THE EFFECT OF GROWING MEDIA AND TEMPERATURE ON
SEED GERMINATION AND SEEDLING GROWTH OF GUDDAIM

(Grewia tenax Forsk) FIORI

By

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DEDICATION

To my parents in grateful recognition for The help so graciously given

To my brothers and sisters for their thoughtfulness and encouragement

Neda
Verily, my prayer, sacrifice, living and dying for Allah, the Lord of the Worlds, I am greatly indebted to my supervisor Dr. Mustafa M. Ali El Balla for appropriate guidance of my research utmost care, genuine help, and encouragement. I would like to express my gratitude to the Department of Horticulture, Faculty of Agriculture, University of Khartoum for providing the required facilities.

Sincere thanks are extended to the nursery workers, Uncle Hassan, Alsir, Rifaat, Abdelmajid Abdelnabi, Obeid and Mussa and to the Department of Agronomy Teaching Staff, Dr. Faissal and Laboratory Technicians, Peter and El-Nour for their assistance. I am grateful to everybody else who assisted me at one time or another during the period of my research.

Finally, I would like to express my gratitude to Mr. Abdelhamed Abdelrahim and Abuelgasim Elsisy for efficient typing of the dissertation.
ABSTRACT

Grewia tenax, "Guddaim", is used in traditional medicine, as a famine food. Three experiments were conducted to evaluate the effect of growing media and temperature on germination and seedling growth of Grewia tenax.

Experiment 1 investigated effect of growing media, and temperature, on germination percentage of Grewia tenax. The results showed that peat moss resulted in the highest germination%, shoot length, fresh weight and dry weight followed by sand, river silt and then sand and river silt mixture. Sowing date showed no effect on germination percentage . On the other hand, the interaction between growing media and sowing date showed a significant difference.

The study showed that river silt had given a high shoot length followed by river silt + sand mixture and peat moss, respectively. There was significant difference between river silt and river silt + sand mixture when compared with sand. The late sowing date increased shoot length significantly when compared with early sowing date but no significant difference was obtained with regard to the interaction.

Peat moss gave the highest fresh weight followed by river silt, river silt + sand mixture and sand, respectively. Also early sowing date resulted in high fresh weight.

The peat moss gave a high dry weight followed by sand, river silt and river silt + sand mixture but no significant difference was recorded besides a high dry weight and significant difference between late and early sowing date was recorded. Interaction between growing media and sowing date gave a significant difference. There was a significant difference between river silt, river silt + sand mixture and
sand concerning the number of leaves which was produced by late sowing date.

Experiment 2 was planned to examine the effect of temperature on germination percentage, germination rate, shoot length, fresh weight, dry weight and number of leaves. It was found that the increase in temperature significantly decreased germination %.

The temperature 25°C caused a high germination rate while 35°C gave a low germination rate. The shoot length and fresh weight were decreased gradually by increase in temperature. 35°C fresh weight was significantly decreased at 35°C when compared with 15°C and 25°C. The dry weight was significantly higher at 15°C than 35°C and the number of leaves gradually decreased by increasing temperature.

Experiment 3 was designed to investigate the influence of temperature fluctuation on germination %, germination rate, shoot length, fresh weight, dry weight and number of leaves. It was found that high temperature affected all parameters studied except germination percentage. The dry weight was statistically significant and the number of leaves was highly significant.
بسم الله الرحمن الرحيم

خلاصة الأطرحة

أخضع نبات القسم لهذه الدراسة لأنه نبات شائع الاستعمال في الطب التقليدي

وكفاءة الكورث.

أجريت ثلاثة تجارب لتقييم أثر وسط النباتات ودرجة الحرارة على إنباذور ونمو

بادرات نبات القسم.

التجارب الأولى أجريت للبحث في أثر نوع التربة (الوصط) ومواقع الزراعة على

نسبة النباتات في بذور نبات القسم وأظهرت النتائج أعلى نسبة إنباذور كانت في وسط

الدبب والرمل ومرة طينية وأخيراً رملية + طينية. لا توجد اختلافات معنوية بين أنواع

التربة الطينية ولكن الزراعة المتاخرة أظهرت نسبة إنباذور عالية بدون مرن اضطراب معنوية

وذلك التفاصيل بين أنواع التربة ومواقع الزراعة أظهرت فروقات معنوية.

أظهرت الدراسة أن التربة الطينية أعلى أطوال نباتات تليها التربة الطينية + رمل ثم

الدبب على التوالي.

توجد فروقات معنوية بين التربة الطينية ثم التربة الطينية + الرمل عندما قلعت

مع الرملية. الزراعة المتاخرة أعطت فروقات معنوية في زيادة أطوال النباتات عندما

قلعت مع الزراعة المبكرة ولكن التفاصيل لم يزعم أي فروقات معنوية ودرباب أعطي أعلى

وزن طازج تليه التربة الطينية والترابية الطينية المختلطة مع الرمل ثم التربة الرملية وأيضاً

تحصلنا على أعلى ووزن طازج في الزراعة المبكرة.

كذلك أعلى وزن جاف تحصل عليه في الدباب بديعة الرمل والترابية الطينية ثم التربة

المختلطة التربة الطينية + الرمل ولكن لا توجد فروقات معنوية جنب مشابه على وزن جاف

وتوجد فروقات معنوية بين الزراعة المتاخرة والزهور المبكرة وتوجد فروقات معنوية في

التدفق بين أنواع التربة ومعاهد الزراعة. في الزراعة المتاخرة أعطت التربة الطينية

والترابية الطينية + الرملية والترابية الرملية فروقات معنوية في عدد الأوراق.

التجارب (2) أجريت التجربة الثانية لاختيار أثر الحرارة على نسبة النباتات ومعدل

الإبتاع وأطوال البذور والوزن الطازج والوزن الجاف بعد الأوراق. ووجد أن زيادة

في درجة الحرارة تخفض نسبة الإبتاع ودرجة الحرارة 25° م تسبب أعلى معدل إنباذور بينما

درجة الحرارة 35° م أعطت أقل معدل إنباذور. أطوال البذور والوزن الطازج يحدث لهم

انخفاض سريع كلاً زادت درجة الحرارة. الوزن الطازج تخفض معناها عند
درجة الحرارة 35°م، عندما قورنت بدرجة الحرارة 25°م و 15°م أما الوزن الجاف معنويًا أعلى في 15°م من 35°م وعدد الأوراق ينخفض تدريجيًا عندما تزيد درجة الحرارة.

التجربة (3) صممت للبحث في أثر تنذيب الحرارة على نسبة الإناث ومعدل الإناث وأطوال البادرات والوزن الرطب والوزن الجاف وعدد الأوراق، ووجد أن درجات الحرارة المرتفعة أثرت على معدل الإناث وأطوال البادرات والوزن الرطب، الوزن الجاف، عدد الأوراق ما عدا نسبة الإناث كذلك وجدت فروقات معنوية في الوزن الجاف وفروقات معنوية عالية في عدد الأوراق.
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CHAPTER ONE

INTRODUCTION

There is a rich and varied vegetation in the Sudan due to variations in climates and soil types. The people usually make use of the plants available in their close neighbourhood particularly for nourishment, treatment of various ailments, building materials and furniture.

A fusion of Pharaonic and Islamic culture has developed over the years and greatly influenced the folkloric usage of plants. This, in addition to Sudanese indigenous culture, have resulted in materia medica representing a unique mixture of traditions. Islamic medicine is related through injunctions, concerning health, in the Holly Quran and Hadith. Most of the early Islamic Philosophers from Elkindi to Ibn-Rushd were accomplished physicians. Some of them like Mohamed Ibn-Zakaria, Elrazi and Ibn-Sina played a key role in the development of herbal medicine. A number of herbal drugs are mentioned in Hadith popularly known as Eltib Elnabawi such as Habbat Elbaraka (Black seed), Hilba (Fenugreek), Zanjabeel (Ginger) and Sabre (Aloe).
Because the price of western medicine has tremendously increased over the last decade and because traditional medicine is practiced in rural areas of the country where medical care is inadequate, efforts have been exerted to make Sudan self-sufficient by encouraging the production and manufacture of local medical materials and Pharmaceutical preparations in a systematic manner. Several scientific projects have been launched to explain some of the characteristics and curative phenomena associated with traditional herbal remedies and to identify simple technology that will produce adequate therapeutic materials at low cost to alleviate diseases and sufferings. Grewia is a multi-purpose medicinal plant used by people in rural areas as haematinic and for the treatment of anemia and malaria (*Grewia tenax* Guddaim).

**Objective of the present study:**

*Grewia tenax* was chosen for this investigation to obtain information on the effects of different temperatures and growing media on germination and growth in the hope of establishing a proper (*Grewia tenax*) nursery practices for seedling production.
CHAPTER TWO
LITERATURE REVIEW

2.1. Classification:

Taxonomy and nomenclature of Grewia tenax (Forsk) fiori.

Class: Magnolipsida.

Order: Tiliales.

Family: Tiliaceae.

Genus: Grewia.

Species: Tenax.

2.2. Botanical description:

Grewia tenax is a shrub or small tree up to 7m in height, the young shoots and the flowers are covered with red-brown hairs and the leaves are oval, alternate or simple, stipules present or absent (Andrews, 1956), pointed or rounded leave’s tips, toothed leave’s edge, the vein network is very clear below (Andrews, 1956), petioles are up to 0.5–1.25cm long. Flowers actinomorphic inflorescence mostly cymose, sepals valvate, petals free, absent, contoroted, valvate or imbricate (Von Maydell, 1986; El Amin, 1990), white, purple or yellow in color. Many stamens in the center, free rarely connate into 5–10 bundles, ovary syncarpous very rarely
apocarpous (Von Maydell, 1986; El Amin, 1990). Flowering under Sudan conditions occurs from November to July, fruits shiny, fleshy, sweet scented, orange or red in color when ripened 1–4 lobed, in the size of a maize kernel, glabrous and edible (Von Maydell, 1986; El Amin, 1990). Fruits are available from February to June in South Africa, seeds are variable in size, hairy and seed coat is very hard. One kilogram contains about 19000–21000 seeds (Von Maydell, 1986). The bark of *G. tenax* is dark–brown to grey with smooth texture, the branches are brown with white lenticels (El Amin, 1990).

### 2.3. Agroecology:

*Grewia tenax* is a widespread shrub, found in semi-arid woodland in dry and moist mid and lowlands (1000 – 230)m Grewia species are widely distributed in the tropical and subtropical areas of Africa, Asia and Australia and are rarely found in the temperate region. Guddaim distribution is discontinuous, being found in the arid zone of Morocco, Mauritania and Senegal to India, South Algeria, Northern Burkina Faso, Niger, Chad, East Africa, South to Namibia and Botswana (FAO, 1982) and is also found in Kenya and Somalia (Von Maydell, 1990). In Africa, the genus Grewia comprises about 150 species (Willis, 1973) but only 7 species
including *G. mollis*, *G. flavescens* (Burret). *G. ferruginea*, *G. carpinifolia*, *G. erythraea*, *G. bopulifolia* (Vahi) and *G. tenax* are present in Sudan (Andrews, 1956).

**2.4. Distribution of *Grewia tenax* in Sudan:**

In Sudan, *Grewia tenax* is distributed on sandy soils and on rock ground in the dry grass savanna, Red Sea hills, Kassala, Khartoum, Blue Nile White Nile, Kordofan, Upper Nile, Bahr El-Ghazal and Equatorial States (El Amin, 1990). The rainfall ranges between 200 – 1200 mm and altitude is between zero – 1500 m (FAO, 1982; Voget Kess, 1995).

**2.5. Uses of *G. tenax* in Sudan:**

It is well known that in Northern and Southern Kordofan states, the ripe fruits are collected and eaten raw. The fruits are sweet and chewed and the sweet juice is swallowed. Shepherds and children are the primary consumer category of this type of the fruits in normal times but adults may consume the fruits as well in food shortage period. It is also used to increase hemoglobin concentration, to cure anemia and malaria as it contains a high level of iron. A thin porridge “Nesha” prepared by boiling the fruit pulp and millet- flour is given to pregnant and lactating women to improve their health milk production and is also used as a famine food (Abd EL muti, 1991). Guddaim fruits are used as a refreshing tonic drink and a great thirst-
quencher especially during the hot months from March to July. The fruit pulp is used in making jams and Guddaim slices “Gamardiens” and the residue of the processed fruits is used as animal food (EL Amin, 1995, Nada and et al., 2000). Guddaim’s fruits are used to feed Bovans chicks (Ayed, 1995) and the shoots of the plant are given to sheep at lambing to help delivery (Sudanese Veterinarians, personal communications).

2.6. Uses of *Grewia* species in other countries:

*Grewia* species have been used for various purposes in different parts of the world. For example, in India the fruits are usually eaten raw especially in drought conditions and considered as famine foods. In Tanzania, parts of the plant are used as remedy for colds and chest complaints. Mixture of the root, of three *Grewia* species, *G. villosa* (Wild), *G. tenax* forsk and *G. flavascens* (Juss) is used for the treatment of tuberculosis, syphilis and smallpox (Von Maydell, 1986). In Kenya the bark is used as an anthelmintic and for the treatment of typhoid (Voget Kess 1995). In Pakistan the plant is used as fodder or shelter, in health care and in agroforestry system to improve soil fertility (Von Maydell, 1990). The same author mentioned the ash applied as poultice and the powder of the roots is used for the treatment of edematous swelling, tonsillitis and throat infections. The park is used in rop making and also for the treatment of jaundice. The leaves are intensively browsed by animals and also used as detergents. A kitchen salt is obtained from the ash of the plant branches and roots and used as aphrodisiac.
2.7. Chemical composition of fruits:

The chemical composition of the fruits of *Grewia tenax* has been described by Robert Freedman (2003) and is summarized in table (2.1). This author mentioned that the seeds contain 80% unsaturated oils. Phytochemical analysis of aerial parts of *Grewia tenax* including the fruits demonstrated the presence of tannins, sterols, triterpermes, saponins, flavonoids and anthraquinones (AL-Yahya *et al*., 1990). The stem park of the plant contains B-amyrin, B-sitosterol, triacontanol, lupenone and erythrodiol (Parkash *et al*., 1979).
Table (2.1). Chemical composition of *Grewia tenax* fruits (Sudan sample)

<table>
<thead>
<tr>
<th>%</th>
<th>Chemical composition</th>
<th>%</th>
<th>Chemical composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7 g</td>
<td>Methionine</td>
<td>6.3 g</td>
<td>Protein (crude)</td>
</tr>
<tr>
<td>3.4 g</td>
<td>Leucine</td>
<td>0.4 g</td>
<td>Fat</td>
</tr>
<tr>
<td>2 g</td>
<td>Isoleucine</td>
<td>8.1 g</td>
<td>Fiber</td>
</tr>
<tr>
<td>2.5 g</td>
<td>Tyroine</td>
<td>4.5 g</td>
<td>Ash</td>
</tr>
<tr>
<td>2.2 g</td>
<td>Phenylalanine</td>
<td>15.1 g</td>
<td>Starch</td>
</tr>
<tr>
<td>2 g</td>
<td>Lysine</td>
<td>1.6 g</td>
<td>Sucrose</td>
</tr>
<tr>
<td>1.1 g</td>
<td>Histidine</td>
<td>21 g</td>
<td>D-glucose</td>
</tr>
<tr>
<td>3.2 g</td>
<td>Arginine</td>
<td>24.3 g</td>
<td>D-fructose</td>
</tr>
<tr>
<td>0.10%</td>
<td>Sulphur</td>
<td>(g{16gN}^{-1})</td>
<td>Amino acid</td>
</tr>
<tr>
<td>0.08%</td>
<td>Potassium</td>
<td>8.1 g</td>
<td>Aspartic acid</td>
</tr>
<tr>
<td>0.17%</td>
<td>Magnesium</td>
<td>2.1 g</td>
<td>Threonine</td>
</tr>
<tr>
<td>0.61%</td>
<td>Calcium</td>
<td>2.4 g</td>
<td>Serine</td>
</tr>
<tr>
<td>0.01%</td>
<td>Sodium</td>
<td>6.2 g</td>
<td>Glutamic acid</td>
</tr>
<tr>
<td>21 mg/kg^{-1}</td>
<td>Zinc</td>
<td>11.6 g</td>
<td>Praline</td>
</tr>
<tr>
<td>10 mg/kg</td>
<td>Manganese</td>
<td>3.5 g</td>
<td>Glysine</td>
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<tr>
<td>74 mg/kg</td>
<td>Iron</td>
<td>2.4 g</td>
<td>Alanine</td>
</tr>
<tr>
<td>7 mg/kg</td>
<td>Copper</td>
<td>2.8 g</td>
<td>Valine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 g</td>
<td>Cysteine</td>
</tr>
</tbody>
</table>

2.8. Propagation by seeds:

In nature, propagation happens through different pomactic seed, runner and suckers, in addition to artificial planting and vegetatively by layering, cuttings, grafting, budding and by tissue and organ culture techniques, propagation for some plant species by (seed or vegetatively) needs special environmental conditions such as (temperature, sufficient light and water supply); these exist in greenhouse or prepared beds in which seed can germinate (Hartman and Kester, 1983).

Seed means, morphologically the structure developed from the fertilized ovule in seed plants. It contains the embryo, which develops into the new plant, usually surrounded by a protective seed coat (Schmidt, 1997). The economic importance of seed resides in it’s use as a source of food, drugs, beverage – making, paints varnishes clothes, ornaments and many other commercial products. Extracted oils from seeds are used in various ways as food products, soap and lanoline (Ben-hill, et al, 1976).

2.9. Germination and dormancy of seeds:

When a viable seed is wetted, the respiration, protein synthesis and other metabolic activities begin after certain period of times, the embryo emergences from the seed, normally radicle first that means the seed has germinated. In the life cycle of most organisms, there is a stage of rest,
where metabolism runs slowly during unfavorable conditions (Harper, 1977). This stage of rest is known as dormancy, which has been defined as a failure of viable seeds, spores or buds to germinate though exposed to conditions normally appropriate for germination (Schmidt, 1997). Baskin and Baskin (1998) summarized the knowledge about seed dormancy of 1452 plant species along the rainfall and temperature gradient from rain forest to vegetation in an area with less annual rainfall and decreasing temperature such as areas in hot and cold deserts. They found a reduction in plant species with non-dormant seeds from 61% in tropical rain forests to about 18% in the desert and only 1% in cold deserts; the percentage of plant species with dormant seeds increased from 39% in tropical rain forest to 84% in hot desert and up to 99% in cold deserts. Amin (1968) suggested that seed dormancy is caused by a block to the process of germination within the imbibed seed.

Dormancy is regarded as a germination regulation system depending on the prevailing conditions, stage of maturity of fruits and most likely on genotype (Bellefontaine, 1992). The causes of dormancy are exemplified by the nature of the seed coat, the condition of the embryo or by a combination of both. The seed coat dormancy may be brought about by the impermeability of the seed coat to water and to oxygen or due to mechanical
resistance of the seed coat to the expansion of the embryo and seed content.

Seed coat, due to physical or chemical structure and adhering fruit parts can prevent or delay germination (Said, 1986). El Nour et al. (1991) found that the epicarp prevented and mesocarp delayed germination of the seed of Balanites aegyptica L.

2.10. Effect of environment on seed germination:

Environmental conditions are an important effective factor on germination such as (light, moisture percentage, soil, temperature, soil and temperature etc…). The temperature is perhaps the single most important environmental factor that regulates germination and control subsequent seedling growth. Seeds of different species not only have maximum and minimum temperature limits for germination but also respond to specific seasonal and daily fluctuations. It changes with time and interacts with some other environmental factors such as light (Vegis, 1964). If seeds germinate and seedlings grow at high temperature, it is important that other environmental conditions be favorable. Moreover, fluctuating day – night temperatures sometime give better results than constant temperature for both seeds germination and seedlings growth (USDA, 1962).

Temperature affects both germination percentage and germination rate (Kokowaro, 1976). Germination percentages usually increases directly with
temperature and may remain relatively constant at least over the middle part of the temperature range, if sufficient time allows for germination to occur (Koller, 1972). Longman (1987) reported that, small changes of a round 1–2°C macro-climate have many effects on plant growth. At low temperature shoot growth reduces more than root growth (Wild, 1993). Three temperatures, minimum, optimum and maximum, have usually been designated for seeds. Often these are determined at constant temperature by use of seed germinator and may give misleading information, for field practices due to temperature fluctuations in the field which can produce results different from those obtained at constant temperature.

Optimum temperatures are those favourable for seed germination as well as seedling growth. This should be the range at which the largest percentage of seedling are produced at highest rate.

On this basis, the optimum for the quiescent seeds of many plants is between 16.5° and 35°C. The optimum may shift after germination since seedling growth may have different requirements from seed germination.

2.11. Effect of soil media:

The soil media have minor influence on germination as at this stage the embryo is wholly dependent on the stored food (Kozlowski, 1971), however, plant growth depends on soil for support, essential nutrient
elements, water and oxygen. The soil should be free from inhibitory factors such as extreme acidity or basically, disease organisms, toxic substance or impermeable layer (Nia and Bradford, 1992; Bradford, 1996).

The capacity of the soil to hold water is related to soil texture, minerals, content of soil organic matter and soil structure (Bradford, 1990).

Soil texture is the most important character in water holding capacity (Bewley and Black, 1982). Coarse texture soils have low water reaction capacity and efficient water infiltration and air movement (Vegis, 1964; Baskin and Baskin, 1998). Such soils provide physical support to plants and with minor contribution to plant nutrition. Whereas, fine textured soils are higher in water holding capacity and poor in water air movement (Bewley and Black, 1994). Soil texture affects both shoot and root growth. However, the rate of plant growth is at or near maximum when the soil is at field capacity, and it stops or be at minimum when the soil is at wilting point (Finch-Savage et al., 2000).

2.12. Germination and seedling growth:

Germination is a process of sequential series of physiological and morphogentic events that result in the transformation of an embryo into a seedling. When the growth is resumed, the protein synthesizing system of the cell becomes active, and the energy becomes available, hence fresh and
dry weights of the storage materials are decreased (Streat and Opik, 1970; Berre et al., 1987; Lars Schmidt, 1997).

There are three conditions that must be fulfilled before germination begins, viz: seed must be viable, adequate inner conditions (eg. living embryo, physiological and biochemical factors …etc) and appropriate environmental condition (Hartman and Kester, 1983). However, such growth and survival in plants is a result of an interaction of environmental factors (light, moisture, nutrients, temperature … etc) and plant internal physiological factors such as carbohydrate reserves, hormone levels, … etc (Street and Opik, 1970; Lavender, 1984). Thus raising seedlings to a desired phenotypic in the nursery is possible by the manipulation of the plant material and the surroundings such as climatic and edaphic factors (Lavender, 1984).

2.13. Main factors affecting seed germination and seedling growth:

Seed of some species have hard cutinized seed coats that completely prevent water imbibitions and gaseous exchange, resulting in seed coat dormancy. Thus, to remove this type of dormancy, various treatment designed to soften, puncture, wear away or split the seed coat in order to make it permeable without damaging embryo (Willan, 1985; Moilinga, 1992).
Failure of germination is sometimes due to protracted soaking which may be associated with the accumulation of toxic substances during anaerobic or increased susceptibility to fungal attach (Kozlowski, 1971) and Alecar et al. (1979) found that, germination percentage of some species was high without any treatment of seed. Mohamed and Sunder (1990) reported that seed treatment positively affects the maintenance of seed viability and consequently seed germination. The percent of germination of *Ziziphus spina –* christi was affected by soaking in cold water. Moreover, hot water affected both *Ziziphus spina –* christi and *Ziziphus macrontha* (Zietsman et al., 1987; Branny, 1990; Ahmed, 1994).

Shretha and Guatman (1989) found that both cold and hot water treatments increased germination and reduced the time to completion of germination of *Grewia optiva*. Adam (2001) reported that soaking seed in hot water for 24 hours was the best treatment for *Grewia tenax* from Abu Zabad and Elmuglad where germination reached 70% and 65% respectively. Hot water treatment has given good results with a number of leguminous seeds. The seeds are usually placed into boiling water, when removed from the heat source and left to cool gradually (Bhumibhaman, 1973; Kemp, 1975).

Chandra and Sharma (1975) found that, hot and cold water treatment
affect germination percentage and seedling growth of *Grewia elastica*. Commercial sulphuric acid is also used for dormancy – breaking. The time of treatment was found to vary between species, provenances and even between seedlots of the same provenance (Kemp, 1975). Seed of some plant species such as hard-coated leguminous ones (acacias) treated with sulphuric acid for various periods ranging from 5 to 60 minutes. Also some types of seeds with hard and tough pericarp need partial acid treatment: reseaous, cotton, castor, Rosa and Tilia (Hartman and Kester, 1983; Ali, 1991).

Bhaumibhaman (1973) reported that some plant species responded well to treatment with hydrochloric acid.

### 2.14. Seed quality:

Viability of seed is represented by germination percentage to express the number of seedlings, which can be produced by a given number of seeds. Additional characteristics of viability are that germination should be prompt, the seedling growth is vigorous and its appearance is normal. Viability differ from one seed type to another and there are many factors affecting seed viability during storage e.g. moisture content, temperature and storage atmosphere (Hartman and Kester, 1983). On the other hand, low germination percentage and consequently seedling growth may be resulted from genetic difference among cultivars, incomplete seed development on the plant,
injuries during harvest, improper processing and storage, disease and ageing. It has been reported that the main constraints to a good germination of seeds of some tropical forest tree species were: poor seed viability, a very hard endocarp and very high rate of insect damage (Mahgoub, 1992).

2.15. Seed size:

Seed size is expressed as 1000-seeds weight. It may also be expressed as, the weight of seed that can be contained in certain volume such as a hectoliter (Thomson, 1979). This quality has two component; actual size and uniformity of size. The former can influence the effectiveness of seed cleaning operation and make uniform growth of the seedling (Thomson, 1979). Seed size influence germination and early seedling growth, however, significant differences were observed in early seedling height, diameter, number of branches and number of leaves. The variations decreased with the age of seedling. Also a significant positive correlation was observed between seed size, height and dry weight of seedling. Moreover, the site of collection affect seed size, thus the germination percent of seed collected at various location varies, it also affects mean height, diameter and dry weight (Fasehun and Bello- Kura, 1992).

Street and Opik (1970) found that small seeds could support embryo growth for several days whereas, large seeds are capable of maintaining the
growth for a month. In addition, factors like seed shape, coat thickness and weight may affect the response of seed to the treatment and consequently to germination (Mahgoub, 1992).

2.16. Effect of soil media:

The soil (medium) must be loose enough to let roots develop freely, retains nutrients and water and is in the right pH balance (McDonald, 1975).

2.17. Media used in the nursery:

The normal media used in the nurseries in Sudan consists of silt alone or silt mixed with sand or compost. Studies on the effect of soil mix (medium) on plant growth in the Sudan were very meager.

Gadalla (1993) investigated the influence of different media, namely, sand + sawdust (1 : 1 ratio) river silt + sand (1 : 2 ratio) and top soil on management seed germination. The results indicated that there were no significant difference in germination between soil mixes; however, sand + sawdust (1: 1 ratio) and sand were the worst media compared to the other mixes. She also reported that the media had no influence on characteristic of the root system. Seed planted in top soil tended to emerge earlier than those planted in other mixes. The highest germination percentages were noted by Ali (1995) working with seeds of guava, lime and sour orange sown in river silt + sand (2: 1) medium and the lowest values were associated with sand
medium, regardless of the month in which data was recorded. Similar results were noted in plant height measurement taken at the termination of the experiment.

Campbell et al. (1980) defined physical soils amendment as any substance used for the purpose of promoting plant growth or improving the quality of crops by conditioning soils solely through physical means.

This centres primarily on soil improvement by improving water retention and permeability. They classified physical soil amendments into two broad categories: organic and inorganic. Organic amendments are derived from living sources, such as peat, peat moss, sphagnum peat, fibrous peat, composts, rotted manures … etc. Inorganic soil amendments such as calcined clay, pumice, vermiculite, perlite and sand. They reported that composts usually have a good nutrient – holding capacity and are very active biologically and well – decomposed composts aid in creating good, desirable soil structure. They also reported that although low in cost and with great longevity in the soil, sand has limited value as a soil amendment, except as use in special sand mixes such as nursery production.

Low in both water – and nutrient – holding capacities sand causes finer silt or clay soils to compact. The best germination of mango seed was associated with leaf mould followed by sand soil, sawdust and then farmyard
manure (FYM) as reported that by Teaotia and Singh (1971). Good mango seedlings with straight root system were dependent on germination medium. Thus, to get a straight seedling, it was necessary to have good tilled beds or pots and unsuitable soil and unattended seedbeds resulted in crooked stem and tap root as reported by Gangolly et al. (1957).

Chaudhri (1985) reported that addition of organic matter improved texture and fertility of light sandy soils, thus improved seed germination.
CHAPTER THREE
MATERIALS AND METHODS

3.1. Experiment (1) Effect of growing media on germination of *Gerwia tenax*:

*Gerwia tenax* seeds were sown in the Nursery of the Faculty of Agriculture, University of Khartoum at Shambat (Lat 15 39N, Long 32 31E) in April 2003. The experiment was executed under partial shade of 10-15% light intensity namely shade cloth. The seeds were sown in 16 polythene bags (10 × 20cm). The bags were perforated at the lower two – thirds. Four bags were filled with sand and other four bags were filled with river silt besides four bags that were filled with a mixture of river silt and sand at the ratio of (2: 1) and the last four bags were filled with peat moss.

Twenty five seeds were sown in each bag. The lay–out of the experiment was completely–randomized design (CRD). The bags were irrigated on the same day of sowing, then every day for sand and when needed for others (surface irrigation in addition to drip irrigation).

The germination was monitored and counted daily up to the end of the experiment. The experiment was repeated after fifteen days and each experiment (the first A and the second B) was terminated after 45 days. Number of leaves, shoot length, fresh and dry weight from ten seedlings were recorded.
After fresh weight was taken the seedlings were placed in an oven at 70º C for 24 hours to obtain the dry weight.

3.2. Experiment (2) Effect of temperature on germination of *Grewia tenax*:

The objective of this experiment was study the effect of different temperatures on germination and seedling growth of *Grewia tenax*. Three incubators were used in this experiment and were adjusted at 15°C, 25°C and 35°C for fifteen days. Thirty six plastic box (8.2cm × 12.1cm at the top surface, 7.1cm × 11.1cm at the bottom and 6cm in the height) were filled with sand. Twenty seeds were planted in each plastic box. Water was added on the same day of sowing date and daily afterwards. The germination was monitored and counted daily up to the end of the experiment. The boxes were distributed randomly in the 3 incubator (12 boxes/incubator). After thirty days from the start of the experiment, parameters studied were number of leaves, length of shoot and (fresh and dry) weight of all seedlings in each plastic box.

The experiment was repeated 3 times with an interval of 4 days between them using plastic boxes per treatment.
3.3. Experiment (3) Effect of alternating temperature on germination of *Grewia tenax* seeds and seedlings:

Two alternative temperatures were used in this experiment. These were 35/15° C and 25/15°C. The seeds were placed for 12 hrs in the higher temperature i.e. 35°C or 25°C and shifted to the lower temperature i.e. 15°C for the other 12 hrs. The experiment was repeated three times as in the second experiment. The parameters studied were similar to these in experiment two.
CHAPTER FOUR

RESULTS

4.1. Experiment I: Effect of growing media and sowing date:

Table (4.1) shows the effect of growing media and sowing date on germination%, germination rate, number of leaves, shoot length, seedling fresh weight and seedling dry weight of Grewia tenax.

4.1.1. Effect on germination percentage:

The results showed that peat moss recorded a high percentage of germination followed by sand, river silt and then sand and river silt mixture. However, there was no significant difference between growing media when compared statistically. Similarly, sowing date revealed no significant difference but the late sowing date showed a high germination percentage, and also germination no significant difference was recorded according to the interaction. Table (4.1)

4.1.2. Effect on germination rate:

The Results revealed that sand gave a high rate of germination followed by river silt but (river silt/sand) gave a low germination rate with no statistical difference between treatments.

The early sowing date recorded a high germination rate than the late one, but no significant difference was observed. On the other hand, the
interaction between growing media and sowing date showed a significant difference Table(4.2)

4.1.3. Effect on shoot length:

The study showed that river silt gave the highest shoot length followed by river silt + sand mixture, peat moss and sand respectively. The statistical analysis showed a significant difference between river silt and river silt + sand mixture when compared with sand. Table (4.3)

On the other hand, the late sowing increased shoot length significantly when compared with early sowing. No significant difference was recorded according to the interaction between sowing date and growing media.

4.1.4. Effect on fresh weight:

The results showed that peat moss gave the highest fresh weight followed by river silt, river silt + sand mixture and sand, respectively. The statistical analysis showed a significant difference between sand, river silt, river silt + sand mixture when compared with peat moss Table (4.4). The early sowing date recorded a high fresh weight with no significance, the result of interaction between growing media and sowing date was not significant.
4.1.5. **Effect on dry weight:**

The peat moss gave the highest dry weight followed by sand, river silt and river silt + sand mixture, but no significant difference was recorded between the different media. Significant difference between late and early sowing date was recorded. Interaction between growing media and sowing date was significant. Table (4.5).

4.1.6. **Effect on number of leaves:**

The study showed that the river silt gave the highest number of leaves followed by mixture soil, peat moss and sand respectively Table (4.6).

The statistical analysis showed a significant difference between river silt and river silt + sand mixture when compared with sand. On the other hand, a high number of leaves was achieved by late sowing date but the interaction between growing media and sowing date was not significant.
Experiment II: Effect of temperature on germination and seedling growth of *Grewia tenax*

Table(4.7) shows the effect of temperature on germination %, germination rate, shoot length, fresh seedling weight, dry seedling weight and number of leaves.

4.2.1. Effect on germination percentage:

The results showed that increase of temperature significantly decreased germination percentage gradually with a high significant difference between all treatments. Germination percentage was the highest at 15° C followed by 25° C and the lower germination percentage was recorded at 35° C Table (4.7).

4.2.2. Effect on germination rate:

The results showed that 25° C recorded the highest germination rate whereas 35° C gave the lowest germination rate. However, no significant difference was recorded between the different temperatures Table (4.7).

4.2.3. Effect on shoot length:

A gradual decrease in shoot length was recorded by increasing temperature. The statistical analysis revealed no significant differences between treatments. Table (4.7).
4.2.4. Effect on fresh weight:

The result showed that fresh weight decreased gradually by the increase in temperature. Analysis of variance showed that 35° C decreased fresh weight significantly when compared with 15° C and 25° C but no significant difference was observed between 15° C and 25° C. Table (4.7).

4.2.5. Effect on dry weight:

In the highest dry weight was recorded at 15º C whereas, the result revealed that 15° C gave a high dry weight 35° C gave the lowest and a significant difference was recorded between the treatments. Table (4.7).

4.2.6. Effect on number of leaves:

The results showed that number of leaves decreased gradually by increasing the temperature but no significant difference was recorded statistically. Table (4.7). (Plate 1, 2 and 3).

4.3. Effect of alternating temperature regime on germination%, germination rate, shoot length, fresh weight, dry weight and number of leaves:

The results in Table (4.8) revealed the constant temperature regime gave a high number on all measurements except germination percentage. On the other hand, statistical analysis showed significant difference on dry weight and a highly significant on number of leaves but no significant difference was recorded between the two regimes on the other parameters Table (4.8) (Plate 4, 5 and 6).
Table (4.1). Effect of growing media and sowing date on germination percentage of *Grewia tenax*

<table>
<thead>
<tr>
<th>Growing media</th>
<th>Sowing date</th>
<th></th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20/4</td>
<td>5/5</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>45.9</td>
<td>44.7</td>
<td>45.3</td>
</tr>
<tr>
<td></td>
<td>42.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>41.95&lt;sup&gt;a&lt;/sup&gt;</td>
<td>42.3&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>River silt</td>
<td>32.5</td>
<td>42.1</td>
<td>37.3</td>
</tr>
<tr>
<td></td>
<td>34.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.43&lt;sup&gt;a&lt;/sup&gt;</td>
<td>37.61&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Peat moss</td>
<td>44.0</td>
<td>52.0</td>
<td>48.0</td>
</tr>
<tr>
<td></td>
<td>41.51&lt;sup&gt;a&lt;/sup&gt;</td>
<td>46.17&lt;sup&gt;a&lt;/sup&gt;</td>
<td>43.84&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>River silt + sand</td>
<td>27.3</td>
<td>36.8</td>
<td>32.0</td>
</tr>
<tr>
<td></td>
<td>31.51&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>34.42&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>37.3</td>
<td>43.8</td>
<td>34.42&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>37.61&lt;sup&gt;A&lt;/sup&gt;</td>
<td>41.46&lt;sup&gt;A&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

| S.E. ± sowing date  | 1.95<sup>ns</sup> |
| S.E. ± growing media| 2.77<sup>ns</sup> |
| S.E. ± S x G        | 3.92<sup>ns</sup> |
| CV%                 | 19.82        |

Table (4.2). Effect of growing media and sowing date on germination rate of *Grewia tenax*

<table>
<thead>
<tr>
<th>Growing media</th>
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<th></th>
<th>Mean</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>20/4</td>
<td>5/5</td>
<td></td>
</tr>
<tr>
<td>Sand</td>
<td>16.59&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.23&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>14.91&lt;sup&gt;A&lt;/sup&gt;</td>
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<tr>
<td>River silt</td>
<td>17.13&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.19&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.66&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Peat moss</td>
<td>11.92&lt;sup&gt;b&lt;/sup&gt;</td>
<td>14.49&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>13.21&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>River silt + sand</td>
<td>12.26&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.14&lt;sup&gt;b&lt;/sup&gt;</td>
<td>12.20&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>14.48</td>
<td>13.01</td>
<td></td>
</tr>
</tbody>
</table>

| S.E. ± sowing date  | 0.63<sup>ns</sup> |
| S.E. ± growing media| 0.89<sup>ns</sup> |
| S.E. ± S x G        | 1.26<sup>*</sup>  |
| CV%                 | 18.56        |
Table (4.3). Effect of growing media and sowing date on shoot length (cm) of *Grewia tenax*

<table>
<thead>
<tr>
<th>Growing media</th>
<th>Sowing date</th>
<th></th>
<th>Mean</th>
</tr>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Sand</td>
<td>10.30&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>11.63&lt;sup&gt;a&lt;/sup&gt;</td>
<td>13.65&lt;sup&gt;a&lt;/sup&gt;</td>
<td>12.64&lt;sup&gt;A&lt;/sup&gt;</td>
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<td>11.43&lt;sup&gt;AB&lt;/sup&gt;</td>
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<td>12.41&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>10.89&lt;sup&gt;B&lt;/sup&gt;</td>
<td>12.19&lt;sup&gt;A&lt;/sup&gt;</td>
<td></td>
</tr>
</tbody>
</table>

S.E. ± sowing date 0.29**
S.E. ± growing media 0.41**
S.E. ± S x G 0.58<sup>ns</sup>
CV% 10.02

Table (4.4). Effect of growing media and sowing date on fresh weight of *Grewia tenax*

<table>
<thead>
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<th>Growing media</th>
<th>Sowing date</th>
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<th>Mean</th>
</tr>
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<tbody>
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<td></td>
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<tr>
<td>Sand</td>
<td>2.30&lt;sup&gt;bc&lt;/sup&gt;</td>
<td>1.95&lt;sup&gt;c&lt;/sup&gt;</td>
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<td>River silt</td>
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<tr>
<td>Peat moss</td>
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<td>3.37&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.96&lt;sup&gt;A&lt;/sup&gt;</td>
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<tr>
<td>River silt + sand</td>
<td>2.16&lt;sup&gt;c&lt;/sup&gt;</td>
<td>2.22&lt;sup&gt;bc&lt;/sup&gt;</td>
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<tr>
<td>Mean</td>
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<td>2.05&lt;sup&gt;A&lt;/sup&gt;</td>
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</table>

S.E. ± sowing date 0.10<sup>ns</sup>
S.E. ± growing media 0.14**
S.E. ± S x G 0.2**
CV% 15.72
Table (4.5). Effect of growing media and sowing date on dry weight of *Grewia tenax*

<table>
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</thead>
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<td>Sand</td>
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<td>0.85&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Peat moss</td>
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<td>0.85&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>River silt + sand</td>
<td>0.63&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.72&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>0.61&lt;sup&gt;B&lt;/sup&gt;</td>
<td>0.77&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>S.E. ± sowing date</td>
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<tr>
<td>S.E. ± growing media</td>
<td>0.05&lt;sup&gt;ns&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>S.E. ± S x G</td>
<td>0.07&lt;sup&gt;*&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>CV%</td>
<td>19.92</td>
<td></td>
</tr>
</tbody>
</table>

Table (4.6). Effect of growing media and sowing date on leaves number of *Grewia tenax*

<table>
<thead>
<tr>
<th>Growing media</th>
<th>Sowing date</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20/4</td>
<td>5/5</td>
</tr>
<tr>
<td>Sand</td>
<td>6.48&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6.28&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>River silt</td>
<td>7.03&lt;sup&gt;a&lt;/sup&gt;</td>
<td>8.20&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Peat moss</td>
<td>6.80&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.18&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>River silt + sand</td>
<td>7.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>7.35&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>7.02&lt;sup&gt;A&lt;/sup&gt;</td>
<td>7.25&lt;sup&gt;A&lt;/sup&gt;</td>
</tr>
<tr>
<td>S.E. ± sowing date</td>
<td>0.18&lt;sup&gt;ns&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>S.E. ± growing media</td>
<td>0.26&lt;sup&gt;**&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>S.E. ± S x G</td>
<td>0.38&lt;sup&gt;ns&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>CV%</td>
<td>10.30</td>
<td></td>
</tr>
</tbody>
</table>
Table (4.7). Effect of temperature on germination and seedling growth of *Grewia tenax*

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Germination Rate</th>
<th>Shoot Length</th>
<th>Fresh Weight</th>
<th>Dry Weight</th>
<th>Number of Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>15°C</td>
<td>51.7% 45.98</td>
<td>14.27</td>
<td>4.74</td>
<td>0.46</td>
<td>0.180</td>
</tr>
<tr>
<td>25°C</td>
<td>41.2% 39.95</td>
<td>14.93</td>
<td>4.69</td>
<td>0.39</td>
<td>0.045</td>
</tr>
<tr>
<td>35°C</td>
<td>16.2% 23.76</td>
<td>12.98</td>
<td>4.17</td>
<td>0.07</td>
<td>0.014</td>
</tr>
<tr>
<td>LSD</td>
<td>9.52**</td>
<td>2.73NS</td>
<td>1.29NS</td>
<td>0.27**</td>
<td>0.09**</td>
</tr>
<tr>
<td>CV%</td>
<td>8.59</td>
<td>9.71</td>
<td>14.29</td>
<td>28.27</td>
<td>38.91</td>
</tr>
</tbody>
</table>

Table (4.8). Effect of alternating temperature on germination and seedling growth of *Grewia tenax*

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Germination Rate</th>
<th>Shoot Length</th>
<th>Fresh Weight</th>
<th>Dry Weight</th>
<th>Number of Leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>15°-25° C</td>
<td>39.1% 35.71</td>
<td>9.10</td>
<td>4.96</td>
<td>0.118</td>
<td>0.021</td>
</tr>
<tr>
<td>15°-35° C</td>
<td>22.2% 28.09</td>
<td>9.78</td>
<td>5.56</td>
<td>0.172</td>
<td>0.034</td>
</tr>
<tr>
<td>LSD</td>
<td>16.22NS</td>
<td>3.30NS</td>
<td>2.36NS</td>
<td>0.06NS</td>
<td>0.01*</td>
</tr>
<tr>
<td>CV%</td>
<td>22.43</td>
<td>15.14</td>
<td>19.80</td>
<td>18.63</td>
<td>18.48</td>
</tr>
</tbody>
</table>
Plate showing seedling of *Grewia tenax* on temperature 15°C

Plate (1)

Plate showing seedling of *Grewia tenax* on temperature 25°C

Plate (2)
Plate showing seedling of *Grewia tenax* on temperature 35° C

Plate (3)
Plate showing seedling of *Grewia tenax* on alternate temperature 15°C ↔ 35°C
First culture

Plate (4)

Plate showing seedling of *Grewia tenax* on alternate temperature 15°C ↔ 35°C
Second culture

Plate (5)

35
Plate showing seedling of *Grewia tenax* on alternate temperature 15°C to 35°C
Third culture

Plate (6)
CHAPTER FIVE
DISCUSSION

The results of the present study indicate that the germination of *G. tenax* seed increased in sandy soil but with reduced shoot length, fresh and dry weight and number of leaves. Although the germination rate in river silt followed that in sand, the shoot length and number of leaves were high than in other media.

River silt resulted in high germination rate, shoot length and number of leaves that might be due to the fact that river silt was very fertile and tended to supplement the plant with the essential nutrient elements for their growth and development. In agreement with these findings were those reported by Chaudhri (1985) who indicated that river silt improved the texture and fertility of growing media.

On the other hand, peat moss resulted in higher germination percentage, fresh and dry weight than other media.

Some of the investigators reported that the use of the right growing medium is fundamental requirement for plant growth and it must possess the following characteristics: readily available, relatively inexpensive, porous serves as a reservoir for water and nutrients and free from pests and diseases (M, Donald, 1975; Hartman and Kester, 1983; Davidson *et al.*, 1988).

It was found that the increase in temperature reduced the germination
percentage and that 25°C gave a higher germination rate whereas 35°C reduced the germination rate.

It is well known that seed germination is a complex physiological process that is responsive to many environmental signals including temperature, water potential and other factors (Bewley and Black, 1994; Baskin and Baskin, 1998).

It has been suggested that seed of higher plants enter a stage of development arrest known as primary dormancy before completion of maturation process (Gardner et al., 1985), for germination, quiescent or non dormant seeds require only rehydration after release from primary dormancy while dormant seeds need additional external stimuli such as light (Thomas, 1992), temperature (Van Assche and Vanlerberghe, 1989) and chemicals (Taylorson, 1972). Germination percentage and rate of some plant seeds decline with decreasing osmotic potential of germination medium but the magnitude of this decline may vary according to temperature (Sharma, 1976). Seed germination and seedling growth may be adversely influenced both by decreasing rate and total amount of water absorbed and by the increase of certain ions in the seed which may be toxic in high concentration (Bernstein and Hayward, 1958).

In summer, high temperature and evaporation rate may occur, which
with the use of saline irrigation water caused high salt concentration in soil. In this condition, seed germination and seedling may be reduced, delayed and speed over time (Benlay and Black, 1994).
REFERENCES


Bhauibhamon, S. (1973). Seed problems In Thailand IUFRO Intersym. On,
Seed processing "Bergen Royal " Co. For Stockholm, Sweden.


*Plant physiology, 98: 1057 – 1068.*


Preliminary study in seed pre-germination treatment and


Indica. *In: The uango Indian Council of Agricultural Research* New Delhi. P467


Moilinga, M.K. (1992). *Pre-germination treatments and juvenile*


Shrestha, P.K; Gaultman, M.K (1989). Pretreatment of Bhimal (Grewia optiva) Seed, agricultural center, lumle, technical paper No 2-89


