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DEPARTMENT OF NATURAL RESOURCES

PROPAGATION, NURSERY AND EARLY FIELD GROWTH PERFORMANCE OF *KIGELIA AFRICANA* (LAM) BENTH

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DECLARATION

I, Edington Dzumbunu registration number B191050B do hereby attest that this work is entirely a product of my findings and has never existed or been presented to any part for evaluation or publication elsewhere. Any reference to previously published work has been indicated. This dissertation is sustainable for submission to the faculty and has been checked for conformity with faculty guidelines

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DEDICATION

I dedicate this project to my uncle Mr Mazvihwa, my brothers, Albert,Molick, and Munashe. And my friends Tinashe and Tafadzwa who have been my pillars of strength

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Firstly i would like to thank The Almighty God for his infinite love and the gift of life that enabled me to be where i am today.

I am also sincerely grateful to the entire family for their unwavering support and commitment in pushing me towards success. I am also greatful for my friends who have seen me through thicks and thins making sure i push forward. I would like to extent my gratitued to my supervisor, Mr Gundlande for pushing this project's success

ABSTRACT

The study aimed at assessing the effectiveness of the selected propagation methods, early nursery and field performance of *Kigelia africana* at Bindura University nursery and the university farm. The selected propagation methods were seed and branch cuttings. A completely randomised design (CRD) was employed for the study. The pre-treatment that was applied to *K. africana* seed included, soaking in 98% sulphuric acid, and the control with untreated seeds. Each treatment had 3 replicates. The branch cuttings had 3 replicates each with 22 cuttings. The results showed that propagation of *K. africana* can best be done through seeds. The seeds that were pre-treated in sulphuric acid had higher germination of 85.3% and seeds in the control had 82.5%. The effect of pre-treatment method and time of exposure significantly ($P < 0.05$) influenced seedlings. This study has therefore shown that pre-treatment significantly affects germination. This study also recommends an attempt at other seed pre-treatment methods such as boiling and nicking. The study also recommends further studies to be carried out using other propagation methods such as root cuttings, truncheons and tissue culture to assess the nursery and field growth performance of *K. africana.*

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LIST OF ACRONYMS

EMA- Environmental Management Agency

RCD- Root Collar Diameter

PWMA- Parks and Wildlife Management Authority

FC- Forestry Commission

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Indigenous tree species are principally used in preventing and curing diseases in animals and humans all over sub-Sahara (Hens, 2006). The development of health insurance is still in its early stages and very expensive. Even though most African countries have established and are developing various networks of clinics and other modern health services, there is still need to looke at alternativemethods of health provisions (Hens, 2006). The most affordable, accessible to the majority of Africans is herbal medicines and therefore they rely on them. Successfully, herbal medicines have been used to treat malaria, wounds, and diabetes related illnesses. However harvesting is done by anyone with or without knowledge on how it is to be done. This has had a detrimental effect on *K. africana* and various other indigenous trees. This may be attributed to the loss of Indigenous Knowledge Systems (IKS) on how to harvest indigenous resources (Kolawole, 2004).

Recently there have been efforts made to research on how to cultivate, improve and propagate indigenous trees. However, much research over the past years was done only on commercially cultivated exotic species like the eucalyptus whose silvicultural knowledge base is abundant and readily available. This has left a huge knowledge gap on indigenous tree species. Domestication of most indigenous tree species has not only been done on levels and most of them exhibit low recruitment and regeneration rates in the natural environment. Therefore, there is more need to develop propagation techniques for indigenous tree species (Mojeremane *et al.*, 2005).

Factors such as deforestation, wildfire outbreak, urbanisation and population growth are causing the miombo forests of Southern Africa to rapidly recede. This has brought serious problems on the availability of wild fruits, medicinal plants and other plant products (Campbell, 1997). This has exposed the most vulnerable segment of the community that solely depend on indigenous resources, for example the aged, the poor, women and children, to malnutrition and reduced income, as their livelihoods depend on the timber and non-timber forest products.

The seeds of most indigenous tree species, even when mature and viable are hard and do not germinate even if they are planted in appropriate conditions. Bewley (1994) defined dormancy as the state in which viable seeds may fail to germinate even when provided with conditions that are normally favourable for them to germinate. It is common in seeds of species that grow in environments where conditions are not favourable for successful plant establishment following seed dispersal. Most of African indigenous tree species mainly exhibit seed dormancy and their propagation is difficult. Resultant to this fact, there has been little study to develop their propagation due to the fact that most of them are of low commercial value. Little efforts have also been made in trying to cultivate indigenous tree species through vegetative propagation methods. Most of the studies done have mostly been limited to sexual propagation which at times is expensive and at times it brings out low and unsatisfying results.

Despite the high medicinal uses of *K. africana* by most people around the world at large, the tree only exists as a protected and semi domesticated species. Anthropogenic activities have put a lot of pressure on the forest thereby depleting a lot of genetic resources. In that regard, there is need to prevent total loss or extinction of important forest food trees and medicinal species, especially the endangered ones, there is need for them to be cultivated more intensively (Baiyeri, 2003; Ugwunze, 2003).

This study sought to investigate the nursery, and field growth performance of *K. africana* so as to develop appropriate propagation techniques so the tree can easily be domesticated. Since it is an indigenous tree there is almosst no information on how to effectively manage the performance of the tree. Thus the study seeks to generate information.

1.2 PROBLEM STATEMENT

Anthropogenic activities have significantly affected biodiversity. These activities have also been highly linked to causing climate change which in turn has contributed to biodiversity loss.

Rainfall patterns have changed and this has affected the growth and recruitment of tree species such as *K. africana*. Due to the medicinal nature of *K. africana,* it is subject to a series of harvests. The different components of the tree have different healing properties for a wide range of aliments. These are used by the people especially in the rural areas for treatment since they normally cannot afford modern medicine. This however, has led to the tree being threatened because the harvests are unsustainable and have detrimental effects to the trees. There is very little and scarce information on the nursery and field performance of *K. africana* tree species. The species is threatened with being endangered and therefore the research was undertaken in order to investigate how to propagate the tree efficiently so that it may be adopted around homesteads or for enrichment plantings in the wild lands and help increase its population.

1.3 JUSTIFICATION

The development of ways to propagate *K. africana* can be of great importance to the nation as a whole. This will help the promotion of adoption and domestication of indigenous tree species. This information will be essential for the conservation and revegetation of indigenous tree species. The information from the study will help avail information on how to easily and effectively propagate this tree for domestication. The study will provide useful information for sustainable forest resources management to various stakeholders in Zimbabwe, which include Silviculturists, the Forestry Commission (FC), Environmental Management Agency (EMA) and the Parks and Wildlife Management Authority (PWMA). The research will also provide information base for future studies to be carried on the indigenous tree.

1.4 AIM

To assess the effectiveness of selected propagation methods for *K. africana* and its early nursery and field performance.

1.5 OBJECTIVES

1.5.1 To determine the most effective propagation method for *K. africana*.

1.5.2. To assess the early nursery growth performance for *K. africana* in terms of root collar diameter, and total height from January 2026 to February 2026.

1.5.3. To assess the early field performance for *K. africana* in terms of root collar diameter, and total height in the field from February 2026 to April 2026

1.6 RESEARCH QUESTIONS

1.6.1 Which propagation method yields the best results for *K. africana*?.

1.6.2 What are variations in performance for *K. africana* in early nursery owing to

1.6.3 different propagation methods?

1.6.4 What are the variations in performance for *K. africana* in early field growth?

CHAPTER 2

LITERATURE REVIEW

2.1 THE TAXONOMY AND MORPHOLOGICAL FEATURES OF *K. AFRICANA*

Family: Bignoniaceae

Accepted names: *Kigelia africana* (Lam) Benth

Synonyms: *Kigelia pinnata (Jacq) DC*

Common Names: Sausage tree, Cucumber tree

Shona Name: Mubveve , Musonya ,Muvhumati.

Ndebele: Umvebe

History shows that plants play an important role in the management of various diseases. They have been heavily utilised in the sustainable development of drugs which provide a major global healthcare delivery (Graham *et al*., 2000). *Kigelia africana* (Lam.) Benth belongs to the family Bignoniaceae. This tree is a multifunctional tree species with many medicinal attributes and potentials. The tree can grow up to 20m tall or even more (Roodt, 1992). The tree is evergreen where rainfall occurs throughout the year, but where there is a long dry season, it is deciduous. It has leaves that are opposite or in whorls of three, 30 – 50 cm long, pinnate, with six to ten oval leaflets up to 20 cm long and 6 cm broad. The terminal leaflet can be either present or absent. The flowers and later the fruit hang down from branches on long flexible stems (2-6 m long). It has bisexual flowers which are produced in panicles. The leaves are bell shaped and similar to those of the African tulip tree except they are darker and waxier, They have an orange to reddish colour or purplish green and about 10cm wide. Individual flowers do not hang down but are

oriented horizontally and some birds are attracted to these flowers (Joffe, 2003). They have a notable scent which is most clear at night indicating their reliance on pollination by bats, which visit them for pollen and nectar (Hoyo *et al*., 1997). *K. africana* is abundant in the tropics and is widely used traditionally in Southern Nigeria as a herb remedy for various ailments such as anticancer, antiulcer, anti-aging, antioxidant, and anti-malarial. It is also widely applied in the treatment of genital diseases, gynecological disorders, renal ailments, fainting, epilepsy, sickle-cell anemia, eczema, central nervous system depression, respiratory ailment, skin complaint, body weakness, leprosy, worm infestation, tumours (Hoyo *et al*., 1997).

2.2 *KIGELIA AFRICANA* USES

History from the earliest civilizations explains that plants have been used as a source of medicine for many years. *Kigelia africana* is a medicinal tree that has been used over the years for medicinal relief. *K. africana* is widely used to treat gynecological disorders (Grace et al., 2003). Aqueous preparation of the roots, fruits and flowers are administered orally or as a virginal pessary while the fruits and bark are used to promote breast development in young women or in contrast to reduces welling and mastitis of the breasts (Grace et al., 2003). More so, known for its anti-implantation activities as well (Prakash et al., 1985). *Kigelia africana* has many medicinal values and is used in traditional medicines for a variety of purposes (Grace and Davis 2002, Gabriel and Olubunmi, 2009). Extract is found in commercially available skin care products. The extracts of the tree's fruit are now on the international market, found in for example commercially available skin care products. It is supplied exclusively from wild harvested material and there are concerns that even the most well intentioned sustainable collecting initiatives might be detrimental in the long term, and monitoring is necessary since there has been some concerns about overexploitations by cutting down *Kigelia africana* to make canoes. The wood is hard and perfect to use for dugout canoes, planks and fence posts. It is also used for making boxes, drums, stools, yokes, tool handles, mortars and carvings (Grace and Davis 2002). *Kigelia africana* is planted as an ornamental tree and regarded as sacred in many regions.

Study was done using ethanolic stem bark extract in mice using barbiturate induced sleeping time and Rota rod bar to check the extract effect on muscle coordination. resultantly, it indicated that the extract has stimulant effect on the Central Nervous System (CNS) (Owolabi et al., 2008).

Using the root bark is recommended for the treatment of cancer of the uterus (Msouthi and Mangombo, 1983). Extract has been tested against melanoma cells tumor of pigmented skin cells, which can develop into malignant melanoma-the potentially fatal form of skin cancer. The extract inhibited the growth of cultured melanoma cells to a significant degree (Houghton et al., 1994). The stem bark and fruit extract are reported for their cytotoxic activities and showed promising results in treating melanoma and renal carcinoma (Houghton et al., 1994). The plant extracts have shown to possess various potential anticancer agents (Kolodziej, 1997; Owolabi and Omogbai, 2007; Carey et al., 2008; Msouthi and Mangombo, 1983; Khan, 2003).

In Kenya, the roasted seeds mixed with beer are used for the enlargement of male sexual organs (Kokwaro, 1976). The people of South eastern Nigeria mix the fruits and flowers with alcohol or water and they are used by traditional healers for fertility treatment among women and men of child bearing age (Ogbeche *et al*., 2002). Some interesting diverse biological studies on *K. africana* have been reported such as the anti-implantation (Prakash *et al.,* 1985). Extracts of the stem-bark and fruit are screened for their cytotoxic activities and showed promising results against melanoma and renal carcinoma (Houghton *et al.,* 1994). While the root-bark showed activity against KB cells (Weiss *et al.,* 2000). Previous studies of the fruits showed some anti-inflammatory effects and anticancer activity (Picerno *et al*., 2005; Owolabi and Omogbai, 2007).

The World Health Organization (WHO) has estimated that 80% of the world's population depends on health care based on traditional medicines (WHO, 2005). The pharmaceutical and cosmetics industries have been increasingly relied on biodiversity for raw materials, research, and commercial production. It is a tree species that has many medicinal properties and also is used for domestic purposes. Many herbs were eliminated due to the development of synthetic products. However, a significant increase in consumption of medicinal and non-medicinal natural products has been noted during the past decades.

Table 2.1: Pharmacological activities of different phytoconstituents of *Kigelia africana*.

Activity	Irridoids	Naphthoquinone	Meroterpenoid Naphthoquinone	Coumarin derivatives	Lignans	Sterols	Flavonoids
Anticancer	+	+	+	+	+	+	+
Mollusicidal	+	–	–	–	–	–	+
Syphilis & Gonorrhea	+	+	–	–	–	+	+
Antidiarrhoeal	+	–	–	–	–	–	+
Antiulcer	+	–	–	–	–	–	+
Antifungal	–	–	+	–	+	+	+
Antimalarial	–	–	+	–	+	–	–
Antiinflammatory / analgesic	+	+	+	–	–	+	+
Antibacterial	+	+	+	–	+	+	–

Postpartum Haemorrhage	+	–	–	+	–	+	–
Pneumonia	+	–	–	–	–	+	+

2.3 PROPAGATION

2.3.1 VEGETATIVE PROPAGATION

As an alternative to overcome pre-treatability problems, long growth periods and inconsistency of seed germination (Kelly *et al.*, 1992), vegetative propagation through cuttings and stump plants can be used. A cutting is any vegetative plant part that is capable of redeveloping into a new plant after being detached or sepurated by cutting from the mother plant. Vegetative propagation can also be described as a method of developing new plants through the use of detached vegetative plant parts which, if placed under conditions suitable for growth, will then develop into a completely new plant (Hartmann and Kester, 1983). Hartmann *et al.* (1997) states that cuttings can be taken from vegetative portions of a plant, such as the stem or roots.

The source of cutting materials plays a very crucial role in cutting propagation process. A good cutting source is essential to guarantee the success of propagation. According to Hartmann *et al.* (1990), three characteristics of good cutting source from stock plants to ensure high quality production of plants are true-to-type stock material, free from pest and diseases and in proper physiological state. This ensuresproper development of a cutting into a plant.

2.3.2 BRANCH CUTTINGS

Vegetative propagation of tree by stem cuttings is the most common type of propagation that is used in the development of trees. However, Leakey (2014) has developed some principles to aid the development of propagation techniques for tree species. Stem cuttings can come in many forms, but the two major groups are leafy softwood cuttings from juvenile shoots which are dependent on photosynthesis for rooting and leafless hardwood cuttings from older and more lignified shoots which are dependent on the mobilization of stored carbohydrate reserves (Leakey, 2014). Propagation through stem cuttings aims to obtain, segments of shoots containing

lateral or terminal buds which are expected, under proper conditions to become independent plants (Hartmann *et al.*, 2002).

The planting stock for vegetative propagation should be taken from young, vigorous shoots or suckers from healthy, mature trees, during the dormant season, to encourage fast-growing stems (Hartmann *et al.,* 2002). The ability of adventurous roots and buds to form on root and branch cuttings is dependent on the ability of the plant cells to differentiate and develop into either root or shoot system as pointed out by (Hartmann *et al.,* 1990).This ability is known as totipotency. Totipotency is the ability of plant cells to divide and regenerate to develop the missing parts of the plant when separated from the parent plant. Propagation through cuttings has many advantages for plant species. Several new plants can be well propagated in an area from a few plants. Unlike the other asexual methods like grafting, budding and micro propagation, cuttings are easy, cheap and quick to establish (Hartmann*et al*., 1997).

2.3.3 EFFECT OF CUTTING POSITION

The influence of cutting position has a great influence on the growth and development of cuttings. (Hartmann and Kester, 1983). Rooting ability varies between cuttings from different parts of the same plant, especially in woody species (Leakey and Mohammed, 1985) and this was correlated with structure of the stem difference in chemical composition of the plant along the stem (Hansen, 1986). A mature or older stem develops a continuous sclerenchyma ring between the phloem and cortex, exterior to the point of origin of adventitious roots, occurs, and this hinders root development. This is mostly observed in difficult-to-root species such as olive, *Hederahelix* and *Ficus pumila* and various indigenous trees species, whereas easy-to-root types are characterized by discontinuity or fewer cell layers of this sclerenchyma ring (Hartmann *et al*., 1997).

2.4 SEED GERMINATION

Seed germination can be defined as the emergence of the embryo through the seed coat Copeland and McDonald (1994). Seeds usually remain inactive until they receive favourable environmental conditions that can trigger the growth and development of the embryo (Copeland and McDonald, 1994). However, the response of seeds to favourable environmental conditions varies. Some seeds are capable of germinating only a few days after fertilization and long before their normal harvesting time, while others are dormant and require an extended rest period before

germination can occur (Benstink, 2000). This however, is species dormant and it may last for only a few days or for many years (Hartman *et al.*, 1997). For germination to occur, hormonal, temperature, and light requirements must be met (Kelly *et al.*, 1992).

2.4.1 SEED VIABILITY

Seeds viability is the state in which seeds have live cotyledons and embryos, regardless of their dormancy state. Bewley (1986) defines seed viability as the capacity of a seed to germinate even in the absence of dormancy. The seed viability test establishes the quality of the seeds. Viability of a seed lot may be high even though the germination results may be low (Bewley, 1986). The development and utilisation of the tetrazolium chloride (TC) test as a rapid method of seed viability testing was a major step in seed propagation (Bewley, 1986). Another test that can be used in order to determine viability is the floating test. In this test, the seeds are put in water for a few minutes. The seeds that float on the surface of water just after soaking are then discarded because they may be non-viable (Daneshvar, 2017). The test is important in that it helps avoid working on or sowing seeds which are dead or of bad quality.

2.4.2 SEED DORMANCY

Seed dormancy has been defined as the inability of a viable seed to germinate under favorable conditions (Bewley, 1997). The failure of the seeds to germinate is only temporary and with the right conditions dormancy can be broken. For instance, the seeds of *S. alata* are difficult to germinate due to dormancy. Many tree species are propagated by seeds, but seed germination information is limited due to inadequate research (Mng'omba *et al.*, 007). Seed dormancy allows seeds to overcome periods that are unfavorable for seedling established and is therefore important for plant ecology. Most indigenous seeds tolerate relatively long storage periods, and hence have inherent primary seed dormancy. Bryant (1996) also stated that seeds of most tree species become dormancy before or shortly after being separated from the parent plant. Seed germination and behavior of many Southern African tree species are have not been completely established or researched on (Mng'omba *et al.*, 2007).

In nature, dormancy is broken gradually or by the occurrence of a particular environmental event for instance flooding. The type of event that may break dormancy depends on dormancy type. The process of pre-treatment is used to replace the natural dormancy-breaking mechanism

(Schmidt, 2000). Pre-treatment methods have been developed and prescribed for many species. Yet, dormancy still causes problems of low germination rates for several tropical tree species. This may be because of lack of general knowledge of their seed physiology, or partly because of variation in dormancy rate.

2.4.3 TYPES OF SEED DORMANCY

Baskin and Baskin (2004) have reported that there are different types of seed dormancy. They vary from very slight to very deep. The degree of dormancy may change during the lifetime of the seed, this may be as a response to external conditions. Thus, dormancy may be natural or can be developed by a seed in response to external conditions (Schmidt, 2000).

Seed dormancy can be attributed to different parts of a seed. Coat imposed dormancy is one which, the outer coat of a seed of a fruit induces dormancy. The seed coat may be impermeable to water and gases, thereby preventing rehydration of the seed and respiration. The seed coat may also physically constrain embryo growth thereby preventing radicle emergence (Kelly *et al.*, 1992). Another type is the peri carp impermeability. In this type of dormancy even in the presence of favorable germination condition, viable seeds will not always absorb water thus leading to germination failure. Seeds that fail to absorb water remain hard and are therefore commonly called impermeable or hard seeds, in contrast with seeds which absorb water and soften during germination. Embryo imposed is also another type of seed dormancy that can be found. In this type of dormancy, changes in the balance of germination promoters and inhibitors within the embryo may both cause the dormancy and also break the dormancy (Baskin and Baskin, 2004).

2.4.4 SEED PRE-TREATMENT

Seed pre-treatment is a procedure that is done to aid germination of dormant seeds. It improves germination and seedling establishment. Some indigenous species need seed pre-treatments to break their dormancy. There are various methods of seed pre-treatment that can be used. However the most used are hot water, scarification and dry heat. Some pre-treatment procedures are not directly related to seed dormancy, but are carried out in order to speed up the germination process or promote seedling establishment (Schmidt, 2000). The main reason of pre-treatment is to make sure that seeds germinate, and that germination is fast and uniform.

Pre-treatment methods have been developed and described for many species. Yet still, they has been little success in attaining higher germination rates for several tropical tree species for example, *C. fistula,* and *C. auriculata.* This may be attributed to the lack of extensive studies and research of their seed physiology, partly because of variation in dormancy (Beguma *et al.*, 2013). The strength of dormancy, and elaboration of pre-treatment methods can often be limited to increasing or shortening the duration of already known methods, rather than adopting new ones (Schmidt, 2000).

2.5 FACTORS AFFECTING GERMINATION

Light has been known as a germination-controlling factor (Baskin and Baskin, 2004). Study also found that light plays a major role in dormancy and release. Light also interacts with temperature, which aids the germination of seeds. Therefore light is equally important in the germination of seeds. Moisture also plays an important factor for germination (Baskin and Baskin, 2001). It is important for many activities in seed germination such as enzyme activation; breakdown; translocation and use of storage material. Seeds are usually low in moisture during their resting period. This allows the seeds to maintain a minimum level of metabolic activities, this insures their long-term survival during storage (Copeland and McDonald, 1994).

McLaren and McDonald (2003) reported that seeds of most tropical species mature during the dry season and are then dispersed at the beginning of the rainy season when there is sufficient moisture for germination and seedling growth. In the dry tropics germination and early establishment of seedlings depend mainly upon moisture availability. Another important factor is temperature. Optimum temperature may be defined as the temperature giving the greatest percentage of germination within the shortest time. Maximum temperature is the temperature at which denaturation of proteins, that is essential for germination occurs (Hartman *et al.*, 1997). Temperate region seeds require low temperature than tropical region seeds and wild species require lower temperatures than domesticated plants. Seeds with high quality are able to germinate under a wider range of temperatures than low-quality seeds (Copeland and McDonald, 1994).

2.6 SURVIVAL

Proper care for the seedlings from the time they leave the nursery until they are planted should be administered. It is critical to protect seedlings from extremes in moisture and temperature as well as from physical damage. Poor care and handling can result in reduced seedling survival and growth (Elefritz *et al.,* 2006). Therefore the survival of seedlings is important to help establish vegetation cover. Seedling survival involves many silvicultural practices. One important aspect of a successful seedling survival is the planting quality seed (Baskin and Baskin, 2004).Findings from a study conducted by Li (2009) indicates that soil pathogens may have harmful effects on seed germination and seedling survival on various tree species. Studies in tropical forests showed that the presence of fungal pathogens resulted in significant losses of buried seeds (McLaren and McDonald, 2003). Survival has been poorly studied, particularly in tropical areas. McDowell *et al. (*2008) cites that, in tropical forests, severe droughts events may strongly influence the water relations of tree seedlings and thereby increase their mortality. Tropical tree seedlings survival has given new clues to why some species are better at surviving drought than other.

CHAPTER 3

METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA

This study was carried out at the Bindura University of Science Education in Bindura. Bindura district is a Zimbabwean district located in Mashonaland Central Province, which is around plus or minus 87 km North-East of Harare. Bindura is the provincial capital of Mashonaland Central Province and is a small town of about 47 000 inhabitants (Zimstats, 2012). It is boarded by Mazowe, Shamva, and Mt. Darwin. The area is dominated by deep clayey soils that are of high nutrient value. It is largely characterized of savanna climate, which is characterised by wet summer season from October to mid-April. The winter season starts from mid-April to July. Temperatures are highest in October and lowest in June. The annual temperatures on average range from 24^0C to 32 ^{0}C and average rainfall is 800 - 1000 mm per year. Miombo woodlands is the dominant vegetation type found in the area and the dominant tree species are *Brachystegia spiciformis, Julbernardia globiflora* and *Brachystegia boehmii.*

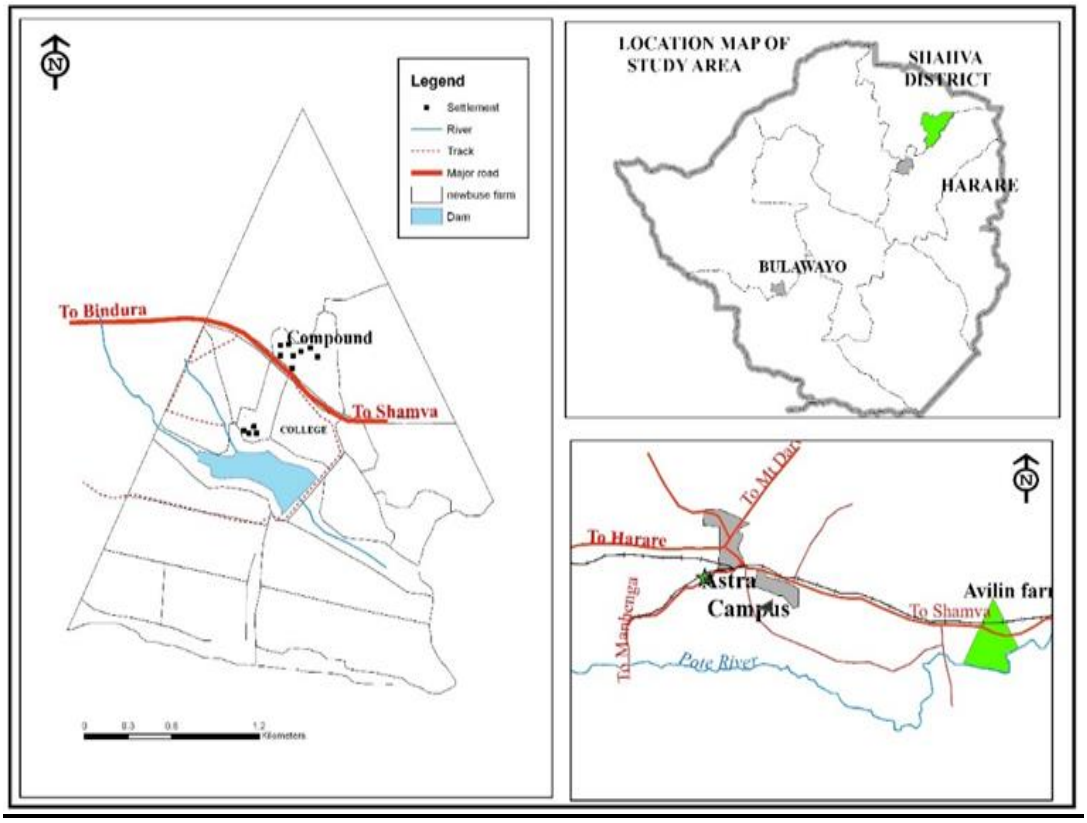


Figure 3.1: Map showing Bindura University and Bindura Farm.

3.2 DATA COLLECTION METHODS

3.2.1 SEED AND CUTTINGS COLLECTION

Propagation material for *K. africana* was collected from mature trees. Seeds for the species were collected from mature fruits. This was because it was late in their maturing season and therefore some of the fruits were scattered on the ground. The seed extract were done by slicing the fruit and rubbing it on a mesh wire at Bindura University. The seeds were pile yellow and very hard.

Branch cuttings of *K. africana* were cut using a machete. They were cut were the lateral segments had nodes to show that the cutting could develop shoots. The branch cuttings were about 20 cm in length.

3.2.2 SEED VIABILITY TESTING

Seed viability testing was conducted in order to determine the seed quality before sowing. The floating viability test was done were the seeds were all put in water. The seeds that floated were thrown away as they were a sign that the embryo is dead and the ones that sank were taken and sown.

3.2.3 EXPERIMENTAL DESIGN AND TREATMENTS

The experiment on propagation of *K. africana* was done at Astra Campus in Bindura. This was done to evaluate the effects of pre-treatment method to break seed dormancy of *K. africana* and to also evaluate the effectiveness of different propagation methods. A completely randomized design (CRD) was used to evaluate the effects of different propagation methods of *K. africana.* The experiment had branch cuttings and seedlings which were randomly sampled. A total of 66 branch cuttings were used and they were planted in a sand bed and which had three replicates of 22 branch cuttings each. They were ±20 cm long and had a diameter of ±2.5 cm. The cuttings were planted at a 45^0 angle. The branch cuttings were monitored for shoots which were counted and measured. The cuttings were kept in a shaded nursery.

The viable seeds of *K. africana* were randomly sampled and were put under one pre-treatment method namely: soaking in 98% concentrated sulphuric acid, a total of two treatments were used for the study including the control. For each treatment, 30 seeds were used. Three replications, of 30 pots, each containing 1 seed were done for all the two treatments. Replicates were randomly placed in the nursery. Seeds were then germinated in medium sized black polythene pots. Measurements taken were germinated seeds, germination percentages and germination count was recorded for 3 weeks.

Table 3.1: List of pre-treatment methods used for the study.

	Treatment	**Number of seeds**
1	Acid treatment	30

2	Control	30

3.3 TREATMENTS USED

3.3.1 SOAKING IN 98% CONCENTRATED SULPHURIC ACID

Scarification can be used to speed up the process of seed germination, rather than waiting for nature to alter the seed coats. Soaking seeds in concentrated sulphuric is a process that commercial growers use to scarify seeds. A total of 30 seeds which were stored for 1 year were soaked in concentrated sulphuric acid for five minutes and a stop timer was used to measure the soaking times and then washed thoroughly for 30 minutes under running water. Thereafter the seeds were sown in polythene bags with media. After every seven days the germinated seeds were counted. The counting continued until germination stopped. Germination percentage was calculated as the ratio of germinated seeds during a specified time to the total number of planted seeds.

3.3.2 THE CONTROL

A total of 30 seeds which were fresh from the fruit were planted in polythene bags with media and then monitored for germination and replicated three times with 30 pots having 1 seed.

3.3 NURSERY AND FIELD PERFORMANCE EXPERIMENTAL LAYOUTS

A completely randomised design was used for this experiment. Sowing was done in medium-sized black polythene pots that were filled with media which were randomly placed in beds. A total of 3 replicate plots were used for the treatment. Transplanting of the seedlings was done at the Bindura University Farm. The seedlings were planted in holes that were 15 cm by 15 cm.

3.4 SURVIVAL, NURSERY AND FIELD GROWTH PERFORMANCE

3.4.1 MEASUREMENTS

Survival was determined at the end of the nursery period. A pair of digital calipers was used to measure root collar diameter. The total height and root collar diameter and number of seedling were measured and recorded once a week.

Survival of the seedlings in early field was determined at the end of the field trial. A pair of digital calipers was used to measure root collar diameter. The total height and root collar diameter were measured and recorded every week.

3.4.2 DATA ANALYSIS METHODS

All data were tested for normality using Kolmogorov-Sminorv test and equality of variances using a Levene's test and met the assumptions. To test for the effect of time on height, survival, germination and root collar diameter a repeated measures ANOVA was used. Since same trees were measured each week, the height for each week was fitted as the within-subjects variable. Where significance occurred LSD post hoc with a confidence interval adjustment was used. Data were analysed in SPSS version 23 at 5% level of significance.

CHAPTER 4

RESULTS

4.1 GERMINATION RATE OF *K. AFRICANA*

There was a significant difference in the germination percentage of *K. africana* across the treatments ($F_{6,15}$ = 17.02; p=0.045). The highest germination percentage was recorded in sulphuric acid (85.3%) while the lowest was recorded in the control (82.5%) (Figure 4.1).

Treatment	Mean Total Height ± SE	F-value	P-value

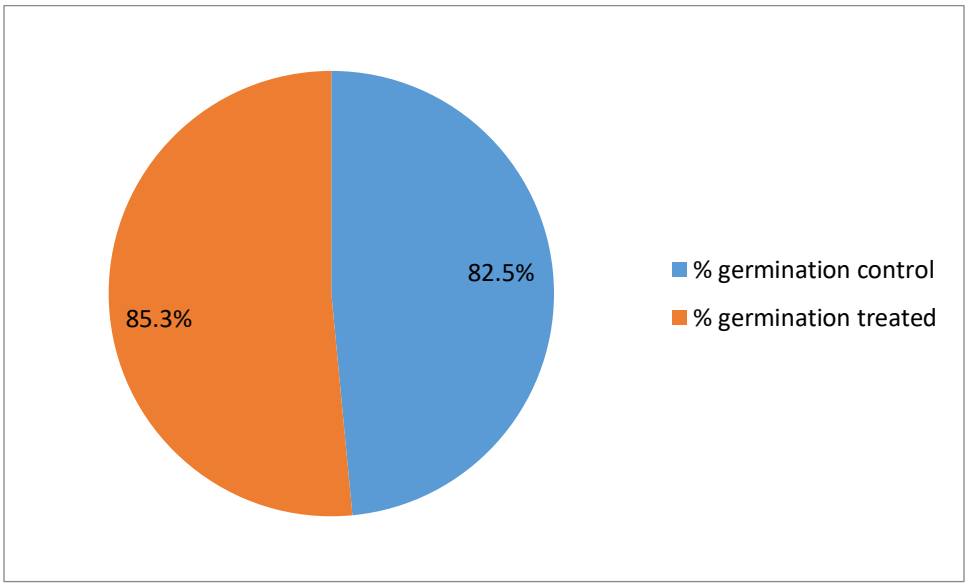


Figure 4.1: Germination percentage of *K. africana* for seeds subjected to different treatment. methods.

4.2 TOTAL MEAN HEIGHT AND ROOT COLLAR DIAMETER OF *K. AFRICANA* DURING EARLY NURSERY PERIOD (JANUARY 2019 TO FEBRUARY 2019)

In terms of mean total height performance, *K. africana* seedlings had a slight difference between the two treatments (Table 4.1). The seeds which were soaked in sulphuric acid had a higher mean height (7.89±0.13 cm) and the seeds which were not treated had (7.73±0.13 cm).There was significant difference in terms of root collar diameter seed which were soaked in sulphuric acid had a higher mean of (3.18±0.038 mm) and untreated had (2.93±0.044 mm).

Table 4.1: Nursery Growth Performance Mean Height for *K.africana* Mean±SE

Sulphuric Acid	7.8945±0.13220	38.596	0.000
Treatment	**Mean Total**	**F-value**	**P-value**
Untreated	7.7344±0.13948	39.771	0.000
	Diameter ± SE		

Sulphuric Acid	3.1817±0.03814	9.537	0.000
Untreated	2.9393±0.04411	8.829	0.000

Table 4.2**:**Nursery Growth Performance Mean Diameter for *K.africana Mean±SE*

4.3 ROOT COLLAR DIAMETER AND TOTAL HEIGHT OF *K. AFRICANA* DURING THE EARLY FIELD PERIOD (FEBRUARY 2019 TO MARCH 2019)

The mean height of *K. africana* did not change significantly during the 1st two weeks, but increased in week 3 before it dropped in week 7 and the mean root collar diameter did not significantly increase during the four weeks and then dropped in week 7.

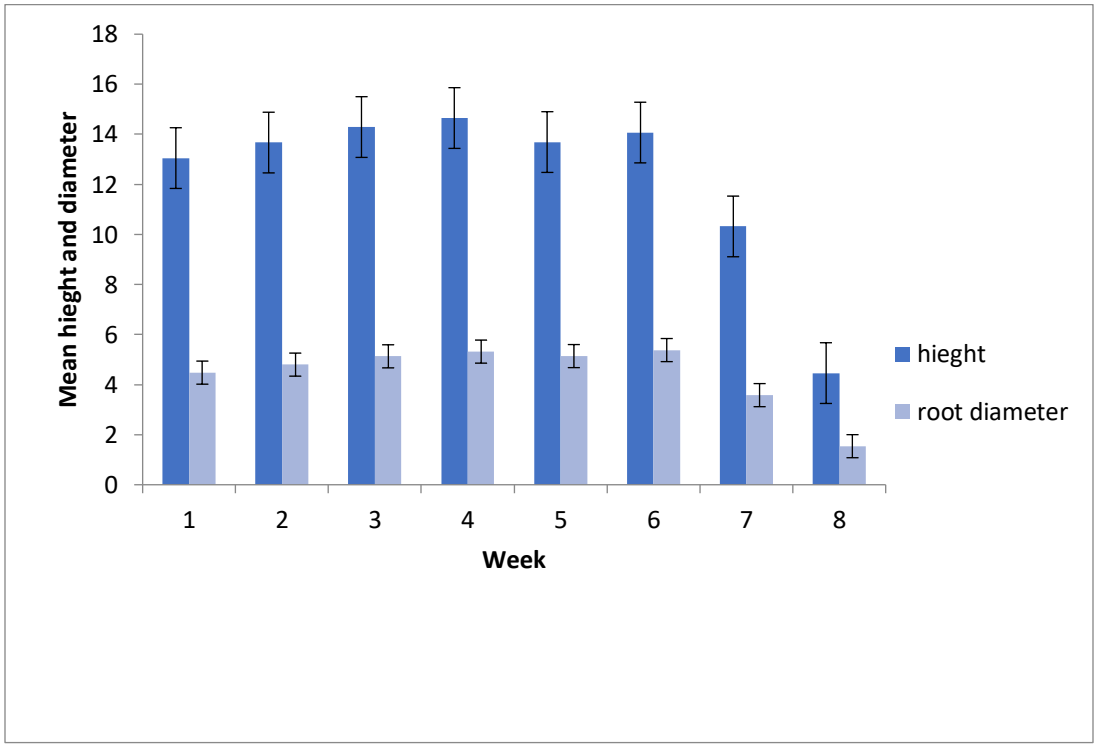


Figure: 4.2 mean height and root collar diameter in the field for eight weeks

4.4 ESTABLISHMENT AND PERFORMANCE OF BRANCH CUTTINGS OF *K. AFRICANA* FROM JANUARY TO MARCH 2019

The number of shoots significantly differed across the weeks (($F_{8,12}$ = 33.6; P<0.001). The number of live shoots sharply increased during the early weeks of growth from 4 shoots at week 2 to 41 shoots in week 3. However, there was a significant drop in the number of live shoots as the number of dead shoots increased (Figure 4.8).

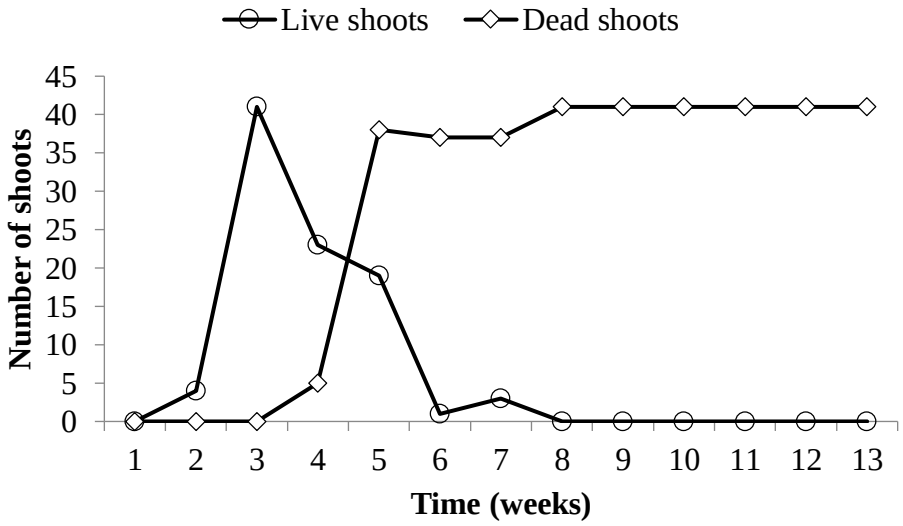


Figure 4.8: Number of shoots counted per week for 13 weeks during the nursery period for branch cuttings.

CHAPTER 5

DISCUSSION

5.1 EFFECTS OF DIFFERENT PRE-TREATMENT METHODS ON *K. AFRICANA* GERMINATION

Seeds of Bignoniaceae family are well-known for exhibiting dormancy due to their hard seed coats. The seed-coats are impermeable to water and oxygen (Ali *et al*., 2011). This is a trait which cuts across the entire genus in this family. Seed coats may possibly impose dormancy because they may contain growth inhibitors according to Baskin and Baskin (2001). It is interesting to note that the results of different treatments in this present study do not confirm that *K. Africana* seeds truly exhibit dormancy due to hard seed coat. According to Grace et al. (2003) germination rate is poor, and seeds are slow to germinate, germination improves after 1 year of storage. Dormancy is a limiting factor for germination. This was shown through the germination percentages obtained from the present study where the germination had a slight significance difference. This further highlighted the report of Rao *et al*. (2006) that says unlike cultivated species, seeds of wild plant species are dormant.

Soaking in sulphuric acid was the most effective pre-treatment method. This concurs with the report that was given by Nalawadi *et al.* (1977) that seeds of *C. fistula* which were soaked in sulphuric acid for 5minutes had the highest germination percentage. However, in this study, though sulphuric acid had a higher percentage, it was slightly higher than the germination percentage of untreated seeds. This could explain the higher germination of acid treated seeds as compared to untreated because acid causes a wet-heat combustion on the seed-coat causing it soften allowing in moisture and oxygen. Arowosegbe (2016) states that the highest germination percentage was found in the seed lots soaked in 98% sulphuric acid which had 100%.

5.2 EARLY NURSERY GROWTH PERFORMANCE AND SURVIVAL OF *K. AFRICANA*

During early nursery performance, the use of seedlings proved to be the most effective propagation method of *K. africana.* The seedlings showed higher and greater performance in terms of height and root collar diameter. The findings from the study concur that seedlings are usually the best and most effective way to propagate *K. africana*. Similar results were obtained by Agbogid *et al.* (2012) who demonstrates that due to the pre-treatment of *Dacryodes edulis* it had a significant effect on improving seed viability and it enhances seedling growth and

performance. The RCD of the seedlings was initially lower until it started to gradually increase. The seedlings were growing in height more than RCD.

The cuttings of *K. africana* had good early nursery performance. The cuttings in the first few weeks had buds which later developed into shoots. However, the shoots died before they could be measured. This concurs with a study done by Kochhar *et al*. (2005) stated that the stem cut may have converted most of the stored material for lignifications rooting and shooting. The presences of the buds were due to the fact that the cuttings were using stored food but after the food was used up the shoots dried and died.

The cutting could have been treated with rooting hormones in order to encourage root formation. In this study however the researcher failed to acquire rooting hormones due to financial constraints. This helps the cuttings to develop hormones that enable it to develop into an independent plant. Another study also revealed that the basal surface of the cuttings should be coated to keep out water and to heal the wound and promote plant growth. The present study did not coat the cuttings therefore, this could be a reason why the cuttings could not become independent plants.

The results from the present study confirm the assertion made by Leakey *et al.* (1983) who highlighted the difference between performances of different rooting medium. He attributed this difference to some internal factors controlling rooting ability such as oxygen, pH, water and porosity which are generally different from one substrate to another. In fact, as described by Loach (1988), these factors may affect tissue respiration and cell dedifferentiation at the base of the cutting from where roots appear.

5.3 EARLY FIELD PERFORMANCE AND SURVIVAL OF *K .AFRICANA*

Field performance of *K. africana,* was only measured by the use of seedlings. This was because other propagation method of branch cuttings did not succeed and make it to the field trial. In the field the species performed fairly well. During the first few weeks the species had a higher height growth rate than that of RCD. This may because the species was adjusting to the new environment and hardening off. During the last few weeks the RCD became higher, may be because the seedlings had hardened off. The growth rate in height later decreased probably because the place had many weeds which were weeded regularly but the seedlings could still not compete enough. Therefore, seedlings were competing for light, space and nutrients this may

have contributed to their growth performance. This corresponds with a study done by Hennon *et al.* (2009) shows that it is possible that the slower early growth of seedlings allows for greater competition from adjacent vegetation.

While in the field, some of the seedlings died this may have as a result of failing to adapt to the field conditions. Some of the seedlings developed brown spots on their leaves. After the appearance of the brown spots all the leaves fell and the plants subsequently died. Spots on the leaves of *C. alata*, are most often brownish and tan or black (Ebbels and Allen, 1979) similar to the present findings. Therefore, this affected the survival of seedlings in the field, the fact that the seedlings were attacked by bright light. However, few of the seedlings were able to survive. In order to maximize survival and growth, it is essential to water, weed around the transplanted seedlings and the protection against pests enhance seedling growth (Bognounou *et al*., 2010).

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

From the study it is concluded that both pre-treat and untreated seeds of *K. africana* can be used successfully as propagation method. Treating seeds with soaking in acid improved germination. The study also revealed that propagation of *K. africana* can also be done successfully using untreated seeds. However, the exogenous factors like media pH, temperature of the environment and the season in which they are grown must also be considered. Hence, from the study at present, *K. africana* can be successfully propagated from seed germination.

6.2 RECOMMENDATIONS

6.2.1 The use of untreated and acid treatment can be adopted for germinating *K. africana* seeds.

6.2.2 This study also recommends an attempt at other seed pre-treatment methods such as boiling and soaking in tape water.

6.2.3 This study also recommends that further research be done on the effects of the use of rooting media for root and branch cuttings.

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