainable Development in a Diversifying Economy*, *In*: Adekunle, V.A.J, Ogunsanwo, O.Y and Akinwole, A.O (Eds). *Proceedings of the 39th Annual Conference of the Forestry Association of Nigeria* held in Ibadan, Oyo State, Nigeria. Pp 549-557

Hounkpèvi, A., Kouassi, E. K and Kakaï, R. G. (2018). Effects of climatic variability and local environment patterns on the ecology and population structure of the multipurpose plant species, *Vitex doniana* Sweet (Lamiaceae) in Benin. *Tropical Ecology* 59 (1): 129–143.

Ibeawuchi, I. I., Okorie, O.H., Obiefuna, J.C., Allgba, R.A and Okoli, N.A (2012). Seed weight and organic manure sources: determinants of quality marketable yields of fluted pumpkin (Telfairia occidentalis Kook F) (Ugu). *Nigeria Journal of Horticultural Science* (NJHS) 17: 20-26.

Ky, K. J .M. (2008). *Vitex doniana* Sweet, in: Louppe, D., Oteng-Amoako, A. A., Brink, M. (Eds.), Prota 7(1): *Timbers/Bois d'oeuvre 1. Bacqkhuys Publishers, Leiden, /CTA, Wageningen, PROTA Foundation,Wageningen, Pays Bas*, pp. 578–581.

Ladeji, O., Udoh, F.V and Okoye, Z. (2005). Activity of aqueous extract of the bark of *Vitex doniana* on uterine muscle response to drugs. *Phytotherapy Research* 19:804-806.

Mackay, W.A., Daris, T.D and Sankhla, D. (2001). Influence of scarification and temperature on seed germination of *Lupinus arboreus*. *Seed Science Technology*, 29: 543-548.

Mapongmetsem, P.M. (2006). Domestication of *Vitex madiensis* in the Adamawa highlands of Cameroon: phenology and propagation. *Akdeniz Üniversitesi Ziraat Fakültesi Dergisi*, 19: 269-278.

Maundu, P., Achigan-Dako, E.G and Morimoto, Y. (2009). *Biodiversity of African vegetables*, in: Shack leton, C.M., Pasquini M.W., Drescher A.W. (Eds.), African Indigenous Vegetables in Urban Agriculture, Earthscan, London, UK. 65– 104.

Michael, G. L., Joyce, P. N., Weston, F. M and Clement, Z. C. (2008). Effect of seed collection
times and pre-treatment methods on germination of *Terminalia sericea Burch*. Ex. Dc. *African Journal of Biotechnology*, 7(16):2840-2846.

N' Danikou, S., Achigan-Dako, E. G., Tchokponhoué, D. A., Assogba Komlan, F., Gebauer, J., Vodouhè, R. S and Ahanchédé, A. (2014). Enhancing germination and seedling growth in *Vitex doniana* sweet for

horticultural prospects and conservation of genetic resources. *Fruits,* 69: 279-291.

Nour-EL-Din, N., El-Azazi, E. M. A., Ali, M. A. M and El-Mekawy, M.A. (2010). Enhancing *Balanites aegyptiaca* seed germination in Egyptian deserts gene bank by breaking dormancy treatments. *Four Saudi Science Conferences,* 1(1):1–15.

Oboho, E. G. and Ogana, F. N. (2012). Effects of varying hot water temperatures on the germination and early growth of *Dialuim guineense* (Willd) seeds. *Annals of Biological Research,* 3 (3):1247-1254.

Okafor, J.C. (2010). Improving edible species of forest products. An article on improving the contribution to dietary supplies and income generation of edible products from the West African forest zone (including derived savannah), with particular reference to Nigeria. Unasylva N0 165-Forest Product. www.fao.org./3/u2440e/u2440e04htm

Okunomo, K. (2010). Seed germination of *Tetrapleura tetraptera (Taub)* as influenced by various nursery techniques. *African Journal of Agricultural Research and Development,* 3 (2): 1-6.

Oni, P.I. (2013). Evaluation of silvicultural requirements of *Dialium guineese* (Wild), a neglected indigenous fruit tree in Nigeria. In: Popoola, L., Idumah, F.O., Ogunsanwo, O.Y and Azeez, I.O (eds). *Forest Industry in a Dynamic Global Environment. Proceedings of the 35th Annual Conference of the Forestry Association of Nigeria* held in Sokoto, Sokoto State. Pp 351-357.

Orwa, C., Mutual, A., Kinat, R., Jamnadass, R and Antony, S. (2009). Agroforestry Database, a tree reference and selection guide version 4.0 (http://www.agroforestry.org/sites/treadbs/freeedatabases.asp).

Otegbeye, G.O., Owonubi, J. J and Oviasauyi, P. K. (2001). Interspecific variation growth of Eucalyptus growing in northern Nigeria. In: Popoola, L, Abu J.E and Oni, P.I (Eds). *Proceedings of 27th Annual Conference of the Forestry Association of Nigeria*, pp 12–16.

Padmalatha K., Jayaram K., Raju N.L., Prasad M. N.V., and Arora R. (2009). Ethnopharmacological and Biotechnological significance of Vitex. *Bioremediation, Biodiversity and Bioavailability* 3: 6-14.

Pye-Smith, C. (2010). The fruits of success: A programmeto domesticate West and Central Africa's wild fruit trees in raising incomes, improving health and stimulating the rural economy. ICRAF Trees for Change no 4. Nairobi: World Agroforestry Centre, 32pp.

Rincon-Rosales, R., Culebro-Espinosa., N. R., Gutierrez-Miceli, F. A and. Dendoveen, L. (2003). Scarification of seeds of *Acacia angustissima* and its effect on germination. *Seed Science and Technology,* 31:301-307.

SAS, **(**2003). Statistical Analysis System. SAS release 9.1 for windows, SAS Institute Inc.cary,NC, USA

Schmidt, L. (2000). *Guide to Handling Tropical and Subtropical Forest Seed*. *Danida Forest Seed Center,* Krogerupvej 21, Humleback, Denmark, pp 511

Silveira, F. A.O. (2013). Sowing seeds for the future: the need for establishing protocols for the study of seed dormancy. *Acta Botanica Brasilica*, 27: 264-269.

Sikiratu, U.Z. (2014). The influence of seed pretreatments on seed germination and seedling vigour in *Acacia senegalensis* in the nursery. *Journal of Biology, Agriculture and Health Care,* 4(12):57-62.

Tigabu, A and P. C. Oden. (2001). Effect of scarification, gibberellic acid and temperature on seed germination of two multipurpose *Albizia* species from Ethiopia. *Seed Science and Technology*, 29:11-20.

Truong, H. D and Hans, B (2007). The influence of temperature, light, salinity and seed pretreatment on the germination of *Sesbania sesban* seeds. *African Journal of Biotechnology*, 6 (19): 2231– 2235.

Upadhaya, K., Pandey, .N., Law, P.S. (2007). The effect of seed mass on germination seedling survival and growrh in *Prunus jenkinsii* HOOK f. 8thoms. *Turkish Journal of Botany* 31: 31-36.

Wang, R., Bai,Y.,Low, N. H and Tanino, K. (2006). Seed size variation in cold and freezing tolerance during seed germination of winterfat (*Krascheninnikovia lanata*) (Chenopodiaceae).*Canadian Journal of Botany*,84(1): 49-59.

Yarou, B.A.A. (2007). Prétraitements et germination des graines du prunier noir (*Vitex doniana* Sweet). Ecole Polytechnique d'Abomey-Calavi, Université d'Abomey-Calavi, Benin, Mémoire de fin d'études d'ingénieur des travaux, 63 p.