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GERMINATION RESPONSES, EARLY GROWTH PERFORMANCES, USES AND COMMUNITY PERCEPTIONS OF *Rhamnus prinoides L'Herit* (Rhamnaceae) AT TAHTAY MAYCHEW WEREDA, CENTRAL ZONE, TIGRAY REGIONAL STATE, ETHIOPIA.

By

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Addis Ababa, Ethiopia

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A Thesis Submitted to the Department of Zoological Sciences in Partial Fulfillment of the Requirements for the Degree of Master of Science in General Biology

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GRADUATE PROGRAMS

DECLARATION

This is to certify that the thesis prepared by EfremGebreaftseentitled: Germination responses, early growth performances, uses and community perceptions of *Rhamnus prinoides* L'Herit (Rhamnaceae) and submitted in fulfillment of the requirementsfor the degree of Master of Science in General Biology, complies with the regulations of the University and meets the accepted standards with respect to originality and quality.

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1. _____	(Examiner)	_____	_____
2. _____	(Examiner)	_____	_____
3. Prof. Legesse Negash	(Advisor)	_____	_____
4. _____	(Chairman)	_____	_____

DEDICATION

This paper is dedicated to my beloved wife Roman Gidey, my sister Kiros Gebreaftse and to the whole family members for they have nursed me with care and affection and paved me the way towards education thereby contributing immensely to the success of my life.

STATEMENT OF AUTHOR

First, I declare that this thesis is my own work and that all sources of materials used for this thesis have been duly acknowledged. This thesis has been submitted in partial fulfillment of the requirements for MSc degree at Addis Ababa University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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Name: Efrem Gebreaftse. Signature……..

Place: Addis Ababa University, Addis Ababa

Date of submission:……

BIOGRAPHICAL SKETCH

I, Efrem Gebreaftse The author of this thesis, , was born on March 28, 1970 E. C in Central Zone of the Tigray Regional State, Northern Ethiopia from my father Ato Gebreaftse and mother W/ro Tsehaynesh Birhane. I attended my primary, junior and high school education between (1984- 1994 E. C) in Adwa, then I joined Abbi-Addi, College of teachers' education, in 1995 E.C and had awarded Diploma in Biology in 1996 E.C and I had awarded My BSc degree in 2003 E.C from Mekelle University.

After My graduation, I worked as Teacher in Tahtay Michew woreda for 14 years and now have been working in the same woreda Wukro Maray preparatory school for 8 years.

In 2005 E.C, I joined the School of Graduate Studies of Addis Ababa University to pursue My MSc study in General Biology in the School of Zoological Sciences.

Abbreviations

CG= Control group

EG= Experimental group

GP=Germination percentage

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By Efrem Gebreaftse

Abstract

Gesho is scientifically *R. prinoides* that belongs to genus Rhamnus, family Rhamnacae and order Rhamnales that grows at altitude ranges from 1400-3200 masl. The objective of the study was to assess berry germination responses of *Rhamnus prinoides L'Herit* (Rhamnaceae). The study also addressed farmers' perceptions about this economically useful plant. This is achieved by designing and administering appropriate set of questionnaires to randomly selected respondents. The growth media used were mixtures of red soil, animal dung and sand in a ratio of 2:1:1, respectively under shade conditions. The study found that treated groups of seeds started germinating 20 days after planting these in the germination media, but the control group started after 22 days. Treated seeds yielded a final germination of 84%, while the control seeds resulted in 60%. Seedling survival of the treated *R. prinoides* seeds was 84.5%, while the control group was 66.6%. The mean root collar diameter provided 1.2 mm and 1.1 mm for plants derived from the treated seeds and the control seeds respectively. Mean value of height measured three times is 1.55cm, 3.05 cm 5.05 cm, and 1.5 cm 2.97 cm 4.85 cm for plants derived from the treated and the control seeds, respectively. At the same time, mean number of leaves (2.2, 3.3, 6.1 and 2, 3, 5.2) respectively at treated group with significant value. Dry weights (0.045 g and 0.032 g) for plants derived from the treated and control seeds, respectively, were significantly ($p < 0.05$) different from one another. Questionnaires presented to selected members of communities indicated that *gesho* plant is evergreen (with characteristically deep-green leaves), ecologically friendly and economically useful. They affirmed that the species can resist the effect of termites and can be harvested annually, if environmental conditions are favorable. However, the farmers lamented that this useful plant was highly affected by exotic plants such as eucalypt trees, which have become all too common around homesteads and smallholder backyard farms. Members of the communities (100%) said that *R. prinoides* has multipurpose uses, including its use for traditional beverages (*tella*, *tej*, *areki*), for medicine, as well as for economic benefits. According to 87.5% of the respondents, *gesho* plants differ in their periods of flowering and fruiting. Significant number of respondents (75%) said that, *gesho* plants can grow to flowering within 2-3 years, provided that environmental conditions are favorable. These respondents added that flowering often occurs in June and July of anyone year. Quite a number of respondents (25%) said, the plant can flower continuously, thus producing berries that pass through different developmental stages that range from immature green and red to mature, black (purple) stage, at which berries are eaten up by birds. This needs a great deal of care and patience is required for collecting ripe berries, since the latter are favorite foods for birds. Most respondents (65%) said, they collect ripened fruits and they follow correct steps but (35%) collect immature red from harvested leaves lead to an efficient germination. A significant percentage (77.5%) of the respondents explained that seedling establishment around homesteads is a challenge since it requires a constant supply of water. However, quite a number of the same respondents (22.5%) emphasized the possibility of establishing *gesho* plants around homesteads. The study also found out that it is not possible to make *gesho* leaf harvests more than twice a year (70% of the respondents), while 30% of them claimed that more than two-times harvest per year is possible if water and other inputs are available.

Key words/phrases: Berries, biomass, *gesho* root collar diameter

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1. Introduction

1.1. Background of the Study

Ethiopia is essentially a rural country whose economy is largely based on renewable natural resources. It is a center of plant genetic diversity with many important domesticated or wild crop species that have nutritional and/ or economic significance (Hancock, 1992). The domestication of useful plants and possession of the corresponding ethno-botanical knowledge on the traditional uses of plant species by a community is extremely essential. Further, understanding the process of domestication and developing strategies for sustainable use and conservation of plant species is critical since human evolution and civilization have been strongly linked to the skills of plant selection and propagation techniques (Legesse Negash, 2010). Consequently, knowledge of genetic diversity and ethno-botany of plant species could be useful in improving the selection and breeding strategies of local producers. In addition, it is important that plants of ethno-botanical significance have a wide range of ecological benefits and can serve as sources of valuable set of economic products and supplementary foods for the rural communities.

Rhamnus prinoides has multipurpose importance with relatively wider occurrence along climatic and edaphic gradients (Tefera Mokonen *et al*., 2015).Consequently, understanding and developing efficient propagation method for the species is very important. Since *R. prinoides* is primarily propagates by seed, it is critical that both berry collection and seed processing handled properly. Improper collection and storage methods are likely to produce less viable seeds especially when immature or diseased seeds are collected.

The germination performance of a seed lot can be summarized in terms of its viability and germination energy (Hampton and Hill, 2002). However, numerous other factors affect seed germination including seed dormancy, temperature, moisture and light quality (Bewley and Black, 1994). In increasing treats to the species and for the successful propagation and cultivation of the tree, understanding the germination physiology of the seeds and conditions for the establishment of the seedlings are very critical (Legesse Negash, 1995). The ecological and biological effects of wood ash recycling are one to maintain the traditional knowledge on the effect of wood ash applications for germination. The effect of alkaline wood ash on forests

and the physiological and biochemical responses of trees makes it possible to recommend wood ash for particular utilization to soil used as biochemical indicators (Fuzesi, 2015). In the current study, a question raised why most farmers rub using wood ash during extracting fruits of *gesho* as well as enough seedlings of *gesho* could not be found at nursery sites. In addition to this, the society has different traditional back ground knowledge of this plant in fruiting time and using for different purposes. Thus, the researcher triggers to attempts made to investigate the effects of wood ash on seed germination, early growth performances, uses and perceptions of society at *R. prinoides* and finally to document and share the knowledge of society.

1.2. Research Questions

1. How R. *Prinoidies* respond to environmental conditions during germination at nursery site?

2. How do communities manage the domestication, propagation and cultivation of *R. prinoides*?

3. How can an effective method of seed-based propagation developed in order to make *R. prinoides* as an important component of home garden that keep the livelihoods of the communities?

4. How difficult or easy is it to get mature berries of *R. prinoides* that are suitable for the propagation of the species from seeds?

5. How important is *R. prinoides* in the livelihoods of rural communities?

2. Objectives of the Study

2.1 General Objective

The general objective of the study was; to investigate seed germination responses, early growth performance and uses of *Rhamnus prinoides*.

2.2 Specific Objectives

-To determine the germination status of *R. prinoides* at nursery conditions in plastic pots.

-To identify the effect of wood ash for the process of germination of *R. prinoides.*

-To identify the better method of propagation of *R. prinoides*.

-To determine the growth performances (height and biomass) of seedlings in both groups.

-To assess the economic importance of *R. prinoides* to the community.

3. Literature Review

3.1 Biology of *Rhamnus prinoides*

Rhamnus prinoides L'Herit (Appendix. 1A) is evergreen shiny leaf buckthorn African shrub or small tree that belongs to the *Rhamnaceae* family. The plant grows up to 8 meters in height and has globular, glossy and serrated leaves (Thulin, 1988). The longer and shorter leaves found on the same branch with alternate on either side in a distinctive arrangement and their length of leaves varies from the shorter 10 mm up to the longer 125 mm (Vetter, 1997). The shape of leaves may be ovate, oblong or elliptical with acuminate to acute apex and acuneate to rounded leaf base (Vetter, 1997). The flowers of *Rhamnus prinoides* are light yellow-green, solitary up to 20 mm when in fruit and they are popular with bees that probably pollinated them. In addition to this, the flower consists of a puberulous receptacle, 5 acute sepals, 1 mm long petals (may be absent),1 mm long filaments, 3 or 4 ocular ovary and a 1 mm long style (Orwa *et al*., 2009). The raw fruits are about the size of pea, round that clearly divided in to three-compartment parts with 5-8 mm in diameter, attached with about 2 cm dropping stalk. The glossy foliage and colorful fruits at various stages are fleshy green and shiny red turning to blackish-purple as they ripen (Appendix.1B), sometimes becoming black so many fowls favored to eat and most likely disperse the seeds. Again, it contains with obconic stone with 3 or 4 seeds inside (Volleson, 1989; Orwa *et al*., 2009).

3.2 Taxonomy of *Rhamnus prinoides*

Rhamnus prinoides is under kingdom Plantae, order Rhamnalesand the genomic name is *'Rhamnus'*, which is derived from an ancient Greek word *rhamnos* for blackthorn meaning a 'tuft of branches' and the species name *prinoides* means 'resembling prions' which is an ever green oak. The taxa belonging to the genus *Rhamnus* found in all tropical, sub- tropical and temperate regions (Thulin, 1988; Orwa *et al*., 2009). In this genus there are about 150 taxa, but from these only- two, namely *Rhamnus staddo* and *Rhamnus prinoides* species occur in Africa (Berhanu Abegaz Molla., *et al*, 1999; Thulin, 1988; Kebede Teshome 1994) belong to the family *Rhamnaceae (*Phillipis, 1994*)*. French botanist Charles Louis L'Heritier de Brutellefirst described it in 1787 (Thulin 1988). *R. prinoides L'Herit*, common name is dogwood, Amharic, Afan Oromo and Tigrigna name is *gesho* (Azene Bekele *et al*., 1993).

3.3 Ecological Distribution of *Rhamnus prinoides*

R. prinoides is both wild and garden plants of the species that have evergreen shrub or small tree height up to 8 meters, which is widely distributed and commonly cultivated between altitudes of 1400 to 3200 meters above sea level (m.a.s.l) of Africa (Volleson, 1989; Hedberg and Edwards, 1989). Even though it grows readily in most types of soils but thrives in moist, humus-rich soils of kola, weynadega and moist dega agricultural zones of Ethiopia (Azene Bekele *et al*., 1993), with annual rain fall in the range of 600-800 mm tolerating 500-1200 mm and found in areas with distinct dry season. According to Berhanu Abegaz Molla *et al.*, (1999) in South Africa it referred to as drought and forest resistant plant. Averagely this plant grows best in areas where the mean annual temperature falls with the range 14-22^{o}C but can tolerate 8-32^{o}C with slow growing when in low rain fall areas through it can grow 1 meter per year in wetter area and has noninvasive root system.

Montana wild forest plant usually found in edges or clearings and areas of farmer cultivation also in riverine forest, secondary forests and scrub also widely planted in hedges and garden that is managed by local people or farmers (Fullas, 2003). This plant is native to Africa countries locally found in; East tropical Africa like Tanzania, Uganda, exotic to Kenya; North east tropical Africa Ethiopia, Eretria; South tropical Africa- Angola, Malawi, Mozambique, Zambia, Zimbabwe; West central tropical Africa-Cameron, Democratic Republic of Congo In addition to this, it can also found in Arabica (Thulin, 1988; Orwa *et al*., 2009). Furthermore, with other cultivated species, *Rhamnus prinoides* (*gesho*) has the origin (indigenous) of Ethiopia. It is grouped as dicotyledonous angiosperm plant that is cultivated widely in parts of Ethiopia as household in shrub or tree form (Tefera Mokonen *et al*., 2015). This plant can also casts so deep shade that it often prevents growth around it but can withstand amount of forest and grows well in light shade under trees and equally well in full sun (Orwa *et al*., 2009). From the regions of Ethiopia, *Rhamnus prinoides* also distributed in Tigray, Gonder, Wollo, Arsi, Gojam, Ilbabur, Keffa, Gamogofa, Sidamo, Bale, and Harerge (Tewoldebrhane Gebre-Egziabher *et al*., 1989).

3.4 Economic Importance of *Rhamnus prinoides*

The plant *R. prinoides* has tremendous importance in Africa by using all different parts of this plant harvested and being used for nutrition, medicine or other religious purposes. This

plant can be harvested three times annually if properly managed by cultivation, weeding and irrigation during the dry season that help to generate cash crop for growers by sailing the leaves and stems used to add flavor for the preparation of traditional alcoholic beverages like *tella*, and *tej* by mixing with other components responsible for bitter characteristic. It is estimated that it is consumed by over 5 million people every day (Berhanu Abegaze and Teshome Kebede 1995; Hayeshi. *et al*., 2004; Vitter, 1997; Ashenafi Mogessie, 2006). Besides, it can serve as a commercial hopping agent in the brewery in industry that can be used as alternative substitute hop and raise economic benefits through import substitution (Berhanu Abegaz Molla *et al.*, 1999). Apart from this, in some African countries based on ethno-botanical studies, *Rhamnus prinoides* can be used for several traditional medicinal values. For-instance their leaves are used for the treatment of diseases disorders like stomach complications, joint pain, fever, diarrhea, common cold, malaria, body weakness, appetizer, pneumonia, gonorrhea, rheumatism, ring worm infections (Hilemichael Alemu *et al,* 2007) and diseases caused by *Staphylococusaureus*. This is because *Rhamnus prinoides* maintains acidic PH during *tella* fermentation, so it is used to modify the nature of mesh growth of micro-flora and inhibits the growth of undesirable microorganisms (KebedeTeshome, 1994).

The flowers that make the tree a very important source of honey as it flower profusely when annual honeybee plants ceases flowering. For food to provide nutritional requirements to the bee colonies nectar, as source of honey provides heat energy for honey bees and pollen provides proteins, vitamins, fatty substances and other nutrients (AmsaluBezabih, 2000). This makes important in ensuring sustainable honey production. Because *R. prinoides* have both pollen and nectars, so the honeybees collect these things from the flowers (Fichtl and Admassu Adi, 1994; Dechasa Jiru, 1999; Asfaw Debebe *et al*., 2003). Over all, this plant is a good source of essential minerals and virtually free from toxic metals since the assessment level of essential and heavy toxic metals particularly with respect to human health and quality of their products (Afewerk Gebre and Bhagwan Chandravanshi, 2012). Furthermore, the trees can be cultivated on the banks of streams; to provide shelter, to control soil erosion and as a leaving fence and hedge to act as a windbreaker and loss of water through surface run off minimized. Because the root system of the trees improves drainage and aeration then it helps in retaining soil on sloping land (Fernandes *et al*., 1984).

3.5 Seed Germination

New plant generation starts with a seed, which usually contains a fully developed embryo that can survive to period between a seed maturation and germination (Bentsink *et al*., 2007). Germination incorporates those events that commence with the up-take of water by the quiescent dry seed and terminate with the elongation of the embryonic axis (Bewley and Black, 1994). Seed germination is a critically important in the plant life cycle and the ability of an imbibing seed to initiate germination, can be considered as a main regulatory in the development of the plant (Johnson, 2000). So it is a critical period determining further perpetuation of species in natural habitat or their elimination from area (Valverde *et al*., 2004). Due to this, the seed occupies a strategic position in the life cycle of higher plants (Bewley and Black 1994). In addition to the above, the time from seed sowing to seedling establishment is considered as a vital phase, which decidedly influences the final yield and quality of seeds (Wurr and Fellows, 1983). The factors needed for germination to be initiated, three conditions are required (Hartman *et al*., 2004); 1. The seed must be viable, 2. The seed must be subjected to appropriate environmental conditions like availability of water, proper temperature, supply of oxygen and sometimes-light microorganisms are needed for seed coat decomposed, 3. Any primary dormancy present within the seed must be overcome. After the seed is germinated, it requires favorable conditions for its establishment. All these factors become available if the seeds have the chance to germinate in their habitats or if the original habitat is not seriously distributed (Legesse Negash, 1995). Then after the seed absorbs water with the addition of other factors, there is an expansion and elongation of seed embryo next to this the radicle grows out of the covering seed layer (Hermann *et al*., 2007).

3.6 Factors Affecting Seed Germination

Seed germination is one from the critical phases of plant development (Johnson, 2000). Plant propagations of many indigenous tree species from seeds have been difficult due to lack of precise knowledge on their seed biology and germination physiology (Legesse Negash, 1995), good germination response is a function of multiple factors like seed moisture status, suitable germination conditions and good mast-fruiting (Legesse Negash, 2003). Even though this is the fact, each plant species has a specific range of environmental requirements necessary for germination among them. The most common determinants are; water

(moisture), temperature, oxygen and sometimes light and PH of soil (Christoffoleti and Caetano, 1998; Lu *et al.,* 2006). For optimum germination as well as early seedling growth necessary for mass multiplication of any plant species, is the propagation techniques (Nautiyal *et al*., 2001; Butola and Badola, 2006). Some of the factors that affect seed germination are describe below.

3.6.1 Seed Maturation and Dormancy

The issue of seed quality plays a major role in success of a germinated seed (Libson, 2001). Seed germination is a mechanism, in which morphological and physiological alternations result in the activation of the embryo (Herman *et al*., 2007), from these, physiology of matured seeds is very mandatory for planning of collection of seeds for high germination rate (Silva *et al*., 2008).

According to Finkelstein *et al* (2008), seed dormancy is the mechanism by which seeds can inhibit their germination in order to wait for more conditions that are favorable that means secondary dormancy. However, the primary dormancy is caused by the effects of absesic acid during seed development such seeds may never germinate (Bewley, 1997). Although seed dormancy is under the influence of plant hormones, seed morphological and structural characteristics, such as endosperm, pericarp and seed coat properties can also affect seed dormancy (Kucera *et al*., 2005). Timing and location of germination of seeds are also critical for the chances of the newly produced. Due to this, the temporal and spatial patterns of germination of seeds of many species are finally turned to environmental scenario (Sanchez and Mella, 2004). According to Batin (2011), fruit maturity at the time of seed harvest has an influence on the germination dynamics and specificity. For this reason seeds from immature fruits causes to reduced seedling performance as well as lower and slower germination and growth.

3.6.2 Temperature

From the environmental factors, temperature is one of the most important factors that regulates the timing of germination, partly due to dormancy or release and partly due to climate adaptation (Hartman *et al.,* 2004). According to Bewley and Black, (1994) temperature regulates germination in three ways; 1. By determining the capacity and percentage of germination, 2. by eliminating primary and /or secondary dormancy and 3. by

inducing secondary dormancy. Heat and temperature variations can affect seed viability and germination. Fluctuating temperatures that result from daily heating and cooling of seeds can be responsible for scarification of legume seed coats and increased germination percentage (Taylorson and Hendricks, 1977; Mbalo and Witkowski, 1997). Although germination occurs over a wide range of temperature for each species there is an optimal temperature and the rate of germination drops off at both above and below that temperature (Srivostava, 2002). Temperature affects seed germination in three main ways. These three cardinal temperatures can be recognized for every species namely the minimum and the maximum temperature beyond which germination is prevented and the average temperature of these can allow maximum germination in the shorter time (Cheng *et al*., 2012 and Hartmann *et al*., 2004). The optimum temperature for non-dormant seeds of most species is between 25^{o}C and 30^{o}C, but can be as low as 15^{o}C (Hartmann *et al*., 2004). However, temperature range for germination depends on the year in which plants complete their life cycle and geographic origin of the species. Narrowing and widening of range for germination could occur by movement in the low or high temperature that limit for germination or both depending on the species (Probert, 2000).

3.6.3. Water and Oxygen

For germination to occur, seeds require moisture and oxygen (Hartman *et al*., 2004). The uptake of water by seeds that occurs through imbibition is the first process that takes place during seed germination. Water absorption is resulting in the expansion and elongation of the composition of the seed. The availability of water in liquid or gases forms in the environment and the permeability of the seed coat or fruit to water determines the context to which imbibition occurs. Though protein is the chief water-imbibing component of the seed, cellulose and pectin contributes to the swelling of seeds, where as it was found that starch does not add to swelling (Hartman *et al*., 2004). Sever water Stress is a dominant factor that limits the establishment of seedlings in the field of Ethiopia (Jirega Gindada *et al*., 2004). For instance, germination of lettuce and wheat in saline soil is reduced by decreased in water potential (Berrie, 1984). Again, it is required by plants for the manufacture of carbohydrates as a vehicle for the translocation of food and minerals. Internal moisture stress causes reduction both in cell division and cell elongation, thus affecting organ growth (Tisdale *et al*., 1985). Exposure of plants to drought stress affects not only growth and metabolic process also

plant survival. In contrast to this, germination is also reduced under waterlogged condition, since at this condition there is an occurrence of oxygen stress. Seeds of many species will not germinate at an oxygen level considerably lower than that normally present in the atmosphere (Mayer and Poljakoff-Mayber, 1982). Over all plants, water relation-ships of tree seedling remain understood as most research efforts focused on crops or larger tree size classes (Bunker and Carson, 2005).

3.6.4 Light

Physiologically mature seeds are either dormant or non-dormant and if germinate once the dormancy is relived or optimum conditions are provided. Environmental conditions may be imposing some dormancy condition on seeds and prolonged inhibition of germination may gradually enter a state of secondary dormancy (Karssen, 1995 cited in Ochuodho and Modi, 2007). Phytochrome appears in two forms, pr (red) and pfr (far red) which can be reversibly converted to either form by radiation at different wavelengths. Germination is determined by the amount of pfr relative to the total amount of phytochrome (Mayer and Poljakoff, 1989 cited in Probert, 2000). Seed germination in many plant species is inhibited by continuous white light and such seeds germinate well in darkness (Bewely and Black, 1994). Photo inhibition involves the operation of phytochrome A and B, and effectiveness depends on the duration of exposure and effluence rate (Bewley and Black, 1994). Photo inhibited seeds do not completely recover their germination conditions, except after treatment with GA_3 (Ochuodho and Modi, 2007). Phytochromes in the seeds are necessary for controlling seed germination, especially when the seeds are subjected to light. Light activates phytochromes as well as hormonal activities in plants (Seo *et al*., 2009).

3.7 Requirements for Nursery Establishment in Plastic Pots

In the fact of treating the species for successful propagation and cultivation of tree, needs understanding the germination physiology of seeds and cultivation of the nursery establishment of the seedlings are very critical (Hooda *et al*., 1986; Legesse Negash, 1995). The type of medium needed for germination should be light and porous to provide adequate oxygen to retain moisture and to allow for proper drainage. The germination mix should be free weed seeds and pests (insects, disease-causing organism) (Gibson, 2001). This is because the nursery bed density, shading, pricking out techniques seedling size at planting, watering

and fertilizer have significant role and long lasting effects on seedling quality. To this problem, based on the experimental results of different scientists that contain a mixture of red soil, well decomposed animal dung and sand with a ratio of 2:1:1 respectively (Legesse Negash, 2010).

4. Materials and Methods

4.1. Study Site

The experimental study was conducted in Tahtay Michew Wereda, at Wukro-Maray town, central zone of Tigray regional state, Ethiopia at a distance of 1050 km to northern part of Addis Ababa. The time interval to do the activity of experiment was carried out from April 11/4/2017 to July 10/7/2017. The study was focused on seed germination responses. Early growth performance of seedlings of *R. prinoides* were conducted using 40 plastic pots with mouth diameter 20 cm, depth 20 cm and 14 cm bottom diameter by comparing the two groups of seeds rubbed with wood ash and without rubbing of wood ash. The same is true to collect the perception of the society at *gesho* interview the samples were taken at Mai-Berazyo kebele and Mai Shum nursery site as well as from Wukro-Maray town.

4.2 Sampling Design

In the present study of the experimental activities 200 seeds of *Rhamnus prinoides* that was planted in to the plastic pots (buckets)were observed, the change of each seed and recorded what was observed from both experimental and control groups to calculate the germination percentage of seeds. The height and the number of leaves of each seedlings were measured counted every 30 days, but the collar diameter was measured at 60 and 90 days. Next to this from the germinated seeds 10 selected seedlings from each group were selected purposely to measure the height, collar diameter and biomass of seedlings of each group. In height measuring of seedlings, 1.5 meter tape was used from collar root up to top end of the shoot (meristem) and finally their mean was compared as in the form of tables and graphs. At measuring the collar root diameter, taking the widest part of the root collar using a Vernier caliper with thump wheel movement scale length of 12.5 cm by placing gently around the collar root and by finding the "0" on the bottom of the scale lines up with the non-sliding scale. Finally the value was read on the non-sliding scale (Appendix 6).

For evaluating biomass of seedlings, mostly distractive method was used. For this purpose, the seedlings were removed after 90 days. The roots of each sample was excavated

manually and washed thoroughly on a sieve of tea to reduce the detachment of root hairs and the detached part was mixed with the corresponding parts. Since it is usually measured by determining each part of seedling, properly labeled and dried until the constant mass at hot air oven at $80^{O}C$ for 12 hours to obtain dry mass (biomass) of each representative seedlings (appendix 7A). The dried seedlings were weighted using electronic balance and the average seedling dry weight was calculated (appendix 7B) and finally the means of both groups were explained.

In addition to this, Mai Berazyo is one of the Kebeles of this Wereda that was purposely selected based on the location of nursery work area of Wereda agricultural office locally called Mishum nursery site, again there are traditional plant growers around this site that regards to the objective of this study. From this nursery area, 15/25 nursery workers, 5/5 traditional tree growers, 5/10 from society around this area who brewers traditionally as well as 15/30 from Wukro Maray town of totally 40 individuals were selected using simple random sampling method and they were interviewed following the developed themes.

4.3. Fruit Collection and Processing

Woreda Tahtay Maychew is found in central zone of Tigray Regional state. It is found in the northern part of Ethiopia at the latitude of 14^{0} 0' 0" N and 14^{o} 0' 0" N and longitude of 38^{0} 30' 0" E and 38^{0} 30' 0" E, (Fig.1A and 1B). It is bordered with Mereb Leke Wereda in the North, Nader Adet Wereda in the south, Laelay Michew in the east and Medebay Zana Wereda in the west. The Wereda capital is called Wukro Maray and it is located 261 km far away from Mekelle to east direction. The Wereda climatic zones are located weynadega and kola with proportion of 70% and 30% of the Wereda's area respectively. The annual temperature is 20 ^{O}C and the annual rainfall is 400-700mm. The highest altitude of the Woreda is 2,493 meter above sea level and the lowest is about 1,401 masl. From this 73.2% of the Woreda is high land area but 26.8% is low land area and WukroMaray town is 1977 masl.

Source: From WoredaTahtayMaychew Plan and Finance office.

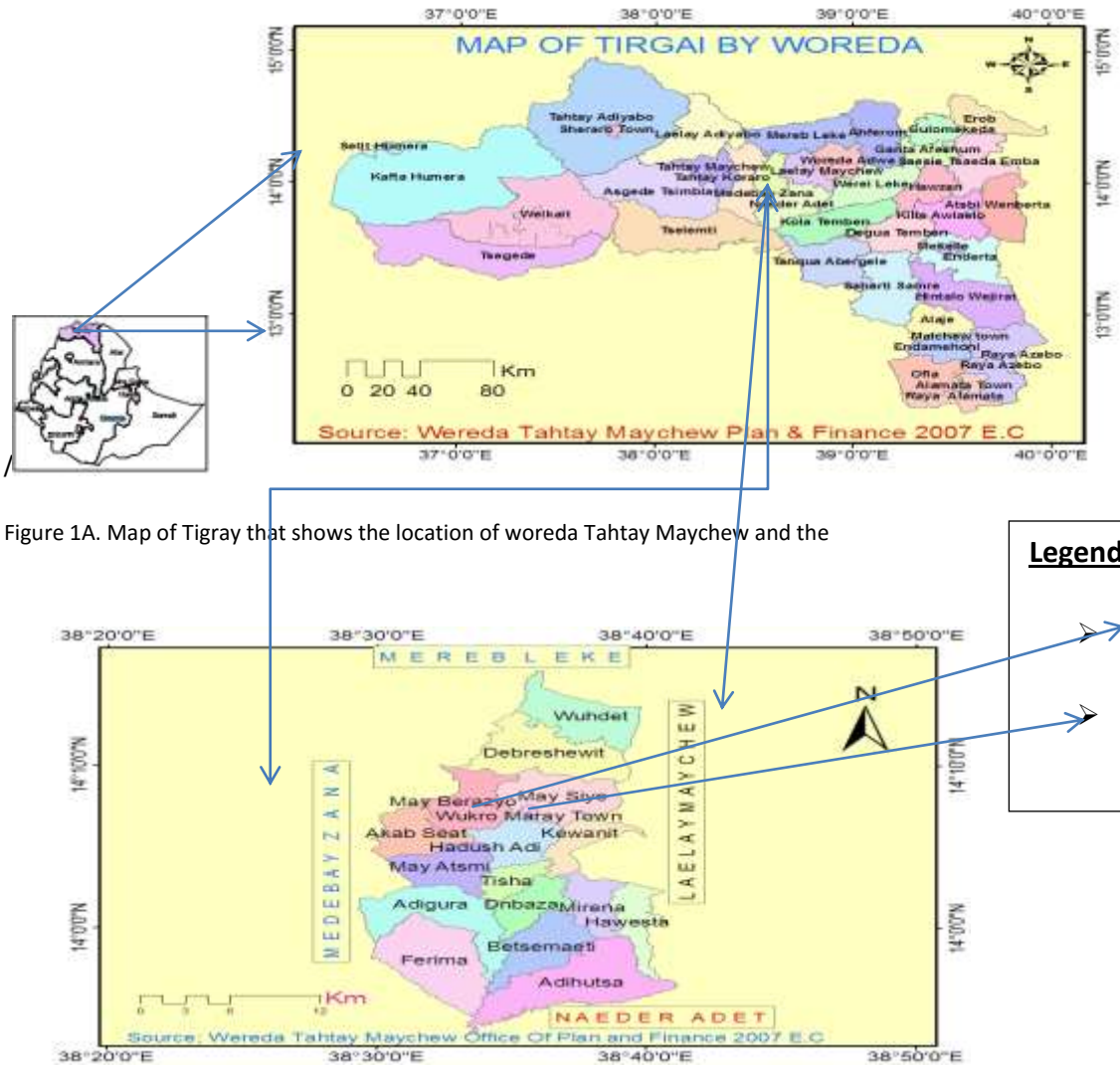
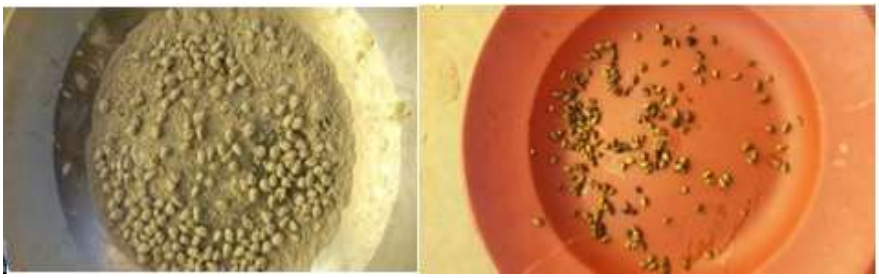


Figure 1A. Map of Tigray that shows the location of woreda Tahtay Maychew and the

Figure1B. Map of woreda Tahtay Maychew that shows the location of its tabias and study area.

The matured and uninjured healthy ripened fruits were collected from March 26-2017 to March 28-2017 in three days. During the time of collection, mainly by following the criteria like, observing the good performance based on the appearance of size and color of fruits (Appendix 1B) and the age of the plant in between *ca* 8-15 years. Because this is important to decrease diseases of the seeds and to increase seed viability. The fruits were collected from a local stand, to ensure a wide range of genetic base they are collected from 21 trees. Immediately after picking the mature fruits from the plant *R. prinoides,* they were collected in to polyethylene bags; next to, this dividing them; equally, in to two parts from their source plants and press them using the thumb and forefinger, the seeds were extracted and finally

rubbed with wood ash (Fig. 2A). In contrast to this at the same time the second half of the collected fruits were extracted but the seeds were not rubbed with wood ash (Fig. 2B), used as control group. Both the experimental and control groups were placed to dry at room temperature for 12 days.



A **B**

Figure 2 . (A) Seeds of *R. prenoides* extracted from ripe berries and rubbed with wood ash; (B) Control as seeds extracted through the same procedure as in A, but without treatment with wood ash.

4.4. Seed Germination and Nursery Establishment of Seedlings in Plastic Pots

The 40 plastic buckets (mouth diameter, 200 mm; depth, 200 mm) were filled with a mixture of soil, animal dung and sand in a ratio of 2:1.1 (Appendix 3). The prepared buckets containing the soil mixture were arranged randomly over a nursery bed and the treated seeds (5 seeds per pot), along with the control seeds (again 5 seeds per pot) were planted in each of the prepared pots. Thereafter, the pots containing the seeds were watered immediately with *ca* 1.5 L of tap water. Watering continued every other day, and the volume of water provided to each pot was *ca* 1 L. Counts were made every after one day until the completion of germination in all the pots. Height measurements were made on several juvenile seedlings at first with 30 days old, and on selected plant thereafter until 90 days the end of the experiment at the same interval.

4.5 Statistical Analyses

The number of seeds emerged to the surface of the soil as soon as data collections of germinated seedlings and they were recorded every other day. The starting and final dates of germination were recorded and the germination count was discontinued when no further

germination occurred for at least 14 days (2 weeks). At the end of this germination responses of seeds and survival were expressed in terms of germination percentage (GP) and seedling survival percentage was calculated using the following formula as follows;

1. GP=(n/N) *100% where; GP=Germination percentage

   n= number of germinated seeds

   N= total number of seeds

2. Percentage seedling survival = Live seedlings/Total seedlings * 100%

The statistical analysis was performed according to the data collected from the composition of experimental group and control group of the nursery establishment of seedlings that was analyzed by a one way of ANOVA using p-value 0.05 is significant (window 10 Microsoft Excel)with treatment factors and data collected from farmers using interview was expressed using percentage.

5. Results

5.1 Seedling Established in Plastic Pots

At the beginning of the experiment until germination of *R. prinoides* begins, no observable change was occurred at each of the plastic pots except germination of weeds. At the first time of observation of experiment, germination began from treated group on 20^{th} day of planting but the control group start to germinate 22^{rd} day. The germination of the experimental group is relatively faster than the control group with 2 days difference. As Fig. 4 showed, the maximum germination was at 24 day 18 seedlings emerged with an average of seven. However, control group 2 days later maximum 10 seedlings emerged to the surface of ground and averagely 5 per day was germinated. The final germination percent in the experimental pots in (table 1.) showed the highest (84%) germination percent followed the control group (60%). Three months are the longest germination period. As the data related that, the seeds germinated with wood ash (experimental group) germination started early compared to control group.

Table 1. Data of germinated seeds of both treatment groups at different time intervals with sums, averages variances and p-value.

Groups	Time of germination, days													Sum	Ave	Var.	p.value
	1	3	5	7	9	11	13	15	17	19	21	23	25				
CG	0	0	4	6	10	8	6	4	8	6	2	4	2	60	5	8.36	0.25
EG	0	6	18	8	16	7	8	5	6	4	2	3	1	84	7	26.9	

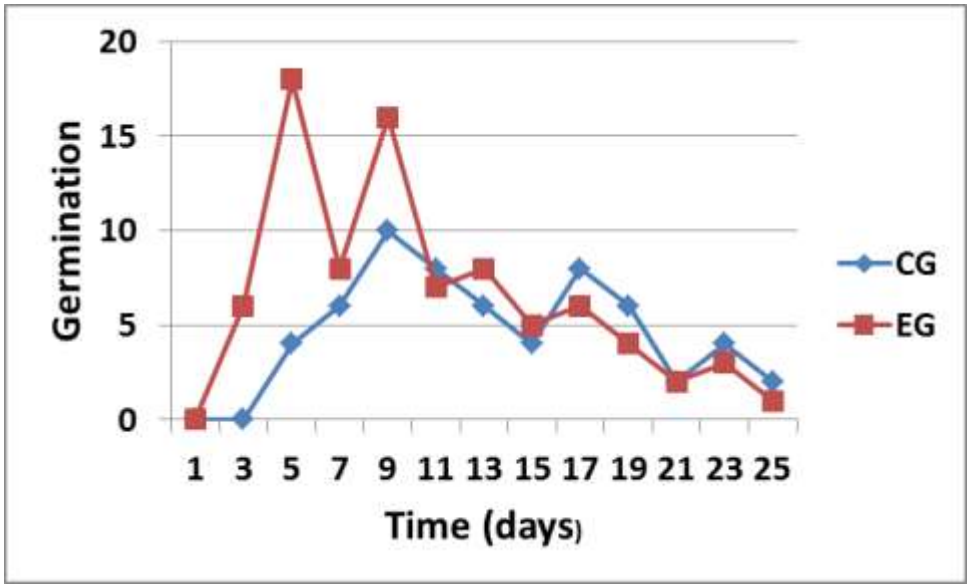


Figure 3 Seeds germinated at different time interval of both groups

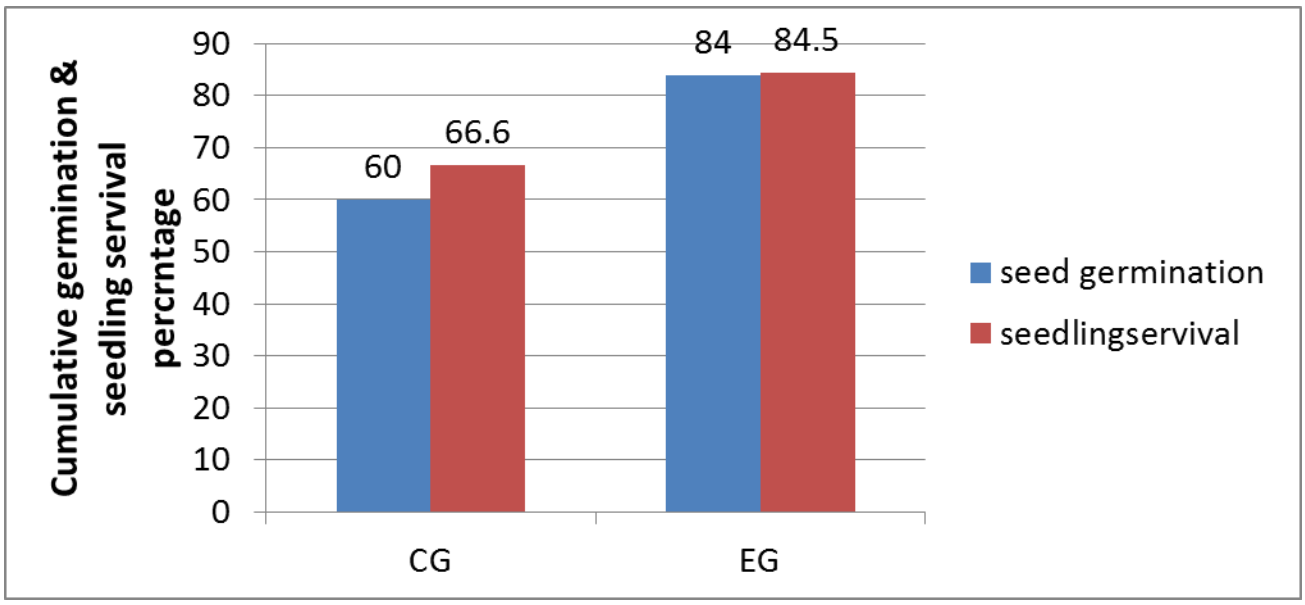


Figure 4. Cumulative germination percentage and seedling survival percentage of both groups

5.1.1 Seedling Survival

The survival percentage during the study period was good for experimental group of seedlings is range 84.5% while the control group ranges 66.6%, because some of the seedlings wilted and dried.

Table 2. Treatment groups, number of planted seeds, percentage germination and seedlings survival of *R. prenoides*

Groups	Number of sowed seeds	Number of germinated seeds	Percent of germination	Number of living seedlings	*Seedling survival Percentage
Experimental	100	84	84%	71	84.5%
Control	100	60	60%	40	66.6%

*Percentage seedling survival = Live seedlings/Total seedlings * 100%

5.1.2 Seedling Height

Seedling height was measured from the soil surface to the tip of the seedlings (Table 3).From the results of mean height measured three times, the first two consecutive results, at first EG 1.55 cm, CG. 1.5 cm with 0.67 p-value, at second is EG. 3.05cm and CG. 2.975cm with 0.62 p-value is insignificant. The final mean height of seedlings measuring day in both experimental and control group were 5.05cm and 4.85cm respectively with 0.5 p-value.

Table 3. Height (cm) recorded at the final day of both groups of seedlings of *R. prinoides* with their sum, average and p-value.

Height of seedlings(cm)											Count	Sum	Aver.	Var.	p-value
CG	4.5	4.5	5	4.5	6	4	4.5	4.5	6	5	10	48.5	4.85	0.44722	0.517
EG.	6	5.5	6	5.5	5	4.5	4.5	4.5	5	4	10	50.5	5.05	0.46944	

Table 4. Height measured at 30 days interval in both group with their sum, average and p-value

Groups	Mean height(cm) with 30 days variation				Count	Sum	Aver.	Var.	p-value
	1	30	60	90					
CG	0	1.5	2.75	4.85	3	9.1	3.033	2.865	0.9
EG	0	1.55	3.05	5.05	3	9.65	3.216	3.083	

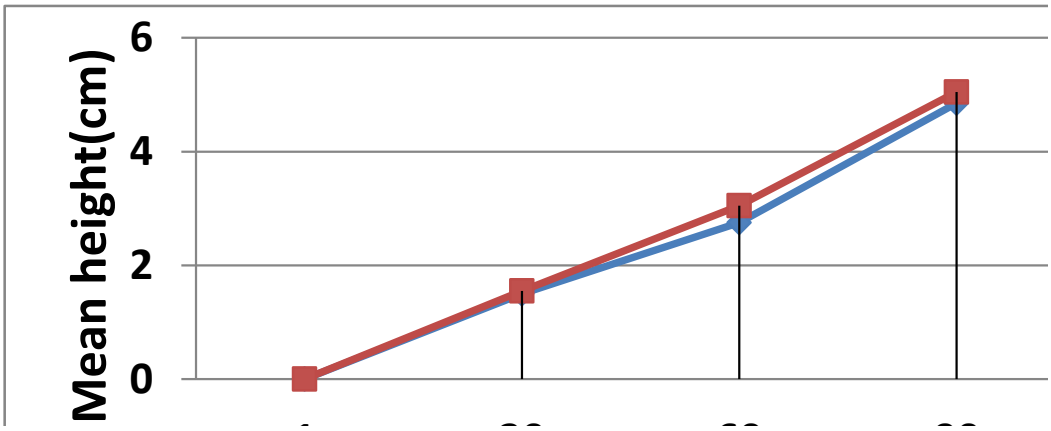


Figure 5 Mean heights measured graph with 30 days interval in both groups.

5.1.3 Number of Leaves

At the first count of 30 days old the mean number of seedlings were 2.2 while control counts 2 with 0.15 p- value. Again at 60 days old the mean value was 3.3 and 3 with 0.065 p-value respectively and at the end counted that, the experimental group having the average number of leaves is 6.1, while the control group averagely ranges 5.2 (table 5).

The values of the seedlings germinated at experimental group was statistically significant ($p<0.05$) compared to control group.

Table 5. ANOVA result of both experimental and control group with their sum, average and p-value of number of leaves.

Number of leaves											Count	Sum	Aver.	Var.	p-value
CG.	5	5	5	6	5	6	6	4	5	5	10	52	5.2	0.4	0.0377
EG.	6	6	7	6	4	5	6	7	8	6	10	61	6.1	1.2111	

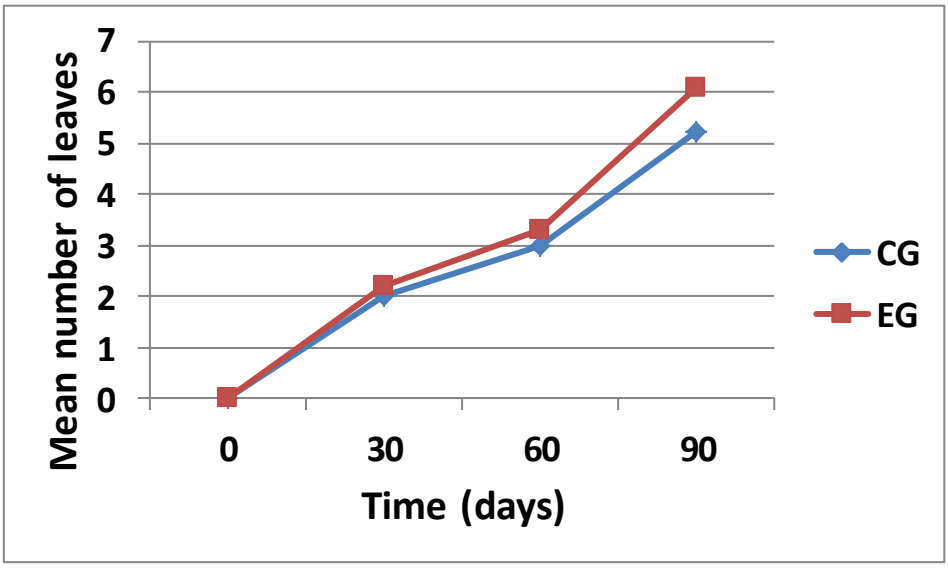


Figure 6 Mean number of leaves measured with 30 days interval in both group.

5.1.4 Collar Diameter

From the study, it was found that the average diameter at an age of two months old were EG. 0.65 mm and CG. 0.6 mm at 0.62 p-value and at three months was averagely attained 1.2 mm at the experimental group and 1.1 mm value of control group collar diameter (Table 6). Even there is a difference of experimental from control group; the result of ANOVA is not statistically significant.

Table 6. Collar diameter of both groups with their sum, average and p-value.

Collar diameter (mm)											Count	Sum	Aver.	Var.	p-value
CG.	1	1	1.5	1	1	1	1	1	1.5	1	10	11	1.1	0.04444	0.35
EG.	1.5	1	1	1	1	1	1	1.5	1.5	1.5	10	12	1.2	0.06666	

5.1.5 Biomass production

The mean dry weights of seedling recorded after 90 days of developmental stage of *R.prinoides*. Seedlings (Table 7) indicated that the mean biomass of the different seedlings at experimental group of total dry weight were 0.045 g, greater than the control group(0.032 g) at 0.02 p-value. The biomass of seedlings grown at experimental group were statistically significant ($p<0.05$) but control group is insignificant.

Table 7. Mean dry weight (g) of seedlings of *R. prinoides* harvested after 90 days of both groups with their sum, average and p-value.

	Dry weight										Count	Sum	Aver.	Var.
CG.	0.03	0.03	0.05	0.03	0.03	0.02	0.03	0.04	0.03	0.03	10	0.32	0.032	6.22E-05
EG.	0.05	0.04	0.05	0.05	0.04	0.03	0.03	0.05	0.06	0.05	10	0.45	0.045	0.000206
P-value	0.0217													

5.2 Interview Results

5.2.1 Importance of *Rhamnus prinoides*

R. prinoides usually planted around homesteads or in cultivated fields, alone or together with other annual/ perennial cash or food crops. Because the species is light tolerant, it thrives in open fields and consequently does not require shade as a prerequisite of its growth and development. Almost all of the respondents 40(100%) responded that *R. rpinoides* is economically useful plant and it has many multipurpose importance. As an example, it is important directly for the preparation of different traditional beverages deals with popular productions of alcoholic drinks like *tella* (Siwa in Tigrigna), t*ej* (Miess in Tigrigna) and

commercially available. In addition to this, some of the respondents 4 (10%) also said that *gesho* is used in beer production as an ingredients and Katikala (Areki Habesha) with a little amount in order to have bitter taste. Again, by selling the leaves of *gesho* for around 50-70 birr per kilogram commercially can solve the problem of the growers (farmers) and merchants. Therefore, it has a great role in the household economic security. Additionally, the same as the other flowering plants honeybees forage pollen and nectar through the year.

Medicinally in traditional way about 34 (85%) of respondents responded that since this plant has bitter taste in nature, then if a child and adult suffers with stomach pain, by chewing the tip meristems or leaves of *R. prinoides* helps to treat. Additionally it is important temporarily for the treatment of tonsillitis. Four of the respondents (10%) informed that, if cattle infected by the leeches, this plant is important to cure from this parasitic worm and if child infected fungi (Forefor in Tigrigna) at their head, the *gesho* juice helps to cure.

Even almost all plants are important to the society and to the ecosystem, all the respondents 40(100%) said that this plant has multipurpose advantages. Because economically more important to cause the environment evergreen, fertility of soil, habitat and more productive throughout the year in rapid responses of harvests per a year which would turn the income of growers than crop products. Fertility of the environment is very good as *Croton macrostachytes, Faidherbiaalbida* (Momonain Tigrigna) and *Cordia africana.* They said that if their plot of land covered by *gesho* plant, the living status of the society increases and the environment evergreen as well as if dried, it could use as wood and charcoal. For instance, four respondents (10%) raised that *R. prinoides* is not affected by termites. The exotic plants like eucalyptus plant (90%) responded that, they are very dangerous to the products of indigenous plants and they cause to dry the environment. If there is a little product of *gesho* around this plant, it causes the type of drink tasteless (less quality) also; it has with the taste of eucalyptus leaves. Additionally, four respondents (10%) said as evidence, first they were averagely owned 40 root numbers of *gesho* plant each, later when eucalypts plant was planted around this area, the products of *gesho* reduced from time to time and finally all they dried out. It can damage environment by its shadow, roots and shedding of leaves to any indigenous plant around it up to 10-20 meters away from it. From this, it is possible to conclude that exotic plants as eucalyptus changes the moistened environment to arid area and less productive.

5.2.2 Results of Interview Related to Flowering Period, Fruit Characteristics and Germination Process

According to 35(87.5%) respondents the growing time and the flowering period is different. This means if provided conditions are suitable, it is capable of flowering within 2 to 3 years. However, sometimes 5 (12.5%), said it extends up to 4 years. Moreover, with flowers occurring from the base to the tip of the numerous branches and branch lets. According to 30 (75%) respondents, R. prinoides flowers from June to July, 10 (25%) responded that, flowering depends on the species type and they can flower continuously if they get enough water throughout the year, there is flower depending on the growth of the plant that ensures continuous supply of berries. Over all if there is collection of matured leaves products of *gesho,* there are ripened fruits, flowers and immature fruits.

Most of the respondents 27 (67.5%) said all flowers could not reach to fruit. Because there are different environmental factors that influence its growth, like if there is no enough water, immediately it becomes falloff at different stages, like at flowering stage and at un-ripened early stage but some 13 (32.5%) of the respondents said if it flowers, it will reach to fruit. Most of the respondents responded that the different stages of fruits have different colors. This means the berries passthrough 3 observable maturation stages, changing in color from green early stage next flower to red, and then finally to dark-purple or black which is highly eaten by birds. Due to this, it is difficult to collect it. To do this follow up must be made during the continuous ripening period.

Traditionally, to germinate *gesho* seeds, 26 (65%) respondents responded that, the collected ripened black fruits by rubbing with ash then dried at sun over one week, finally they are sowed in to the prepared seed bed and covered with dried grass until germination begins. However, some 14 (35%) responded they collect the red immature fruits from the harvested leaves of *gesho* and they sow without rubbing with wood ash.

In seedling establishment around home, most respondents 31 (77.5%) said that it is difficult. Because it needs great protection from animals and insects. It needs long time for preparation and enough water. For instance, fruit collection begins from September to October with different activities in each time and finalized at June for transplant at the prepared area, this and others causes so difficult. Against to this some respondents 9 (22.5%) said that even

there is difficulty it can establish in plot of land with 50cm*50cm area can perform easily even by fetching water from river or ponds.

Mostly 33(82.5%) they responded that, the product of *gesho* can collect two times per year at September and May; some 17(42.5%) said it can be collected three times in a year at September, January and May.

Based on the interviewers question most 28 (70%) said that, it is difficult to increase the frequency of harvesting. But some 12 (30%) responded that, it is possible to improve from three to four times per year by applying good protection making free from animals by forming fences or building making free from animals, digging continuously, watering and adding of new fresh soil and natural fertilizers.

6. Discussion

6.1 Growth performance of Seedlings

6.1.1 Germination and Seedling Survival

According to this result, the average germination time of experimental was on 20th day with 84% germination percentage with insignificant result_compared to control group (60%) (Table 1). This is because the higher germination percentage observed at pretreated seeds with wood ash, its physical and chemical properties create conducive environment of seed and seedling. Since wood ash has alkaline content, it helps to treat if the soil has acidic content can be neutralized. Due to this result, wood ash implies positive effect at germination. Fuzesi (2015) and Selafimova *et al.,* (2011) supported this result. If seedlings of trees are planted without any pre-germination treatment to break their dormancy that can be a result of hard seed coat impervious to water and aeration required to stimulate germination or presence of chemical inhibitor in the seed cotyledon (Whitmore, 1998). The survivals of seedlings were evaluated by counting the well-established seedlings after 3 months the germinated grew in to seedlings. Seedling survival and growth are affected by several factors such as light and temperature (Mason *et al*., 2004; Criddle *et al*., 2005). In this study seedling survival of *R. prinoides* was investigated by using rubbed seeds with wood ash. Seedling survival was 84.5% in experimental group but 66.6% for control group (Table 2). In this case it is statistically insignificant, there is difference in between. This is due to the wood ash have alkaline content in nature which help to create confortable condition to the seedlings. This result is related with the effect of lime reported by Kator *et al*., (2015). Failure (not to 100% establishment) might be due to both biotic and abiotic factors that affect the successful growth and establishment of seedlings in soil that was reported by Legesse Negash (2010). Therefore, it can be concluded that, survival of *R. prinoides* seedlings at nursery pots rubbed seeds more than un-rubbed with wood ash.

6.1.2 Seedling Height

The seedling height of experimental group was found to be 5.05cm while of control group was 4.85cm (Table 3.). Even there is difference in value statistically it is insignificant.

Seedlings of the same species may have different seedlings heights in different environmental factors (Agren and Ingestad, 1987). In this study seedling growth of *R. prinoides* differences were observed on seedlings that was grown at experimental seeds rubbed with wood ash and control group. Relatively seedlings in the control treatments were shorter compared to experimental group. Even it is statistically insignificant, the change showed that the growth of seedlings of *R. prinoides* was enhanced due to the effect of wood ash.

6.1.3 Number of Leaves

At first count mean result of EG is 2.2, CG is 2 with P-value 0.15, at second EG is 3.3, CG is 3 and with p-value 0.65. After three months of planting, it was observed that the seedlings that were rubbed with wood ash 6.1 leaves averagely, while the seeds planted without rubbing with wood ash had 5.2 (Table 4.). The mean result of experiment from the initial to the final counting number of leaves is increasing rapidly than control group. The result denotes that rubbed seeds with wood ash had highest number of leaves and statistically significant $p<0.05$ with compared to control group. The fastest growths in leaf production were an indication that the species has ecological importance. Because mass exchange characteristics of terrestrial ecosystem such as photosynthesis, respiration, transpiration, carbon and nutrient cycle are in good condition it grows faster in number of leaves.

6.1.4 Collar Diameter

At two months after planting it was observed that seedlings at collar diameter the average measurement of experimental group is 0.65 mm and control group is 0.6 but at the second result was 1.2 mm, while the seedlings at control group was measured 1.1 mm, the difference was not significant at ($p<0.05$). The data indicated that wood ash does not show significant effect at collar diameter of experimental group. Even treatments does not cause statistically verifiable differences in number of stocks, there is slight change. The above ground organic matter grown on different plots could not be detected with 95% level of significance their amount increased by 3-8%, which means the plant were able to produce a greater amount of organic material from excess amount of nutrients during a representative period of time (Fuzesi *et al*., 2015).

6.1.5 Seedling Biomass

A standard assumption in plant ecology is that plants respond to their environment in such a way as to optimize their resource use (Bloom *et al*., 1985, cited in Agren and Franklin, 2003). In this study, the ANOVA result (Table 6.) showed that the effect of wood ash on the experimental group biomass of dried seedling accumulation during the 3 months period was significantly different from the biomass of seedlings grown at control group. Because adding wood ash increases necessary element for the growth of seedlings. At the leaving time before the plant dried and burned with fair, it accumulates essential and non-essential elements becomes recycled and used by seedlings easily available for growth. Serafimova *et al*. (2011) and Park *et al.* (2004) supported this. Wood ash contains essential nutrients needed for development of different plant species. Additionally wood ash behaves like fertilizers with a lot of nitrogen content (NPK: 1:10:50) (Park *et al.*, 2004). Additionally wood ash is very important to increase soil fertility. According to Park *et al* (2004) in wood ash P, K, Ca and Mg was more than enough to compensate for harvest removals and leaching losses (Park, et al., 2004).

6.2 Interview Discussion

Traditional agroforestry home gardens are common in some parts of Ethiopia. As other trees and shrubs *R. prinoides* are very important for farming systems which provide the local communities for sustainable agriculture, environmental friend and to decreases the influence of floods at different areas. As *Faidherbia albida* (Momona in Tigrigna) expressed by Umar *et al*., 2013), have the same result. This is important for proper functioning of the agro-ecosystems and livelihoods of households. According to TesfayeAbebe (2005), home gardens are the most complex and diverse agro-ecosystems that fulfill ecological functions and economically more viable than other land use systems in the tropics, because of high value case crops comprised in them. As Fernandes and Nair (1986) cited in TesfayeAbebe (2005) stated that home gardens as land use practice involving deliberate management of multipurpose trees and shrubs in intimate association with annual and perennial agricultural crops. Development and propagation of proper management of home gardens could sustain the livelihoods of the poor households and bring about wealth to many households. The commercialization of the products of R. p*rinoides* helps for farmers to sell in markets as cash crop to increase their incomes for food security and wellbeing of the households. Additionally

it is used as source of pollen and nectar for honeybees at any time and mainly at dearth period Demel Teketay *et al*., (2010), supported this. If there is further protection from animals by fences or walls that helps to increase frequency of harvesting can be increased from two to 4 times per year in each season.

It is important for the preparation of traditional beverages deals with popular products such as *tella, tej,* and habesha *areki* (Katikala) for consumption at holidays, during special work as stimuli and work facilitator as well as for sale as a business when there is *tella* to sell. This idea was explained that it is assumed over 2 million hectoliters of *tella* to be brewed annually in households and drinking houses in Addis Ababa (Sahle and Gashe, 1991). According to Desta Belachew (1977) areki is colorless local drink prepared by mixing powdered *gesho* leaves with other components. Again the leaves of this plant is useful for the preparation of dyes as reported by Abera Kechi *et al*. (2013), potential dye yielding plant and good dying with higher color strength values reflecting in direct affinity to cotton.

Plants play a vital role in the management of various diseases and have been heavily utilized in the sustainable development of drugs that provide a major focus in global health care delivery (Graham *et al*, 2000). TilhaunTeklehaymanot and Miruts Girmay (2007) reported that *R. prinoides* has medicinal uses. Due to this, traditionally young leaves and apical meristems of *R. prinoides*are chewed and the juice is swallowed to treat tonsil usually in children and sometimes in adults. According to Brhanu Abegaz (2014), the crude extracts of different plants such as *R. prinoides* leaf extract have scientifically evaluated and approved for their antimicrobial activity against the growth of different pathogenic bacteria from which novel bioactive drugs could be obtained. It is very important to prevent internal parasites if you drink local alcohols. This is because the antimicrobial characteristics of *R. prinoides* gives bitter taste improve foam stability and act as antiseptics against microorganisms (Kunze, 1996). It helps to improve the quality of *tella* and to have an extended shelf life Brewers use high amount of *R. prinoides*. This is because it maintains acidic PH during *tella* fermentation to modify the nature of mesh and inhibits the growth of undesirable microorganisms (Kleyn *et al*, 1971).Brhanu Abegaz (1999) also reported antimicrobial characteristics of *R. prinoides*. Traditionally *R. prinoides* has been used in folk medicine to treat ear, nose and throat diseases and skin infections of fungi; (Demel Teketay *et al*., 2010).

Most fruits of *R. prinoides* mature from September to November if they are at stress of water but they become fruiting continuously through the year if they get enough water (Demel Teketay *et al*., 2010). Traditional growers mostly collect the fertile black color fruits during the process of germinating of *gesho* extract and rube using wood ash. However, some of them collected immature red fruits of *gesho*, for this case there is an indication that some parts of the society have missuses of fruits, due to this less quality of seeds causes the germination percentage becomes low or fails to germinate at all. Fruit maturity had an influence on the germination, growth performance of Jatropha causes seeds, and seedlings has an influence on the germination and growth performance (Batin, 2011).

Even though more indigenous species are ecologically more valuable for the conservation of native flora and water conservation in two fundamental processes critical for sustainable agriculture, food security and livelihood maintenance in developing countries such as Ethiopia (Legesse Negash, 2010). So *R. prinoides* has multipurpose importance but due to exotic plants like eucalyptus that were rapidly increasing coverage in much of lower and upstream areas causes low humidity of the environment. The leaf extracts, decaying leaves and soil collected under eucalypts canopies inhibited germination and early growth of associated plant species (Rice, 1984). This is because as Tefera (2002) found that the inhibitory allelopathic impact of leaf extracts was more powerful than of other vegetative parts. According to Legesse Negash (2010), eucalypts plants are green at top but Sahara at bottom. Due to this chemical inhibition, quality and quantity product of *R. prinoides* is reduced.

7. Conclusions and Recommendations

7.1 Conclusions

Based on the findings of this study, it can be concluded that germination responses and early growth performances of *R. prinoides* that grow at experimental groups are averagely well. There were statistically significance difference between the plants biomass and number of leaves of *gesho* seedlings grown between experimental and control groups. This is an indication that, gesho species requires rubbing with wood ash during extracting from their fruits that enhances rapid germination and early growth performance of seedlings is very essential than the un-rubbed seeds with wood ash. Over all, wood ash has significantly economic importance in agriculture.

R. prinoides is very essential to the farmers economically and to have the environment evergreen. Since it is ecologically friendly and termites cannot affect it as well as the society traditionally can use medicinal value to treat different types of diseases, like skin diseases caused by fungi, children, for temporary treatment of tonsillitis, cattle infected by leeches can be treated traditionally. Gesho can be harvested regularly 2 times per year. However, by covering enough available water and other necessary inputs, it is possible to double the product. Since this plant flowers continuously, serves as source of food for honeybees throughout the year.

7.2 Recommendations

Based on the results, the following recommendations are forwarded;

- Gasho maintains moisture content of the soil and increases the productivity of *R.prinoides* with increasing water conservation activities is very essential.
- Gesho enhances that wood ash is necessary for seedlings growth characteristics and collectively increases its biomass.
- Potential traditional knowledge of the people on the diverse uses such as medicinal uses of *R.prinoides* should studied to document indigenous knowledge of the local people.

- Exotic plant species like eucalyptus plant causes drying of the and when planted together reduces the quality and quantity production of gesho.
- Gesho is necessary to plan and implement practices that would enhance the reestablishment of *R. prinoides*.
- Increasing planting more at agricultural area (cover the cropland by *gesho*)and protected hills.
- Increasing the awareness of society in harvesting time and productivity from usual 2 in to 4 times per year.

References

Abera Kechi Chavan, R.B. (2013). Ethiopian dye plants as a source of natural dyes for cottoning: *Universal of journal environmental research and technology*. **3**(**4**):506-508.

Afewerk Gebre and Bhagwan Singh Chandravanshi (2012). Levels of essential and non-essential metals in *Rhamnus prinoides* (gesho) cultivated in Ethiopia: *Bull. Chemistry. Society. Ethiopia*, **26**(**3**):341.

Agren, G.I. and Ingestad, T. (1987). Root: shoot ratio as a balance between nitrogen productivity and photosynthesis. *Annual. Botany*. **10**: 579-580.

Agren, G. I.and Franklin, O. (2003). Root: Shoot Ratios, optimization and nitrogen productivity. *Ann Bot*. **92**: 795-800.

Amsalu Bezabih (2000). *Identification of major pollen sources of Haney plants around HolletaBee research cente*r: Proceedings of the 7 th Annual conference of the Ethiopian society of animal production 9ESAP): held in Addis Ababa, Ethiopia. Pp. 169-178.

Asfaw Debebe, DawitAbebe, and Kelbessa Urga (2003).*Medicinal Plants and Other Useful Plants of Ethiopia*: Ethiopian Health and Research Institute, Addis Ababa. Pp. 210.

Ashenafi Mogessie (2006). A review on the microbiology ofindigenous fermented and beverages of Ethiopia. *Ethiopian journal biological Sciences*; **5**(**2**):189-245.

Azene Bekele, Birnie A, Tengnas B. (1993). *Useful trees and shrubs for Ethiopia*: Identification, propagation and management for agricultural and pastoral communities, technical handbook No 5. SIDAS's Regional Soil ConservationUnit, Nairobi, Kenya. Pp. 380.

Batin. B. C (2011). *Seed germination and seedlingperformance of Jatrophacurcas I. fruit based on color at two different seasons in northern Philippines*. IPCBEE. IACSIT press. Vol. 21. Pp. 96, 100.

Bentsink, L., Soppe, W. and Koornneef, M. (2007). *Genetic aspects of seed dormancy*: In Seed development, dormancy, and germination. Pp. 72-106, (Bradford, K. and Nonogaki, H. eds.), Blackwell Publishing Ltd, USA.

Berhanu Abegaz (2014). Microbial profile of tella and the role of Gesho (R.prinoides) bittering and antimicrobial agent in traditional tella (beer) production. *Int. food Res. Journal*. **2**1:357-365.

Berhanu Abegaz Molla; Ngadjui. Bonaventure. T. Ngadjui; Bezabih.Merhatibeb; Modee. L. K. (1999). Novel natural products from marketed plants of eastern and southern Africa: *Pure and Applied Chemistry***, 71(6)**: 922-923.

Berhanu Abegaz Molla, Teshome Kebede (1995). Bitter principle of *Rhamnus prinoides* and other constituents of the leaves: Bulletin of the chemical society of Ethiopia **9**(**2**):107-114.

Berrie, A. A. M. (1984). *Germination and dormancy*: In Advanced Plant Physiology. Pp. 441-468, (Wilkins, M.B., ed.). Pitman Publishing Inc., Massachusetts.

Bewley J.D. (1997*).* Seed germination and dormancy: *The Plant Cell*, **9**:1055-1066.

Bewley, J.D and Black, M. (1994). *Seed Physiology of Development and Germination*: 2^{ed}edn. Plenum press, New York. Pp. 445.

Bunker D.E. and Carson W.P. (2005). Drought stress and tropical forest woodseedlings, structure and composition: *Journal of Ecology*. **9**3:794-806.

Butola, J.S. and Badola, H. K. (2006). Assessing seedlingemergence, growth andvigor in Angelica glaucaedgew and Heracleumcandicans wall underdifferent growing media and environments. *Journal of non-timber forest products*.**13**(**2**):141-153.

Christoffoleti, J.P. and Caetano, S. R. (1998). Soil seed banks. *Science and agriculture*, **55**:74-78.

Cheng. S. Tie, C. Shao, Zhao, L. and Yang. X. (2012*).* Soilseed banks and forest succession divation reflect soil quality in Ziwuling Mountain. Loess plateau, China. clean soil, air, water, **40**:140-147.

Criddle, R.S., Hansen, L.D., Smith, B.N., Macfarlane, C., Church, J.N., Thygerson, T., Jovanovic, T. and Booth, T. (2005). Thermodynamic law for adaptation of plants to environmental temperatures: *Pure Applied Chem*istry 77: 1425-1430.

Dechasa Jiru (1999). Influence of *Croton macrostachyus* on maize field traditional tree intercrop farming system: Walia, **20**: 19-25.

DemelTeketay, FeyeraSenbeta, Mark Maclachlan, Million Bekele, Pia Barklund (2010). *Edible wild plants in Ethiopia*: AddisAbaba press. Ethiopia: Pp. 300-302.

Desta Belachew (1977). A survey of the alcoholic contents of traditional beverages: *ethiop. Med. Journal*, **15**:65-68.

Fernandes, E. C. M., Oktingati, A. and Maghembe, J. (1984).The Chagga home gardens: A multistoried agroforestry cropping system on Mt. Kilimanjaro. *Agrofor.Syst*. **2**: 73-86.

Fichtl, R. and Admasu, Addi (1994). *Honey bee flora of Ethiopia*: The NationalHerbarium, Addis Ababa University and Deutscher Entwicklungs Dieenst (DED): Mergaf Verlag, Germany. Pp. 510.

Finkelstein, R., Reves, W., Arizumi, T., Steber, C. (2008).Molecular aspectsof seed dormancy. Ann Rev plant boil.**59**:387-415.

Friis, I., SebsebeDemisew and Van Breugel P. S (2010). *Atlas of the potential vegetation of Ethiopia*: Theroyal Denish academy of sciences and letters.Kongelige, Denmark. Pp. 307.

Fullas, F. (2003). *Spice plants in Ethiopia*; their culinary and medicinal applications.

Fuzesi. I, Heil. B, Kovacs. G, (2015). Effects of wood ash on the chemical properties of soil and crop vitality in small plot experiments: *Act a Silv. Lign*. Hung.; **11**; 57-59.

Gibson, J. L. (2001). *Plant propagation basic principles and methodology*: NCSU floriculture. Pp. 1-2.

Graham, J.G. Quinn, M.L., Fabricant, D.S. and Farnsworth, N.R. (2000). Plants used against cancer an extension of the worth of Jonathan Hartwell: *Journal .Ethnopharmacol. (Elsevier)*; **73**:347-377.

Hailemichael Alemu, Berhanu Abegaz Molla, Merhatibeb. Bezabih (2007). Electrochemical behavior and Voltammetricdetermination of Geshodin and its spectro- photometric andanti-oxidant properties in aqueous buffer solution*: bulletin of the chemical society of Ethiopia*, **21**(**2**):189-204.

Hancock, J.F. (1992). *Plant Evolution and the Origin of CropSpecies*: Prentice Hall,Engle wood cliffs, New Jersey.Pp. 127.

Hampton J.G. and M.J. Hill (2002).Seed quality and New Zealand's native plants an unexplained relationship: *New Zealand journal of botany*, **40:357**-364.

Hartmann, H.T., Kester, D.E., Davis, F.T. and Geneva, R.L. (2004).*Plant Propagation Principles and Practices*: 6th edn. Prentice Hall of India Press, New Delhi. Pp. 770.

Hayeshi, R.; Mukanganganyama, S.; Hazra, B.; Brhanu Abegaz.; Haster, J (2004). *Phytother.* research. **18**: 877.

Hedberg, I. and Edwards, S. (1989). Flora of Ethiopia and Eritrea. *Pittosporaceae araliceae*. The national herbarium, biology department.Science faculty, Addis Ababa University and department of systematic botany Uppsala University, Sweden, volume 3.

Hermann, K., Meinhard, J., Dobrev, P., Linkies, A., Pesek, B., Heß, B., Machackova,I.,Fischer, U., Leubner-Metzger,G., (2007).1-Aminocyclopropane-1 carboxylic acid and abscisic acid during the germination of sugar beet (Beta vulgaris L.) A comparative study of fruits and seeds. *Journal. Exp. Bot*. **58**, 3047–3060.

Hooda, R.S., Rao, A.S., Luthra, Y.P., Sheoran, I.S. andSingh, R. (1986).Partitioning and utilization of carbon and nitrogen for dry matter and protein production in chickpea (Cicerarietinium L.). *J.Exp.Bot*. **37**: 189-196.

Jiregna Gindaba, Rozanov, A. and Legesse Negash (2004). Responses of seedlings of two Eucalyptus and three deciduous tree species from Ethiopia to severe water stress.Forest Ecology and Management **201**: 119-129.

Johnson R. (2000). *Characterization of germination related genes inAvenafatuaL*.seeds in: seed biologyadvances and applications, (black, M., Bradford, K.J. and Vagquez, Ramos, J.,eds.). Proceedings of the sixthinternational work shoponseeds, Merida Mexico, 1999.CABI publishing. Pp. 1.-17.

Kebede Teshome. (1994). The bitter constituent of gesho (*Rhamnusprinoides*) leaves. M.Sc. thesis, department of chemistry, Addis Ababa University. Ethiopia.

Kleyn, J., Hough, J.(1971). *The microbiology of brewing*: annual review of microbiology. Pp. 25, 583.

Kator, P.E., Ogbinaka, E., Omamode, C.OA (2015). Comparative analysis of the growth performance ofokra (abelmoschus, esculentus (l.) Moench.In differentsoil media.Global Advanced Research *Journal of Agricultural Science*; **4**(**10**):650-651.

Kucera, B., ZCohn, M. A. Leubner-Metzger, G.,(2005). Planthormone interactionsduring seed dormancy releaseand germination: *Seed Sic Res*. **15:**281-305.

Kunze W. (1996).*Technology brewing and malting*:. 7th edition.VLB Berlin, Germany.

Legesse Negash (1995). *Indigenous trees of Ethiopia: Biology, uses and propagation techniques*: Printed by SLUReprocentralen, Umea Sweden, Ispn. Pp. 285.

Legesse Negash (2003). In situ fertility decline andprovenience difference in the eastAfrica yellow wood (*podocurpusflactus*) measured through in vitro seed germination:*Forest ecology and management*, **174:**127-138.

Legesse Negash (2010). *A selection of Ethiopia's indigenoustrees biology, uses and propagation techniques*: Addis AbabaUniversity press. Ethiopia. Pp. 4-9, 386.

Lu, P.S. W. and Ma, K. (2006). Effects of environmental factors on germination andemergence of croton weeds*: Weed science*, **54**: 452-457.

Mason, W.L., Edwards, C. and Hale, S. E. (2004). Survival and early seedling growth ofconifers with different shade tolerance in Sitka spruce spacing trial and relationship to under story light climate: Silva fennica, **38**: 357-370.

Mayer, A. M and Poljakoff-Mayber, A. (1982). *The germination of seeds*. 6th edn. Pergamum press, Oxford. Pp. 211.

Mbalo, B.A and Witkowski, E. T. F (1997). Tolerance to soiltemperatures experienced during and after thepassage of fire in seeds of Acacia, Karroo, A. tortilis andchromolaenaodorata: *a laboratorystudy. South Africa journalof botany*,**63**(**6**):421-425.

Nautiyal, B. P.; Prakash, V.; Chauhan, R. S.; Purohit, H. and Nautiyal, M. C. (2001). Assessment of germinability, productivity and cost benefit analysis of picrorhizahurrooa cultivated at lower altitudes. Current science.**81** (**5**):579-585.

Ochuodho, J. O. and Modi, A. T (2007*).* Light-induced transient dormancy in Cleome gynandra L. seeds. *Africa Journal. Agricultural . Research.* **2**:587-591.

Orwa C, A. Mutua, Kindt R, Jamnadass R, S. Anthony (2009). *RhamnusprinoidesL'Herit*. Agroforestry database: atree reference and selection guide. Vol. 4. Pp. 1-5.

Park, B. B. Yanai, R. D. Sahm, J. M. Ballard, B. D. Abrahamson, L. P. (2004): Wood ash effects on soil solution and nutrient budgets in a willow bioenergy plantation. *Water Air SoilPollution* **159**: 209–224.

Phillips, S. (1994*). Flora of Ethiopia and Eritrea*: National Herbarium**, 7**:33-39.

Probert, R.J. (2000).*The role of temperature in the regulation of seed dormancy and germination*: In: Seeds: the ecology of regeneration in plant communities. Pp. 261-292.

Rice, E. L. (1984). *Allelopathy.2^{ed} edition.Academic press*: Or rlando, Florida. Pp. 442.

Sahle, A. and Gashe, B.A., (1991): The microbiology of *tella*fermentation.SINET *Ethiop. J. Sci.*,**14**, 81-92.

Sanchez, R. A. and Mella, R. A. (2004). *The exit from dormancy and the indication of germination*: physiological and molecular Aspects: In Handbook of seed Physiology: applications to agriculture. Pp. 221-245.

Seo, M., Nambara, E., Choi, G., Yamaguchi, S., (2009). *Interaction of light and hormone signals in germinating seeds*: Plant Mol Biol. **69**:463–472.

Serafimova. E. K., Mladenov. M., Mihailova, Pelovski (2011). Study on the characteristics of waste wood ash. *Journal of the University of chemical technology and metallurgy*: **46**(1): 30-31.

Silva, R., Wallenstein N., Riedel, C. (2008). *Seismic swarmactivity during 2003-2004in the seismagenic fogo-congro area (Sao Miguel, Azeoyes): relocation andfocal mechanisms*. International association ofvolcanology and chemistry of the Earth's interior (IAVCEL) general assembly, august 17-22.

Srivastava, L. M (2002). *Plant growth and development,hormones and environment*: Elsevier science, Califonia, USA. Pp. 757.

Taylorson, R. B and Hendricks, S. B. (1977). Dormancy in seeds: *Annual review of plant physiology*, **28**:331-354.

Tefera Mekonen, MirutseGidey and Ensermu Kelbessa (2015). Ethno-botanical studyof homegardenplants in sebeta-Awasa district of Oromiaregion of Ethiopia toassess uses, species diversity and management practices: *Journal ofEthno-biology and Ethno-medicine***, 11**:7-12.

Tefera T. (2002). Allelopathic effects ofpartheniumhysterophorus extracts on seed and seedling growth of *Eragrostistef* (Zucc.) *Trotter, Journal. Agro. and Crop Sci*. **185**:306-310.

Tesfaye Abebe (2005). Diversity in Homegarden Agroforestry Systems of Southern Ethiopia Tropical Resources Management Papers, No. 59. Wageningen University and Research Centre, Department of Environmental Science, the Netherlands.

Tewoldebrhan Gebre-Egziabher, Hedberg O, Taaesse M, FrilsI, Hedberg I, Edwards S. (1989*). Flora of Ethiopia: Pittosporaceae to Araliaceae*: volume 3. The national Herbarium, Addis Ababa University, Ethiopia, and the department of systematic Botany, Uppsala University, Sweden. Pp. 390.

Thulin, R. (1988). In: *Flora of Ethiopia*. Hedberg, I. Addis Ababa and Asmara, Ethiopia and Uppsala Sweden vol. 3 .

Tilahun Teklehaymanot and Mirutse Giday (2007). Ethno botanicalstudy of medicinal plants used by people in zegie peninsula North Western Ethiopia. Journal of Ethonbiology and Ethinomedicine, **3**: 1-12.

Tisdale, S. Nelson, W. and Beaton, J. (1985). *Soil Fertility and Fertilizers*: Mecmillan Publishing Company, New York. Pp. 737.

Umar. B., B, Aune. B. J and Obede. I. L (2013). Small holder conservation agriculture systems in eastern and southern Zambia. *African Journal of agricultural research*. 8(2): 173.

Valverde ,T. S. Ouijas, M.,Lopez-Villavicencio and Astillo, S. (2004). Plant ecology.**170**:167-184.

Vetter, S. (1997). *Gesho, its uses, production potential and problems in northern Tigray:* ISD and FARM Africa. Addis Ababa, Ethiopia. Pp. 6-13.

Vollesen, K. (1989). *Rhamnaceae. In Hedberg, I and Edwards (eds) Flora of Ethiopia*. Addis Ababa, Ethiopia.Vol.3.

Whitmore, T.C (1998). An *introduction totropical rainforests*: Oxford university press, oxford. Pp. 282.

Wurr, D. and Fellows, J. (1983). The effect of the time of seedling emergence of crisp lettuce on the time ofmaturity and head weight at maturity. *Journal of Horticulture science*, **58**:661-566.

Appendices

Appendix A

A **B**

Appendix 1 (A). Plants of *R. prinoides* with leaves, and flowers at different flowering stages, as well as green, intermediate and blue-black berries; **1(B)**, Ripe (above) and non-ripe (below) berries of *R. prinoides*.

2 **3**

Appendix 2A. Preparing fertile Soil by separating coarse and other unnecessary parts

Appendix 2B. Prepared mixed fertile soils at a ratio of 2:1:1 for planting both groups.

A **B**

Appendix.3(A). Planting seeds of *R.prinoides* at plastic pots of both groups (**B)**. After planting seeds of *R. prinoides* of both control and experimental group

Appendix 4. Seeds of *R. prinoides* during emerging from the ground

Appendix 5. Seedlings of both groups at different ages with different height and number of leaves in their plastic pots.

Appendix 6. Measuring of collar diameter of seedlings using Vernier Caliper at the collar root part

A B

Appendix 7 (A) Seedlings during drying at hot air oven at 80 ^{o}C for 12 hours.(B) Measuring biomass balance of seedlings of *R.prinoides* using electronic balance in lab.

APPENDIX B

Prepared questions for interview about seed germination and the importance of *gesho* plant for the *gesho* traditional cultivators and nursery workers.

The questions are prepared in the form of open and closed ended forms

The main objective of this interview is to collect information about *Rhamnus prinoides* from the knowledge of society.

Objective of this interview is to collect information about *gesho* to the society in relation to flowering period, fruit characteristics, seed availability, germination process and its important.

Thank you for willingness to ask the following questions genuinely

Personal data

Sex___ Age___ Grade level_____ Qualification _____Work experience_____

A) Questions related to the importance of *gesho*

1. Could you please enumerate the importance of *gesho* to me?

_____

2. List the types of alcoholic drinks prepared using *gesho* plant?

_____

3. Are there any traditional uses of *gesho* other than alcoholic drinks?

A) Yes B) No

4. In question number 3 if your answer is yes, would you please list them?

_____

5. What are /is role/s of *gesho* in household economic security as compared to other plants?

A) High B) Medium C) Low

6) Is *gesho* important in traditional medicine? If so, please enumerate these?

_____

7. What do you think about the production of *gesho* in terms of area coverage? Is it increasing or decreasing? A) Increasing B) Decreasing C) No change

What is the reason?_____

8. Do you envisage the advantages of growing *gesho* at a farmland level, compared to other plants?_____

9. Is there any negative impact of exotic plants like eucalyptus trees to *gesho* plants?

A) Yes B) No

10. In question number 9 if your answer is yes, how are *gesho* plants affected? _____

B) Questions related to flowering period, fruit characteristics, seed availability and germination process.

1. How long does it take for the *gesho* plant to come to flower?

_____

2. At which time of the year does the *gesho* plant flower _____

3. Does the species flower uniformly (i.e., all at one time) or sequentially?

_____

4. Do all *gesho* flowers result in mature berries?

_____

5. What is the color of mature *gesho* berries? Of immature *gesho* berries?

_____

6. Is it challenging to get berries of *gesho*? If so, why?

_____

7. How are *gesho* seeds traditionally germinated?

_____

8. Is there any difficulty in establishing seedlings of *gesho* in your home garden? Why?

_____

9. How many times can one harvest *gesho* in a year?..... Could the frequency of harvesting be improved? _____

if so, how?_____

Checklist of questions

No	Questions related to the importance of *gesho*	Alternatives	Response	%
1	Could you please enumerate the importance of Gesho to me?	-	-	-
2	List the types of alcoholic drinks prepared using Gesho plant?	-	-	-
3	Are there any traditional uses of *gesho* other than alcoholic drinks?	Yes	12	30
		No	28	70
4	Reason of question no 3.	-	-	-
5	What are /is role/s of *gesho* in house hold economic security as compared to other plants?	High	40	100
		Medium	-	-
		Low	-	-
6	Is g*esho* important in traditional medicine? If so, please enumerate these?	Yes	24	60
		No	16	40
7	What do you think about the production of *gesho* in terms of area coverage? Is it increasing or decreasing? What is the reason?	Increasing	40	100
		Decreasing	-	-
		No change	-	-
8	Do you envisage the advantages of growing *gesho* at a farmland level, compared to other plants?	Higher	32	80
		Medium	8	20
		Low	-	-
9	Is there any negative impact of exotic plants like eucalypt trees to *gesho* plants?	Yes	40	100
		No	-	-
10	Reason	-	-	-
B	Questions related to flowering period, fruit characteristics and seed availability and germination process.			
1	How long does it take the *gesho* plant to come to flower?	-	-	-
2	At which time of the year does the *gesho* plant flower?	-	-	-
3	Does the species flower uniformly (i.e., all at one time) or sequentially?	Separately	40	100
		All at once	-	-
4	Do all *gesho* flowers result in mature berries?	Yes	12	30
		No	28	70
5	What is the color of mature *gesho* berries? Of immature *gesho* berries?	-	-	-
6	Is it challenging to get berries of *gesho*? If so, why?	-	-	-

7	How are g*esho* seeds traditionally germinated?	-	-	-
8	Is there any difficulty in establishing seedlings of g*esho* in your home garden? Why?	-	-	-
9	How many times can one harvest g*esho* in a year? .....Could the frequency of harvesting be improved? _____ if so, how?_____	-	-	-

ንቓላዊ ማሕበት ዝተዳለዉ ዕፀዉ ክፉትን ሕቶታት ብዘኣባ ጥቅሚት፣ ባህርያትኣተዓናብ፣ ከዝ ታት ፍረ ጌሾን ከምኡ ነዉ ኣብ ብቕለት ዘትኮሩ ሕቶታት

ዕላማ ናይዚ ማሕበት ብዘዕባ ጌሾ ኣብ ሕብረተሰብ ዘሎ ግንዛበ ከዝ ታት ዕምባባ፣ ከዝ ታት ፍረን ዘርእን ከምኡ ነዉ ጥቅሚ ጌሾን ምድዳእ ዝተዳለዉ ነ ዩ

ቅደማ ግዜኹም ብፅቅዋእ ንቓለ ማሕበት ድልዋት ምኻንኩም ካብ ልቢ የመሰግን

ሰብኣዊ ሚዳእታ

ፆታ— ዕድመ— ደረጃት/ቲ——— ሞያ——— ስራሕልምዂ——

ሀ) ኣብ ጥቅሚ ጌሾ ዘትኮሩ ሕቶታት

1) ጌሾ ካብ ዝህቦም ጥቅምታት ክትዝርዝረለይ ዶ ትኽእል? ———————————————————

2) ጌሾ ብፅሓቃም ዝስርሑ ኣልኮላዊ መጠተታት እንተሃሊዮም ይዘርዘሩ? ———————————————————

3) ጌሾ ካብ ኣልኮላዊ መጠተ ወፃኢ ካለእ ዝህቦ ባህላዊ ረብሓ ኣሎ ዶ?

ሀ) እወ ለ) ኣይፋል

4) ኣብ ሕቶ ቁፅሪ 3 መልሲ እወ እንተኾይኑ ይግለፅ? ———————————————————

5) ብኣብዝሓ ኩሉም ተክልታት እኳ ጠቕሚ እንተኮኑ ምስ ካልኦት ተክልታት እንትነፃፀር ፀገም ገዛ ኣብ ምፍታሕ ዘለዎ ግደ እንታይ ይመስል? ሀ) ዝዓበየ ለ) መኣከላይ ሐ) ዝነኣሰ

6) ጌሾ ኣብ ባህላዊ ግልጋሎት ሕክምና ዝህቦ ረብሓ ኣሎ ዶ? እንተሃልዩ ንምጣታይ ከምዝጠቅም ይዘርዘሩ?

_____

_____

7) ተኽሊ ጌሾ ከባቢ ኣብ ምኽፋን ነታይ ይመስል? ደጪኽ ዶ ይቕንስ?

ሀ) ደጪኽ ለ) ይቕንስ ሐ) ለውጥዩ ለን

ምኽንያቱ ነ ታይ ይከውን? _____

8) ምስ ካልኦት ተኽልታት እንትነፃፀር ጌሾ ኣብ ሕርሻ ከባቢ ምልማዕ ነታይ ረብሓ ይህብ?

_____

9)ከም ቀላሚስ ዝበሉ ካብ ካሊእ ሃገራት ዝኣተዉ ተክልታት ንጌሾን ካልኦት ተክልታት ከባቢን ኣሉታዊ ፅልዋ ኣለዎም ዶ ? እንተሃልይዎም ብከመይ ይግለፅ? _____

_____

ለ) ኣብ ግዜ ምፅንባብ፡ ፍረ፣ ዘርኢ ዘለዎምን ዘየብሉዎን ከምኡ ውዓ ኣብ ብቕለት ዘትኮሩ ሕቶታት

1) ሓደ ተኽሊ ንኽዕንብብ ክንደይ ግዜ ይወስደሉ? _____

2) ጌሾ ኣበየናይ ግዜ (ወቕቲ) ፣ዩ ዝዕምባዝ? _____

3) ዓሌታት ጌሾ ብሓደ ግዜ ደዮም ዝዕምባቡ ወይስ በቢግዚኡ? _____

4) ኩሎም ዕምባታት ጌሾ ዶ ናብ ዝባፅሐ ፍረ ይዓብዩ? _____

5) ዝባፅሐ ፍረ ጌሾ እንታይ _____ይመስል? ዘይባፅሐሽ? _____

6) ፍረ ጌሾ ንምጅካብ ዘፀግም ነገር ኣለዎ ዶ? እንተኾይኑ ንምግታይ? _____

_____

7) ዘርኢ ጌሾ ብህላዊ ኣግባብ ብኾመይ ይፈልስ? _____

8) ፈልሲ ጌሾ ኣብ ገደና (ከባቢ ዛና) ንምፍላስ እንታይ ዘፀግም ነገር ኣሎ? _____

_____

9) ፍርያት ጌሾ ኣብ ዓሞት ክንደይ ግዜ ይህብ? ____ ፍርያት ኣብ ዓሞት ዝህቦ ምፅፋፍ ዶ ይከኣል ? _____ ብኾመይ? _____

Appendix 8. During data collection through interviewing with *Gesho* grower and users.