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EFFECT O SEED SOURCE VARIATION ON SEED GERMINATION OF *Polyalthia longifolia*

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DECLARATION

I, Rabin Kumar Paul declare that this thesis is a result of my own works and that it has not been submitted or accepted for a degree in any other university.

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DEDICATED TO
MY
BELOVED PARENTS

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ABSTRACT

Seed morphology and germination of *Polyalthia longifolia* were investigated with a view to discover the effect of variation in seed sources on seed germination. The experiment was done in nursery of Forestry and Wood Technology Discipline, Khulna University, Bangladesh. Seeds were collected from different healthy trees from various locations of Bangladesh. The locations were Rajshahi, Dhaka, Chittagong, Jessore and pirojpur. Good quality seeds were collected for the experiment. For experimental purpose, a mixture of topsoil and cow dung in the ratio of 3:1 was used. The average length of the fresh seeds was 2.65 ± 0.01cm diameters 2.14 ± 0.01cm and weight 1.82 ± 0.02gm. The highest germination percentage (68%) was found for the seeds collected from Jessore. Second highest germination percentage (67%) was achieved from the seeds collected from Rajshahi. The seeds from Dhaka and Chittagong showed 50% and56% success was found for the seeds from Pirojpur. The result of analysis of variance (ANNOVA) showed significance differences ($P<0.05$) in germination starting days, germination percentage and germination rate among various locations. Based on the study, the seeds from Jessore and Rajshahi may be used for seed germination of *Polyalthia longifolia.*

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CHAPTER ONE: INTRODUCTION

1.1 Background of the study

A significant seed source variation was observed in seed morphology (color, size and weight), seed germination (viability, germination percentage, germination rate, germination starting period, germination closing period, germination period). The seeds were collected five different locations of Bangladesh. The phenotypic and genotypic variance, their coefficient of variability and broad sense heritability also showed a sizeable variability. This offers a breeder ample scope to undertake screening and selection of seed sources for the desired traits. Further, high percentage of heritability coupled with moderate intensity of genetic gain, was observed for seed germination traits, which signifies that germination is under strong genetic control and good amount of heritable additive genetic component can be exploited for improvement of this species. It is widely used as ornamental tree. It is also used as medicinal tree. It shows diagnostic pharmacognosic character in the stem bark (Srivastava et al., 1988). It provides help to control pollution. Considering the following importance, I selected *Polyalthia longifolia* for the purpose of my thesis (Neginhal, 1986).

So far, only few records of provenance trials of the J. curcas exist where an attempt was made to examine the seed source variation and found expected result for seed germination trial (HELLER, 1996; GINWAL et al., 2004).

A study on seed source variation of *Tamarindus indica* was carried out and it was successful for improvement of forestry resources. Considering these, I planned to work on effect of seed source variation on seed germination of *Polyalthia longifolia.* The objective of my investigation was to understand the nature, extent and pattern of variation existing in different sources of *P. longifolia* in respect to seed morphology and germination *(*Azad et al., 2013*)*.

Debdaru (*Polyalthia longifolia*) under the family Annonaceae, order Magnoliales and kingdom plante is an angiosperms, tall handsome evergreen to semi deciduous tree indigenous in Ceylon and much cultivated in garden and avenue in India, Bangladesh and Burma. It is a lofty evergreen tree, native to India, commonly planted due to its effectiveness in alleviating noise pollution. *Polyalthia longifolia* is a prominent species with vide variety of uses.

It exhibits symmetrical pyramidal growth with willowy weeping pendulous branches and long narrow lanceolate leaves with undulate margins. The tree is known to grow over 30 feet in height. It is sometimes incorrectly identified as the Ashoka tree (Saraca indica) because of the close resemblance of both trees. One might mistake it as a tree with effectively without branches, but in fact, a Polyalthia allowed to grow naturally (without trimming the branches out for decorative reasons) grows into a normal large tree with plenty of shade (USDA, 2007).

It grows is slowly. The seeds, which ripen in July and August, do not keep their germination power long and required to be shown as soon as possible after ripening. The young plant does not stand transplanting well, and to ensure the best result the seeds should be sown at sight on the basket (Troup, 1994). Bark dark grey to dull brown, smooth, thick, leaves lanceolate 5-20×2.5-5 cm, acuminate yellowish or green shinning above with undulated margin, membranous. Flowers are in fascicles or short umbels from axils of fallen leaves. Fruits produces in great clusters on glabrous stalks, black when ripe, seed pale brownish, smooth, shine, found scattered on the ground under the tree. Usual germination 50-70%, seed purity 99%, seed collection time September to October, seed counts per kg 1800-2500. The tree is sometimes misnamed as deodar, which is Cedrus deodara. Fruit is borne in clusters of 10-20, initially green but turning purple or black when ripe. From each of the flowers, there appear several egg-shaped fruits. Each fruit is placed on a short stalk and contains one seed. The Bats and flying foxes admire these fruits and during the evening the tree will be covered by the noisy, screaming throngs. For germination the seed stored wet condition. Heated by sunrise is good for germination but soaking in water are better for germination. The fruits either dried in the sun so the fleshy part can be removed manually or mechanically, or soaked to separate the seed. Ripened fruits are soaked in water until they rot, pulped or macerated on newspapers, and dried in warm place. Seeds are several years of dormancy and can be stored satisfactorily if they are kept in air- tight or almost air-tight containers in a dark room under dry condition (Zabala,1990).

1.2 Objectives of the study

Debdaru (*Polyalthia longifolia*) is an important tree species in our country. Each experiment has some desired objectives. I also fixed some specific objectives. The specific objectives of my experiment were

i) To observe the morphological characteristics of seeds of debdaru (Polyalthia *longifolia)* collected from five different locations of Bangladesh.

ii) To find out the effect of seed source variation on seed germination of Debdaru (*Polyalthia longifolia).*

CHAPTER TWO: GENERAL DESCRIPTION

2.1 Description of the species

This tree is a member of the `Anonaceae` family. The tree is known as `Devdar`, `Ashoka`, `Debdaru` and `Asok in hindi language`. The Bengali people call it as `Debdaru`. In Tamil, it is named as `Assothi` and `Mara Illupai` and it is `Choruna` in Malayalam. The tree is the weeping variety of *P. Longifolia* and has wide-spreading slender branches that are issued from the trunk and form a compact and proportioned crown. First two leaves alternate, simple, short petiolate, laceolate, greenish, acuminate, entire or slightly wavy at margin, acute at the base, size of the first two leaves are 4.1 cm x 1.5 cm and 5 x 1.9 cm respectively, primary vein one, distinct, secondary veins 4.5 pairs alternate or sub-opposite, petiole 1.3 cm subsequent leaves alternate, simple, stipulate, 2.3-3.5cm long other characters (USDA, 2007).

During the months of March and April, the flowers appear, but all the g trees do not have flower at the same time. The tree remains covered with a large number of star like flowers for a short time of about two or three weeks only. The flowers are palest-green in color and give the tree a strange hazy appearance. It normally grows in clusters from small bumps all along the dark branches. It has a little calyx and six long, narrow, wavy petals arranged in two sets of three. The stamens remain packed firmly together in a small, pale-green dome. Fruit is borne in clusters of 10-20, initially green but turning purple or black when ripe. From each of the flowers, there appear several egg-shaped fruits. Fruits are placed on a short stalk and contain one seed. They will leave some evidence of their orgy in the nut-strewn ground in the morning. The seeds and fruits are golden brown. They can grow up to 22.5 cm in length and their shapes are like lances. It is usually bright, green in color. The tree looks attractive when the new leaves appear. The contrast between the deep-green colors of the aged leaves, the yellow-green of the half-grown leaves and the oxidized touch of the bendy new tiny leaves are extraordinarily birds such as the Asian Koel and Bats including flying foxes love these. Bark of *polyalthia longifolia* has microscopical and macroscopical, chemical and fluorescence characters (Prasda et al., 1961). Bark properties were investigated in several arid-zone tree species from northern India and found to posse's thick outer barks composed of outer rhytidom or heavily sclerified elements in the secondary phloem. Some of these trees formed multiple periderms, which isolated parts of the secondary phloem, forming an insulating layer of hard, dead tissue. Aging results in accumulation of such tissue and a hard, durable outer bark. Other trees develop heavily sclerified secondary phloem and outer

crusts, which serve essentially the same purpose (Ghouse et al., 1980). Those components were newly isolated from the dried stem bark collected in Dhaka, Bangladesh, and identified by spectral analysis:16beta-hydroxycleroda-3, 13 Z-dien-15, 16-olide (0.054 %), 16-oxocleroda-3, 13 E-dien-15-oic acid (0.007 %) and kolavenic acid (0.33 %) (Hasan et al., 1994).

2.2 Geographic distribution

The common names of *Polyalthia longifolia* are False Ashoka, the Buddha Tree, Indian mast tree, and Indian Fir tree. Its names in other languages include Ashoka or Devadaru in Sanskrit, Debdaru in Bengali and Hindi, Asopalav (Gujarati), Glodogan tiang (Indonesian), Devdar in marathi and Nettilinkam in Tamil. *Polyalthia longifolia* is Localy Distributed in Andaman & Nicobar Islands, Andhra Pradesh, Arunachal Pradesh, Assam, Bihar, Delhi, Goa, Gujarat, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Manipur, Mizoram, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh, and West Bengal. It is found natively in India and Sri Lanka. It is introduced in gardens in many tropical countries around the world. It is, for example, widely used in parts of Jakarta in Indonesia. It also planted in areas of Balgladesh like Satkhira. Khulna, Jessore. Narail, Commila, Khustia (USDA, 2007).

2.3 Habitat and climatic requirements

It grows generally lowland rainforests, dry and humid areas of the world. It is a light demander species. It is generally moderately salt tolerant species. Drought tolerance power is medium. It can survive well generally in frost-free areas with annual lows of (15 to 25)^{0}C, annual highs of (26 to 34)^{0}C, annual rainfall of (800 to 2500) mm and a dry season of 8 months or less. It grows on all types of soil but grows faster on well- drained soil. It requires medium nutrient. It is much taller than broad. The trunk is straight and rather slender with gray bark. It has a dense crown with drooping branches. The entire length of the tree is covered by dark green leaves. The trees pictured in this fact sheet are of their natural forms without pruning modification (Staples et al., 2003).

2.4 Economic importance

Polyalthia longifolia is medicinal plant. The petroleum ether extract of stem bark of *Polyalthia longifolia* exhibited antimicrobial activity. Three diterpenes (165-oxocleroda-3, 13E-dien-15-oicacid, kolavenic acid and 16 beta-hydroxycleroda-3, 13-dien-15, 16-olide), isolated from the extracted, exhibited activity against a battery of bacteria and fungi (Rashid et al., 1996) The bark of this species is used as a febrifuge in Indian medicine and its aqueous extracted showed hypertensive activity in test with laboratory animals. A clerodane diterpene was isolated from the petroleum ether extract. Its structure was deduced by the spectral analysis and by chemical correlation with the corresponding gamma-hydroxybutenolide diterpene isolated earlier. It has diagnostic pharmacognosic character in the stem bark (Srivastava et al., 1988).

The Hindus held it in great esteem and plant it near their temples. The tall straight trunks have light and flexible wood and were ideally suitable for making masts in the days of sailing ships. The wood is straw-colored. The main work was to determine the suitability of debdaru (*Polyalthia longifolia*) as poles from Government and village forest. The poles of debdaru are easily treatable with CCA preservative by full cell pressure method, but difficult to dry (air and kiln). Debdaru poles have been found suitable for power and telecommunication lines when care is taken over drying. *Polyalthiua longifolia* are used as fibre and ornamental plant, along roadside, in parks. Polyalthia longifolia has another significance value on pollution control. (Neginhal, 1986).

CHAPTER THREE: REVIEW OF LITERATURE

Books, technical reports, journals, working plans, and other such materials were followed for review of literature. The tree CD provides abstracts of articles, published in journals on all aspects of forestry and forest products. Such references related to *Polyalthiua longifolia* were searched to accumulate backdated and recent data. For germination to be initiated, three conditions must be fulfilled. The seed must be viable, that is the embryo must be alive and capable of germination. The seed must be subject to the appropriate environmental conditions, available water, proper temperature regimes, a supply of oxygen, and sometimes light. Any primary dormancy is collectively known as after ripening and results from the interaction of the environment with the specific primary dormancy condition.Seed emergence behavior was studied in three geographically diverse populations of T. indica from the Sudan. Tamarind seeds are generally slow to germinate as indicated by the allowance of 15 to 42 days from planting before the first and the last emergence count, respectively. Even though differences were not significant, the highest total percent emergence (97%) was recorded for Western Sudan population, followed by Central Sudan (92%) and Eastern Sudan (90%) populations. Seeds of the Western Sudan population achieved E50 (days to 50% emergence) two and three days earlier than Eastern Sudan and Central Sudan, respectively (K El-Siddig, 2000).

Polyalthia longifolia grow better in the moist tropical climate, at elevation ranging from 100 to 600 meters. Minimum rainfall requirements are 760 mm. with dry season tolerance of 2-4 month. Absolute temperature ranges from 15°C to 37°C (Zabala, 1940).

The most successful tree improvement programme is that where proper seed sources were used. The loss from using the wrong sources can be great and even disastrous (Zobel and Talbert, 1984). They outline the uniqueness of seeds in natural regeneration and propagation; seeds constitute unique genetic composition, resulting from mixing parental genetic material, leading to genetic variation of the offspring, which enhances ecological adaptability. Seeds are usually produced in large numbers and are readily available each year or at longer intervals. Seeds are usually small concentrated packages of plant-to-be, containing plant nutrients for the establishment of the plant and, except for recalcitrant seeds, usually much more resistant to damage and environmental stress than vegetative propagules. When planting trees it is important to consider using seeds of trees with desirable characteristics. Various studies shows that seed provenances of trees from similar environment should also are

considered when preparing a plan for planting trees. The information on seed source variation for different morphological and biomass traits in *Pongamia pinnata* is limited, with intense scrutiny of the literature; it was found that less work has been done on this aspect. Hence the review on biofuel and other tree species have also been included seed source variation experiment can be presented by Pod and Seed characters, Germination characters, Genetic variability, Heritability and Genetic advance Seed weight depends on reserve food material, which is produced as a result of double fertilization (endosperm) and is dominated by maternal traits, also influenced by the nutrient availability at the time of seed setting and environmental factors. Embryo development and its physiological function are contributed by the maternal as well as by paternal (pollen grain) traits in the species. Measured ten seed and seedling characters of *Dalbergia sissoo* population on samples collected throughout the natural range of the species in India and observed the existence of significant genetic variations for the seed and seedling traits. Seed traits such as seed size, seed coat thickness shape and moisture content are already known to affect germination and early seedling establishment (Jijeesh and Sudhakara, 2013).Similarly, fruit or seed trait variation due to seed source has been proven (Jayasankar et al., 1999) which can serve as a valuable tool in tree improvement programs. Variation in the fruit and seed characteristics of the species from different natural habitats should be properly documented for future use in domestication, cultivation and tree improvement programs, thereby controlling its over exploitation from natural habitats. Hence, the present investigation was carried out to study the influence of source and size of the seed on germination and seedling growth of *Strychnos nux-vomica*. The study was carried out at College of Forestry, Kerala Agricultural University, Thrissur, and Kerala during 2010-2011. Fruits of *Strychnos nux-vomica* were collected in bulk from three sources viz. dry deciduous (Chinnar Wildlife Sanctuary), moist deciduous (Pattikkad Reserve Forest) and riparian (Peechi-Vazhani Wildlife Sanctuary) forests of Kerala. The germinated seeds in the root trainers were kept in a greenhouse and timely weeding and irrigation were carried out. The seedling growth attributes like height, collar diameter, number of leaves, biomass production of stem, leaf and root, root: shoot ratio and vigour index were recorded at 180 days after planting. Destructive sampling was carried out using three plants per treatment. Seedling vigour index was calculated as the product of the germination percentage of the seed lot (respective seed source or size grade) and the seedling dry weight (Yari et al., 2010).

The improved fruit traits recorded in moist deciduous forests might be due to the crown and site characteristics, and the lower values obtained with respect to these in fruits of dry deciduous forests may be because of the lower vigour of the trees combined with reduced site quality. The source variation in seed and seedling quality has been reported in species like *Jatropha curcas* (Ginwal and Gera, 2005), *Tectona grandis* (Jijeesh and Sudhakara, 2007; Sudhakara and Jijeesh, 2008), etc.

Seed traits improved with increase in size irrespective of the source. Results are in conformity with the finding that the seed source and size influence the seed attributes (Gunaga et al., 2010; Dlamini, 2011).

A great diversity of edapho-climatic conditions expected to be reflected in the genetic constitution of its diverse seed sources which, intern influence germinability and plant production (Gera et al., 1999; Indira and Chand Basha, 1999). Seed is one of the important inputs for forest nursery production and plantation establishment (Lauridesen and Oleson, 1990). Variation in germination of seed sources has been documented in number of tree species such as *Acacia catechu* (Kumar et al., 2004), *Acacia nilotica* (Shekar et al., 2002), *Albizia lebbeck* (Radhakrishnan and Vanangamudi, 2004), *Dalbergia sissoo* (Devagiri, 1997), *Grewia optiva* (Tyagi et al., 1999) and *Pongamia pinnata* (Vasantha Reddy et al., 2007).

It was reported that out of the six locations of *Pongamia pinnata* in Tamil Nadu, the seed weight was the highest in Salem seed lot followed by Pillur and Erode, while the lowest was in seeds of Karur. The number of seeds per kilogram was highest in seeds of Karur followed by Coimbatore and lowest in Salem. It was found that moisture content varied significantly among the seeds varied from 6.3% in Salem to 5.3% in Karur seed source. (Kumar et al., 2003)

It was confirmed that the higher germination and seedling development of *Jatropha curcas* were observed in the heavier seed than in the lower seeds irrespective of the location. It was also observed that germination and vigour index values were the highest in Walayar seed source and the lowest in Paripatti seed source (Kumar et al., 2003).

Seeds were collected from ten seed sources of Jatropha curcas and expressed that they exhibited considerable variability in seed morphological traits viz., seed length, seed width, germination per cent and oil content (Ginwal et al., 2005).

Characters among different seed sources were also observed in *Emblica officinalis*, *Syzygium cuminii* and *Grewia optiva* (Tyagi et al., 1999).

Seed germination is one of the important characters that help to calculate seed rate for seedling propagation. The seed size is a considerable and significant factor in the germination and early stage of plant growth. Different size of seeds having different levels of starch and other food storage may be one factor which influences the expression of germination and growth of the plants. Concerning photoinduction of seed germination, it was found that continuous irradiation with light of580-700 nm was effective in inducing germination of lettuce seeds, but that of 700-800 nm, as well as 500 nm, was inhibitory (Flint and MacAlister, 1953). It was measured the action spectra for promotion and inhibition of germination, finding the maximum sensitivity for promotion in the region of 640-670 nm and that for inhibition in 720-750 nm (Borthwick et al.., 1952).

Germination trial is an important in estimating the number of seeds, which can germinate from a seed lot under optimum conditions. Provided the test result is representative of the total quantity available, this information can be used to determine the quantity required to be sent in order to achieve the planned annual planting target. It is a particular importance in direct seeding that seed germinate rapidly and that early seedling growth is vigorous. *Polyalthia longifolia* grows better in the moist tropical climate, at elevation ranging from 100 to 600 meters. Minimum rainfall requirements are 760 mm. with dry season tolerance of 2-4 month. Absolute temperature ranges from 15°C to 37°C (Zabala, 1990). But in India the absolute maximum shade temperature varies from 35° to 47.5°C and the absolute minimum from 0°to25°C The mean relative humidity varies from 50 % to 90 % in January and from 70 % to 100 % in July. The tree cannot stand the frost and cold in north India.The flowers of Rain tree appear in the hot season from May to June. The tree is attractive in flowering stage with its numerous rose colored heads of flowers with tufts of pink omens. The pods form rapidly but ripening is quickly and takes place in September to October. The plants tolerate a broad range of soil types i.e. light to heavy, neutral to acidic and seasonally water logged soils. Ripe pods are collected from the trees in September to October. The seeds weights 1800-2500 per kg. Every seed was 1.79gm weight. Average length and diameter was 2.64 cm and 2.13 cm respectively. Usual germination 50-70 %, seed purity 99 %, with watering and under shade, a germination of 77 % to 93% is obtained, the period of germination extending from 19 to 23 days. Early watering and provision of sunlight to the seedlings seems to be beneficial. In case of natural regeneration, the sweet ripen pod that is eaten by wild animals,

termites and ants. Fruit is borne in clusters of 10-20, initially green but turning purple or black when ripe. From each of the flowers, there appear several egg-shaped fruits. Each fruit is placed on a short stalk and contains one seed. The Bats and flying foxes admire these fruits and during the evening the tree will be covered by the noisy, screaming throngs. For germination the seed stored wet condition. Heated by sunrise is good for germination but soaking in water are better for germination. But in *Anthocephalus chinensis* after collection fruits are left no ripen (Pollard, 1969). They are placed in protected areas. The fruits either dried in the sun so the fleshy part can be removed manually or mechanically, or soaked to separate the seed (Venator and Zambrana, 1975). In another method, ripened fruits are soaked in water until they rot, pulped or macerated on newspapers, and dried in warm place (Zabala, 1990). Seeds are several years of dormancy (Fox,1972) and can be stored satisfactorily if they are kept in air- tight or almost air-tight containers in a dark room under dry condition (Zabala,1990).

A study seeks to model aspects of the regeneration of radiata pine (Pinus radiata D.Don) seedlings under a range of environmental conditions. The term "regeneration" as used by ecologists and foresters includes the production and dispersal of seeds, their storage in seed banks until conditions are favorable for germination, followed by their germination and the establishment of seedlings on the forest floor (Barnes et al., 1998).

Radiata pine grows both in natural forests within its limits of natural distribution in California and in approximately four million hectares of managed plantations which are principally located in the Southern Hemisphere (Lavery & Mead, 1998). These radiata pine plantation forests may regenerate themselves (natural regeneration) or be regenerated by human intervention, for example by planting of nursery raised seedlings. This means that radiata pine may regenerate into a wide range of environments where previous studies of radiata pine regeneration in its natural range do not necessarily apply. An example of this which is particularly relevant to plantation grown pines, is the spread of wildings, naturally regenerated seedlings originating from plantations but dispersing into adjacent vegetation as an invasive plant (Richardson & Higgins, 1998).

Therefore, this study aims to develop general models which will be robust enough to describe germination and seedling growth in the wide range of regeneration niches now available to radiata pine within and beyond its natural range. Conventional empirical regeneration models may not meet this criterion of generality. Criticize° empirical regeneration models on

these grounds, and call for greater use of mechanistic models to study forest regeneration. In contrast to empirical models, mechanistic models of plant growth and development specify the responses of plant physiological processes to variation in environmental factors, such flux density of photosynthetically active radiation (PAR), soil water availability and ambient air temperature. Mechanistic models are usually considered to be more general than empirical models, because they are based on physiological processes that are always determinants of plant growth and development, rather than empirical relationships between environment and plant growth that cannot be safely extrapolated outside the boundaries of the data from which they were derived (Korzukhin et al., 1996).

Debdaru is a tall, handsome, evergreen tree with a straight trunk, considered to be a native of the drier parts of Ceylon, very commonly cultivated all over India, in gardens and avenues. Bark smooth, greyish brown, thick; leaves glossy green, lanceolate with undulate margins; flowers in fascicles, yellowish green; fruit a cluster of small ovoid, purple, I-seeded carpels. There are also forms of this tree with markedly drooping branches. The tree grows well in moist and warm localities. Propagation is through direct sowing of seeds at site or planting 2-year old seedlings raised in pots or baskets. The seeds retain their viability for one season only and should be sown in August. It has been recommended for growing in tall hedges. It is reported to be subject to die-back disease caused by a species of Phomopsis. A number of defoliating larvae and a few other insect pests have also been recorded (Wikipedia, 2016).

CHAPTER FOUR: MATERIALS AND METHODS

Study Area

The experiment of seed germination was carried out in the nursery of forestry of wood Technology Discipline, Khulna University. The study area was located in an area of the largest delta in the south-western part of Bangladesh, near the sundarbans, the largest mangrove forest in the world. The climate of the study area is dominated by subtropical nature with well- defined winter, summer and monsoon seasons. The air temperature ranged between 25 and 31°C and the relative humidity was 72%-84% during the experiment.

Table 1: Origin of different seed sources of *Polyalthia longifolia* with latitude, longitude and number of seeds used for germination.

Seed Source	Country Name	Location	Latitude	Longitude	No of Seeds
Location 1	Bangladesh	Rajshahi	24.37 ° N	88.60 ° E	100
Location 2	Bangladesh	Dhaka	23.42 ° N	90.22 ° E	100
Location 3	Bangladesh	Chittagong	22.22 ° N	91.48 ° E	100
Location 4	Bangladesh	Jessore	23.17 ° N	89.20 ° E	100
Location 5	Bangladesh	Pirojpur	22.58 ° N	89.97 ° E	100

Plant materials and design of the experiment

The seeds of *Polyalthia longifolia* were collected from five different locations of Bangladesh. Those locations were: Rajshahi, Jessore, Dhaka, Pirojpur and Chittagong and. The fruit of Polyalthia longifolia is called as pods. The seeds were collected manually from the 5 locations. The mother tree was young and healthy. The tree had straight bole and narrow crown. The seed was kept on the open floor.

Then all the dimensions of the seeds were taken very carefully. Before this, damaged, discolored seeds were eliminated from the selected seeds.

For the experiment 500 polybags were used. The polybags were filled with topsoil and compost in the ratio of 3:1. I worked on the effect of seed source variation on seed germination. I used seeds of 5 different locations. These were called as the followings

L1=Rajshahi, L2= Dhaka, L3= Chittagong, L4=Jessore and L5=Pirojpur. Each location contained 100 seeds. Each polybag contained 1 seed. These polybags were kept in the open area throughout the experiment. The seeds were sown with my own hands and water was given every alternative day. Every location was divided into 4 replications. The polybags under different locations were kept in the nursery according to the appropriate design of the germination trail.

Seed germination:

The germination percentage was calculated by using the following equation:

$$\text{Germination percentage (\%)} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds sown}} \times 100$$

Germination rate

$$= \frac{\text{Number of germinated seeds in first week}}{\text{7 days}} + \frac{\text{Number of germinated seeds in second week}}{\text{14 days}} + \frac{\text{Number of germinated seeds in third week}}{\text{21 days}} \ldots + \frac{\text{Number of germinated seeds in last week}}{\text{Total days needed in germination}}$$

Data analysis

Analysis of variance (ANOVA) and Duncan's multiple range test (DMRT) were used to analyze the data using the SPSS and SAS to explore possible variation in seed sources. Specially, the ANOVA was carried out to determine the effect of variation in seed sources on germination starting days, closing days, germination period, germination percentage and rate of germination. DMRT was conducted to compare mean germination starting days, germination percentage and rate of germination.

CHAPTER FIVE: RESULTS

5.1.1 Morphological characteristic of seeds

It is observed that the seed of *Polyalthia longifolia* were reddish brown more or less smooth uniform color. Seed shape was elliptical. Average weight per seed was 1.82±0.03gm, average length and diameter was 2.66±0.02 cm and 2.13±0.01 cm respectively. Usual germination was 50-70%, seed purity 99 %, seed collection time September to October, Number of seed per kg is 1800-2500. The detailed information of seed was given bellow in table2.

Table 2: Morphological characteristics of seeds of Debdaru (*Polyalthia longifolia)* (means of 40 seeds)

Color	Average Length(cm) ±SE	Average Diameter(cm) ± SE	Average Weight per seed (gm.) ± SE
Radish brown	2.66 ± 0.02	2.13 ± 0.01	1.82 ± 0.03

Effects of variation of seed sources on seed germination

Germination started earlier for the seeds collected from Pirojpur. Germination started later from the seeds of Dhaka and Jessore. Germination closed later for the seeds collected from Chittagong than the other sources. Germination closed earlier for the seeds collected from Jessore than the other sources. Germination completed within 35-40 days after sowing the seeds collected from various locations. Analysis of variance showed no significance difference in germination closing period and germination period among the locations. Analysis of variance showed significance difference in germination starting period, germination percentage and germination rate. The highest (68%) germination percentage was found from the seeds collected from Jessore. The lowest (50%) germination percentage was found for the seeds collected from Chittagong and Dhaka. The seeds of Pirojpur provided 56% germination percentage. 67% success was found for the seeds of Rajshahi. DMRT

showed no significant difference in germination percentage of seeds collected from Rajshahi and Jessore, but these differed significantly for the germination percentage of seeds collected from Dhaka, Chittagong and Pirojpur. From DMRT it was also found that there was no significant difference in germination percentage for the seeds of Dhaka and Chittagong, but these were significantly different from the germination percentage of seeds collected from Rajshahi, Jessore and Pirojpur. ANOVA showed no significant differences in germination closing period and germination period among the sources, but there were significant differences in germination starting period, germination percentage and germination rate.

Here, L1=Rajshahi, L2= Dhaka, L3= Chittagong.L4= Jessore, and L5= Pirojpur.

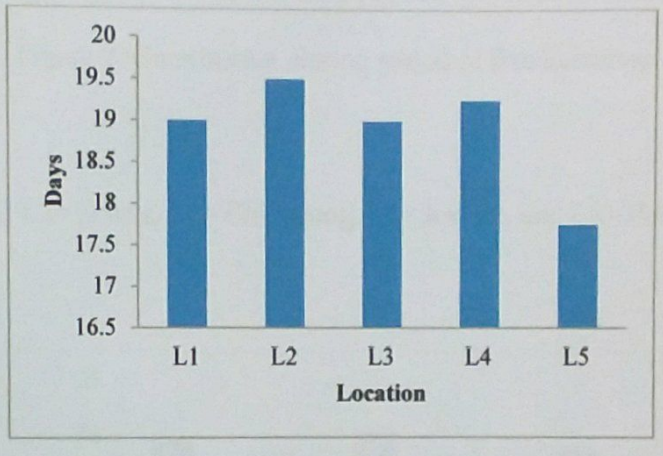

Figure 1: Germination starting days of five locations

Here, L1=Rajshahi, L2= Dhaka, L3= Chittagong, L4= Jessore, and L5= Pirojpur.

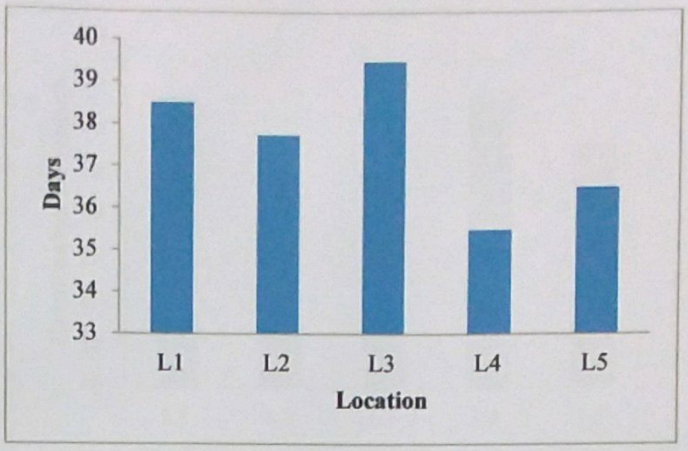

Figure 2: Germination closing period of five locations

Here, L1=Rajshahi, L2= Dhaka, L3= Chittagong, L4= Jessore, and L5= Pirojpur.

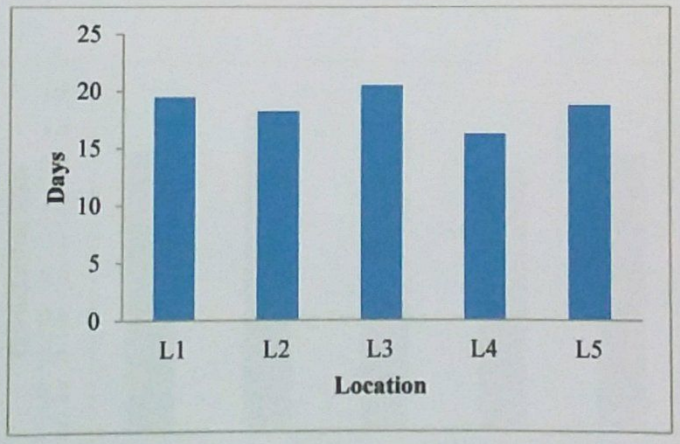

Figure 3: Germination period of five locations.

Here, L1=Rajshahi, L2= Dhaka, L3= Chittagong, L4= Jessore, and L5= Pirojpur.

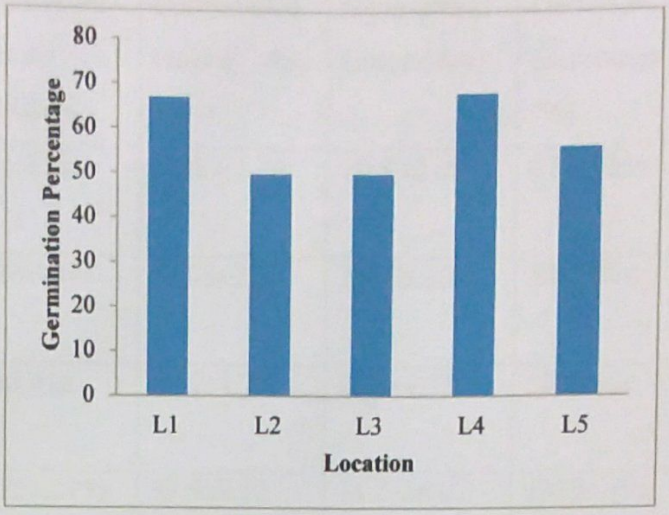

Figure 4: Germination percentage for seeds collected from five different locations

Here, L1=Rajshahi, L2= Dhaka, L3= Chittagong, L4= Jessore, and L5= Pirojpur.

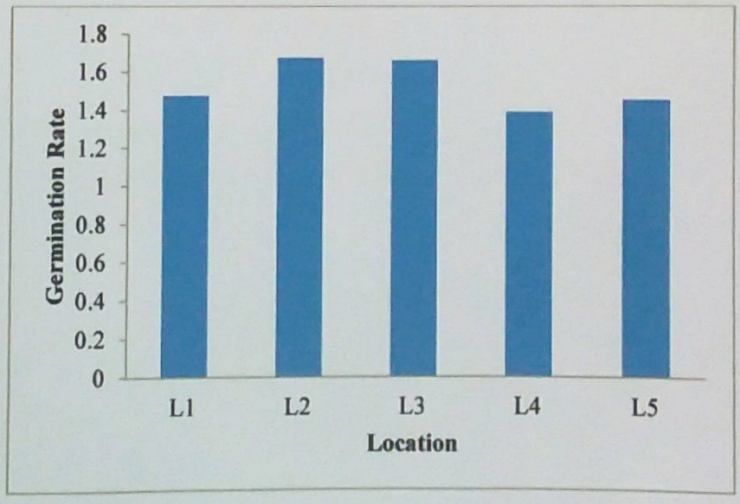

Figure 5: Germination rate of seeds collected from five different locations.

Table 3: Summary of variation in seed sources on specific expressions of seed germination of *Polyalthia longifolia* at the nursery stage

Seed source	Germination starting date(day)	Germination closing date (day)	Germination period (day)	Germination percentage (%)	Rate of Germination
L_1	19 ± 2.58a	38.5 ± 1.29	19.5 ±2.08	67 ±8.33a	1.475 ±0.29b
L_2	19.5±3.32a	37.75±2.36	18.25±2.22	50±8.87c	1.675±0.29a
L_3	19±1.41a	39.5±1.29	20.5±1.73	50±6.93c	1.66±0.29a
L_4	19.25±2.75a	35.5±4.12	16.25±6.07	68±24.30a	1.3875±0.37c
L_5	17.75±1.71b	36.5±2.08	18.75±2.75	56±11.01b	1.453±0.31b

CHAPTER SIX: DISCUSSION

Seed dormancy frequently confines the use of particular species for seed germination trials in nurseries (Azad et al., 2006a, 2006b, 2010a, 2010b, 2011a, 2011b, 2012). Problems related to seed dormancy can differ from the stage of maturity of seeds, the degree of drought and overall species to species variation. The highest germination percentage (68%) was found for the seeds collected from Jessore than the other sources. The lowest germination success (50%) was found in the seeds of Dhaka and Chittagong. DMRT showed no significant difference in rate of germination for the seeds collected from Dhaka and Chittagong, but those were significantly different in rate of germination from the seeds collected from Rajshahi, Jessore and Pirojpur. DMRT also showed no significant difference in rate of germination for the seeds collected from Rajshahi and Pirojpur. Again we found from DMRT, there was no significant difference in germination starting period for the seeds of Rajshahi, Dhaka, Chittagong and Jessore, but all those were significantly different in germination starting period from the seeds collected from Pirojpur. The difference of germination percentages and germination may be due to the difference of temperature and microclimate among the seeds.

The present study revealed that there were no significant differences of closing periods and germination periods among the various seed sources ($p > 0.05$). This may be due to the fact that the microclimates among the seed sources were very similar. Besides, the sub-tropical climate conditions throughout the country have helped to acclimatize this species in Bangladesh. A study on seed germination of *Albizia procera* was carried out and there were no significant difference among the seed sources (Azad et al., 2012).

CHAPTER SEVEN: CONCLUSION

Polyalthia longifolia is an important tree species in Bangladesh. It is an ornamental tree species which is widely used. In order to produce the largest number of good quality seedling for a stated level of cost and labor input, the effect of locations need to be determined. In this study we see that there are significant differences in the germination starting period, germination percentage and rate of germination among the various sources. From the study we find that the seeds of Jessore and Rajshahi are better than the seeds of Dhaka, Chittagong and Pirojpur for producing good quality seedlings. Among the seed sources, the highest germination percentage (68%) was found from the seeds of Jessore and the lowest germination percentage was achieved from the seeds of Dhaka and Chittagong (50%). Therefore, I recommend the seeds of Jessore can be used for producing seedlings of *P. longifolia* as it provided highest germination percentage.

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