EFFECT OF VARIOUS SPACINGS ON THE GROWTH BEHAVIOUR OF TUNG (*Aleurites fordii* Hemsl.) AND THE YIELD OF MAIZE (*Zea mays* L.) UNDER AGRO - FORESTRY SYSTEM OF MIZORAM.

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DEPARTMENT OF FORESTRY
SCHOOL OF LIFE SCIENCES
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2000.

Dedication

Dr. O.P. Singh

In **recognition and appreciation** of your
kindness, thoughtfulness, affection and
hard work for the people of Mizoram,
this Thesis is dedicated to you.

North Eastern Hill University

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CERTIFICATE

*I certify that the Thesis entitled " **Effect of various spacings on the growth behaviour of Tung (Aleurites fordii. Hemsl.) and the yield of Maize (Zea mays.L) under agroforestry system of Mizoram** ". Submitted by Mr. Vanlalhruaia Hnamte in partial fulfilment for the Degree of Master of Science in forestry (Specialization course in Agroforestry) to the North Eastern Hill University, Shillong embodies the record of original investigation carried out by him under my supervision. He has been duly registered and has successfully completed all his papers. The Thesis presented is worthy of being considered for the award of the M.Sc. Degree. Further, this work has not been submitted for any degree of any other University nor has it been publised in part or full.*

I wish Mr. Vanlalhruaia Hnamte all success in life.

Aizawl
The 27th, Nov., 2000

R Mohan 27/11/2K
(DR.RAKESH MOHAN)
Supervisor

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27/11/2k.
(VANLALHRUAIA HNAMTE)

CONTENTS

LIST OF ABBREVIATIONS :

%	=	Percent.
2 K	=	Year 2000.
a	=	Alpha.
Agric.	=	Agriculture.
Amer.	=	America.
Ann.	=	Annual.
ANOVA	=	Analysis of variance.
Bot.	=	Botany.
Bul.	=	Bulletin.
Ca.	=	Calcium.
CD	=	Critical Difference.
Cir.	=	Circular.
cm.	=	Centimeter.
Cons.	=	Conservations.
DAS	=	Days after sowing.
Dept.	=	Department.
Econ.	=	Economic.
Eds.	=	Editors.
et al .	=	et alii, and others.
etc.	=	et cetera.
Expt.	=	Experiment.
Fig.	=	Figure.
ft.	=	feet.
G - 11	=	Ganga - 11.
ha.	=	Hectare.

Hort.	**=**	**Horticulture.**
i.e.	**=**	**id est, That is to say.**
Jour.	**=**	**Journal.**
Km.	**=**	**Kilometer.**
m.	**=**	**Metre.**
MPTs	**=**	**Multi purpose Tree species.**
MT	**=**	**Matric Ton.**
N	**=**	**North.**
No.	**=**	**Number.**
NS	**=**	**Non-Significant.**
o	**=**	**Degree.**
^{o}C	**=**	**Degree Centigrade.**
PP	**=**	**Page to page.**
Proc.	**=**	**Proceeding.**
qt.	**=**	**Quintal.**
Quart.	**=**	**Quarterly.**
Res.	**=**	**Research.**
S	**=**	**South.**
S.E.m	**=**	**Standard of Error mean.**
Sci	**=**	**Science.**
Sq.Km,	**=**	**Square Kilometer.**
Sta.	**=**	**Station.**
Viz.	**=**	**Videlicet, Namely.**
Vol.	**=**	**Volume.**

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CHAPTER - I

INTRODUCTION

1. INTRODUCTION

The term " **Agroforestry** " is a new name for an old practice which is now discussed under heading social forestry in Indian forestry. Growing crops and trees together is not a new invention or concept. This practice in different forms is age old in all the countries.

Cutting of forest and growing of crops is a very old practice all over the world. Traditionally and historically forestry and agriculture are looked upon as competitive and not complementary activities. The ecological system is currently under great stress owing to growing pressure of human and livestock population on the one hand and acute shortage of food, fuel and fodder on the other. This has forced the people to change their attitudes towards the exploitation of the ecological system. In the present time, integration of forestry with agriculture can only solve the problem. Under the protective umbrella of trees, agriculture can prosper and it is only with prosperous agriculture that forests can survive.

In our country, farmers have been integrating tree crop and animal components for sustenance. With the passage of time the agricultural components secured priority over woody elements for sustaining self-sufficiency in foodgrains. The population pressure resulted in small holding and consequently lesser number of trees on the farm providing food, fodder, fibre, fuel, fruit, etc. The introduction of high yielding crops has no doubt resulted in self-sufficiency in food grains but its role in degrading top soil by increasing salinity due to faulty irrigation, loss of fertility and deposition of non-biodegradable agricultural chemicals in soil can not be overlooked. In order to bring a balance between food sufficiency and ecological stability, it is paramount to copy the nature by integrating different biota of life trees dominants, co-dominants including fruit trees, shrubs and bushes, high value cash crops and or animal husbandry. Unfortunately, these three pursuits, namely, agriculture, forestry and animal husbandry have grown independently, but at the grass-root level they are inseparable because of being land based. Linking these either at the village level, or in the governmental functioning would prove to be counter productive. The traditional systems which have been evolved by trial and error by our villagers, are to be preserved and improved by adding scientific input of tree + crop + animal modelling and by introducing superior genetic base in these polycultural system.

Agroforestry systems with their element of intercropping are in essence ecological models similar to natural systems and have, therefore, an element of sustainability associated with them. These systems have lasting production as they help in recycling of organic residues, biological nitrogen fixation, and mineral fertilisation. This happens all the time in an intercropping system involving nitrogen fixing trees. Their litter - fall improves nitrogen level and organic matter in the soil, consequently its overall fertility. Essentially the elements of sustainability that agroforestry affords, stems from the fact that the system is based on the ecological consideration.

In Mizoram, 7,889.00 sq.km. of the total geographical area is under reserve forest. Barring reserve forest areas, almost the entire area is opened to jhum cultivation. Till 1950's when famine occured due to bamboo flowering and upsurge of rodents particulars rats, jhuming was the only way of livelihood of the Mizos except at Aizawl, Lunglei and Saiha township where some shopkeepers and goverment servants were flocking together. With the failure of monsoon and destruction of standing crops during " Mautam " Famine which is a regular phenomenon at an enterval of 50 years, the mentally of Mizos had undergone a change to some extent.

In that process people have started preparing and converting forests in the valley bottom bordering Cachar Distrit and Tripura into paddy fields which was the beginning of conceiving permanent wet rice cultivation. However, such potential areas which can readily developed was very much limited. Therefore, the majority of the Mizo population who were in the habit of cutting annual jhum could not forget about it. The beauty of jhuming remains in the minds of the people and find it hard to leave it overnight. This is true of all the tribals living in the hills in the country not to speak of North-East areas alone. The old practice dies hard (Anonymous, 1997). Shifting cultivation occupies a distinct place in the Mizo economy. It constitutes a vital part of the socio-economic network of Mizo life.

In view of the fast degration of land due to jhuming, ever increase in population and other enviroment unfriendly onslaught of man, the Central Government has suggested measusres to tackle the problem of jhuming in various states. ICAR has suggested three tier system i.e. cultivation of trees at the hill top, cultivation of horticulture crops in the middle portion of the hill slopes and forming terraces at the lower portion of the hill slopes for cultivation of field crops. Similarly, a permanent system of farming for sustainable agriculture development known as " New Contour Farming System " has also been evolved, in which trenches are dug along the contour across the slope about one foot deep on the lower side and 1 1/2 ft. wide.The interval of trench lines varies according to the percentage of slope. With the percentage of slope being higher, the interval is going shorter and shorter. In other words, the interval is longer in the lower slopes and shorter in the higher slopes. At the edge of the trench line, grasses preferably fodder grasses with strong root formation are planted which in turn are supported by a row of hedges of various species preferably leguminuous ones. Planting sugarcane or pineapple are also suggested on the same. Crops are to be grown in between the trenches.

This farming system aimed at permanent cultivation on the hill slopes by conserving soil and water and recycling the lost top soil. Although the above suggested models proved to be promising, they are not free from limitations. It is difficult to construct terraces, contour trenches on the hill slopes which are very cost effective and moreover, require skilled or manpower. Realising the odd effects of jhum cultivation, the government has launched an innovative policy known as " New Land Use Policy " (NLUP). This policy was started in the year 1990. Under the programme of NLUP, different trades such as agriculture and allied sectors, industries and AH & Vety were included. Under agriculture and alllied sector, the people of Mizoram have taken up plantation of Teak (*Tectona grandis*), Tung (*Aleurites fordii*) and horticultural crops in a massive scale.

In Mizoram, the intercropping of paddy (*Oryza sativa*) and Teak (*Tectona grandis*) is the most practice of agroforestry system. This practice is very successful during the initial growth stage of Teak. In recent years, the intercropping of paddy (*Oriyza sativa*) and Tung (*Aleurites fordii*) is also practiced following the same pattern.

1.1. TUNG (*Aleurites fordii*) :

In Mizoram, Tung was introduced as early as the aegis of chieftainship in the Mizo villages. The matured trees of Tung were available at N. Chaltlang in 1940's. It was apparently introduced by the Britishers. The villagers sometimes improvise it and make out washing soaps with the help of caustic soda. The plantation did not pick up till demonstration plot were set up by the soil conservation department. Subsequently, NLUP programme was launched in which plots of land were distributed for Tung Plantations. Recently, two processing units have came up. With this infrastructure for extracting oil, people particularly at Aizawl Town have started plantations in the surrounding areas.

The villagers have also taken up the plantations in a bigger way. During 1998, the Tung growers' association crushed 16 MT of oil (Anonymous, 1997).

Tung tree is also known as Tung Nut, Tung - oil or china wood-oil tree (Fairchild, 1930). The word Tung is Chinese for " heart ", the general shape of the leaf (Potter and Crane, 1957). It is native to central and western China, where seedlings have been planted for thousands of years. It is a soft wooded, smooth-barked deciduous tree that may grow to 30 feet. First blooms appear from late february to April before the leaves appear. In bloom, the tree is highly attractive because of its mass of pink blossoms similar to flower of Catalpa (*Catalpa spp.)*. These are followed by the dense foliage of 3 to 5 inch heart-shaped dark-green leaves.

The colourful and attractive blossoms, which are borne on the ends of the growing shoots of the previous season, vary in type. They may be all staminate, all pistillate, or predominantly one or the other (Dickey and Reuther, 1940, Mc Cann, 1942). The percentage of pistillate flowers may depend on the vigour of the tree, with more such flowers produced on trees making more vigorous growth (Abbott, 1929). The reddish-white flower occur in panicled cymes or clusters with usually about 60 staminate and one pistillate flower each, with rarely a perfect flower (Newell, 1924). Each flower may be an inch or more in length, and the tree is covered with the conopy of blossoms. The pistillate flowers have a three-to-five celled ovary that, when pollinated, produces a top - shaped fruit 2 to 3 inches in diameter, usually bearing 5 seeds. The blossoms secrete some nectar, and the staminate flowers produce a copious amount of pollen (Pering, 1937). Bees visit the blossoms freely.

Angelo *et al.* (1942) showed that plants caged to exclude bees set no fruit and that wind or shaking the tree was of no value in fruitsetting, but when a tree was caged with a colony of honey bees a good set was obtained. Others (Hambleton, 1950, Pering, 1937) also credit honey bees with setting the crop.

The tree is not self-sterile. It merely needs the agency to transfer the sticky pollen from the anthers of the staminate flower to the stigma of the pistillate flower. Brown and fisher (1941) showed that pollination can occur over several days of the life of the blossom. Webster (1943) concluded that when staminate and pistillate flower are on separate trees, one staminate tree for 20 pistillate trees was sufficient for satisfactory pollination, provided that some staminate flower open by the time the pistillate flower are receptive.

Aleurites fordii is found from subtropical dry to moist through tropical very dry to dry forest life zones. This species is reported to tolerate annual precipitation of 6.4 - 17.3 cm., temperature of 18.7 - 26.2 ^{0} C, p ^{H} of 5.4 - 7.1 (Duke, 1978, 1979). Tung trees are very exacting in climate and soil requirements. They require long, hot summer with abundant moisture, with usually at least 112 cm. of rainfall rather evenly distributed throughout the year. Trees require 350 - 400 hours in winter with temperature of 7.2 ^{0} C or lower ; without this cold requirement, trees tend to produce suckers from the main branches. Vigorous but not but not succulent growth is most cold resistant trees are susceptible to cold injury when in active growth. Production of Tung is best where day and night temperatures are uniformly warm. Much variation reduces tree growth and fruit size. Trees grow best if planted on hill tops or slopes, as good air-drainage reduces losses from spring frosts. Contour planting on high rolling land escapes frosts damage. Tung makes its best growth on virgin land. Soils must be well-drained, deep aerated, and have a high moisture-holding capacity to be easily penetrated by the roots. Green manure crops and fertilizers may be needed. Dolomitic lime may be used to correct excessive acidity; p^{H} of 6.0 - 6.5 is best; liming is beneficial to most soils in the Tung Belt, the more acid soils required greater amounts of lime.

Tung trees are cultivated for their seeds, the endosperm of which supplies a superior quick drying oil, utilized in the manufacture of lacquers, varnishes, paints, linoleum, oilcloth, resins, artificial leather, felt-base floor coverings, greases, brake-linings and in clearing and polishing compounds. Tung oil products are used to coat containers for food, beverages, and medicines; for insulting wires and other metallic surfaces, as in radios, radar, telephone and telegraph instruments. During World War - II, the Chinese used Tung oil for motor fuel (James, 1993).

The fruit contains 14 - 20 %; the kernel, 53 - 60 %; the nut, 30 - 40 %; oil. It contains 75 - 80 % a-elaeo stearic, 15 % oleic, ca 4 % palmic, and ca 1 % stearic-acids. Tannins, phytosterols, and a poisonous saponin are also reported (List and Horhammer, 1969 - 1979).

Tung trees usually begin bearing fruit the third year after planting, and are usually in commercial production by the forth or fifth year, attaining maximum production in 10 - 12 years. Fruits mature and drop to ground in late September to early November. At this time they contain about 60 % moisture. Fruits are dried to 15 % moisture before processing. Trees yield 4.5 - 5 MT/ha. fruits. An average picker can gather 60 - 80 bushels of fruits per day, depending on condition of the orchard. Fruits may be gathered all through the winter season when other crops do not need care. As all fruits do not fall at the same time, two or more harvestings were done to get maximum yield. Prices of Tung oil depend on price support, domestic production, imports and industrial demands. Major producing countries are mainland China and S. America (Argentina and Paraguay); United States and Africa.

1.2. MAIZE (*Zea mays L.*) :

Maize is an important cereal and forage crop of Mizoram. In Mizoram, Maize covers an areas of 5,277 ha. with the annual production of 9,702 MT in the year 1999-2000 (Statistical Abstract, Department f Agriculture & Minor Irrigation, Mizoram, 1999 - 2000).

Maize (*Zea mays L.*) belongs to gramineae family. It is a tall annual plant which usually grows to a height of 1 - 3 m or more in some cases.

The root system of maize is fibrous and deep. It consists of seminal roots, crown or coronal roots and brace or aerial roots. The stem is made up of approximately 12 - 18 alternating nodes and internodes, and is completely filled with the pith.

The leaves of maize develop alternately on opposite sides of the stem. Each leaf consists of a thin, flat and expanded blade with a definite midrib and smaller veins and a thicker, more rigid sheath. The number of leaves varies from 12 - 20 (Singh, 1983).

Maize is normally a monoecious plant having two types of inflorescence, the female inflorescence which develop into an ear (cob) and the male inflorescence, which contains the male flowers. The flowers are borne on two different parts of the plant. The male flowers are borne in a cluster (tassel) on the top of end of the stem as a terminal panicle, while the female flowers are borne inside the young cobs which spring from one end of the nodes on the stem usually located about midways on the stalk (Singh, 1983).

Maize kernel is a one-seeded fruit or caryopsis. The seed enclosed within the pericarp, consists of the embryo, endosperm, and remmants of the seed coats and nucellus. The pericarp is the mature ovary wall. The endosperm, beneath the pericarp consists of cells filled with starch granules. It is surrounded by a layer of aleurone cells. The embryo consists of the plumule, radicle and scutellum (Singh, 1983).

Maize is a warm weather plant. It grows from sea level to 3000 m altitude. It can be grown under diverse conditions. The most suitable temperature for germination is 21^0 C. Extremely high temperature and low humidity during flowering damage the foliage, desiccate the pollen and interfere with proper pollination, resulting in poor grain formation. Maize is very sensitive to stagnant water, particularly during its early stages of growth (Singh, 1983).

Maize is best adapted to well drained Sandy Loam to Silty Loam soils. It can be grown successfully in soils whose pH ranges from 5.5 - 7.5 (Singh, 1983).

Maize is one of the World's leading crops cultivated over an area of about 120 million hectares with a production of about 394 MT of grain (1979). Maize crop is utilised in many ways and is consumed as human food. It is also a good feed for Poultry, Piggery and other animals. Maize grain contains about 10 % protein, 4 % Oil, 7 % carbohydrate, 2.3 % crude fibre, 10.4 % albuminoides, 1.4 % ash. Maize grain has significant quantities of Vitamin - A, Nicotinic Acid, Riboflavin and Vitamin - E. Maize is low in Calcium, fairly high in phosphorous (Singh, 1983).

Maize crop furnishes huge quantities on green fodder for cattle. Several industries like starch, milling, etc., are based on Maize product and by-product. In additional, several cottage industries are also flourishing on the by product of Maize (Singh, 1983).

1.3. GENERAL OBJECTIVE :

The general objective of the field experiment was to find out an appropriate viable alternative to shifting cultivation through Tung based agroforestry system.

1.4. SPECIFIC OBJECTIVES :

The specific objectives of the field experiment were :-

(i) To investigate the effect of various spacings on the growth behaviour of Tung (*Aleurites fordii*).

(ii) To investigate the effect of various spacings of Tung on the growth and yield of Maize (*Zea mays*).

CHAPTER - II

SITE DESCRIPTION, EXPERIMENTAL DESIGN, LAYOUT AND PARAMETERS.

2.1. MIZORAM :

Mizoram is one of the states of north east India. The area of the state is 21,081 sq.Km. It is located between 92^0 15' to 93^0 29' E longitude and 21^0 58' to 24^0 35' N latitude. (Statistical Hand Book, Govt. of Mizoram, 1994).

Mizoram is bounded on the north by the district of Cachar (Assam) and the state of Manipur; on the east and south by Chin and Arakan hills of Myanmar (Burma), on the west by the Chittagong hills of Bangladesh and on the north west by the state of Tripura.

Mizoram is representative of the ecological complexity of the eastern hill region. The physical features of Mizoram are dominated by a series of parallel hill ranges oriented north-south with increasing elevation from west to east. The steep hills and narrow valleys are associated with complex drainage basins. The rugged topography is expressed by the dissection of several longitude valleys between the N-S trending long parallel to sub-parallel hill ranges which tend to be higher in the middle of the state and tapering to north and south. The highest peak in Mizoram is the Blue Mountain (Phawngpui) with a height of 2,165 m in the southern part. In the central and western parts of the state, the hill ranges consist of almost unbroken parallel ridges with elevation varying from 40 to 1,550 m (average 700 m), and elevation difference between hill top and valley floor varying between 100 - 200m. Normally the western slopes of the ridges are steeper than the eastern slopes. In the eastern parts the hill ranges are oriented in different hill are higher and steeper, elevation difference between hill top and valley floor being 200 - 600m. The width of the valleys broadens to the north and south (Regional Remote Sensing Service Centre, ISRO, Dept. of Space, Govt. of India, Dehradun, 1999).

The steep hills and narrow valleys of Mizoram are associated with complex drainage basins. Guided by the hill ranges, numerous rivers originate mostly in the central part and flow either due north or south after negotiating tortuous courses. It is very common to see the parallel streams in adjacent flowing in opposite directions.

Mizoram comes under the tropical monsoon climatic zone of India. The whole state experiences direct impact of monsoon. The average annual rainfall is 2,350mm. The number of rainy days varies from 116 to 154 (average 133), well distributed throughout the year. South - west monsoon is active from May to October and 60 - 70 % of the precipitation is obtained between June and September. (Regional Remote Sensing Service Centre, ISRO, Dept. of Space, Govt. of India, Dehradun, 1999).

2.2. EXPERIMENTAL SITE :

The field experiment was conducted at Zemabawk. The experimental site is about 4 km. away from Aizawl eastern side, the capital city of Mizoram. The altitude of Zemabawk is 1,132 m i.e. 3,715 feet from the mean sea level, with an average rainfall of 235 cm. Summer temperature varies from 21^{0}C to 30^0 C whereas the winter temperature varies from 11^{0}C to 23^{0}C.

The texture of the soil in the experimental site was analysed in collaboration with soil testing section, Directorate of Agriculture, Govt. of Mizoram. It was found that the soil is sandy clay having 61.96 % sand, 7.21 % silt and 30.84 % clay with an average pH value of 5.3.

2.3. EXPERIMENTAL DESIGN & TREATMENTS

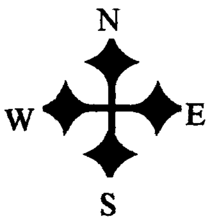
The field experiment was conducted following Randomised Block Design (RBD) with four replications. Tung (*Aleurites fordii)* seedlings were planted at the spacings of 6m x 6m, 6m x 5m and 5m x 4m in the year 1998. The size of each plot measured 12m x 12m. The four treatments i.e. A,B,C and D were allocated in each replications. As such, there were 16 numbers of plots as shown in the layout (Fig. No. 1).

Improved variety of Maize (G - 11) was sown as intercrop at a spacing of 60cm x 40cm over the plantation of Tung trees covering the entire experimental area. 2 - 3 seeds were sown per hill and then thinned in order to retain approximately 9,600 Maize plant population in April covering the entire experimental area during the rainy season (April to early September)

2.4. LAYOUT :

Fig.1. PLAN OF LAYOUT OF THE EXPERIMENT :

R_1	R_2	R_3	R_4
A	D	C	B
B	C	A	D
C	B	D	A
D	A	B	C



DESIGN: Randomised Block (RBD)

TOTAL EXPERIMENTAL AREA	:	48 m x 48 m
PLOT SIZE	:	12 m x 12 m
NO. OF TREATMENTS	:	4
NO. OF REPLICATION	:	4
TOTAL NO. OF PLOTS	:	4 x 4 = 16

TREATMENTS :-

A = Tung (6m x 6m) + Maize (60 cm x 40 cm)

B = Tung (6m x 5m) + Maize (60 cm x 40 cm)

C = Tung (5m x 4m) + Maize (60 cm x 40 cm)

D = Control (Maize alone) (60 cm x 40 cm)

2.5. PARAMETER COLLECTED :

As the field experiment was conducted on a well established plantation of Tung trees, the trees had already attained considerable heights. As such, management of the trees were not necessary. However, three weedings were done; once before the sowing of Maize i.e. during March, 2000. The Maize crops, after germination, were infested with a number of grassy and broad - leaved weed species. The second weeding was done in late April and completed by early May, 2000. The third weeding was started in late June, 2000 and was completed by early July, 2000.

2.5.1. PARAMETERS COLLECTED ON GROWTH COMPONENTS OF TUNG :

(a) Tree height in metre (at 45 days interval)
(b) Basal diameter in centimetre (at 45 days interval)

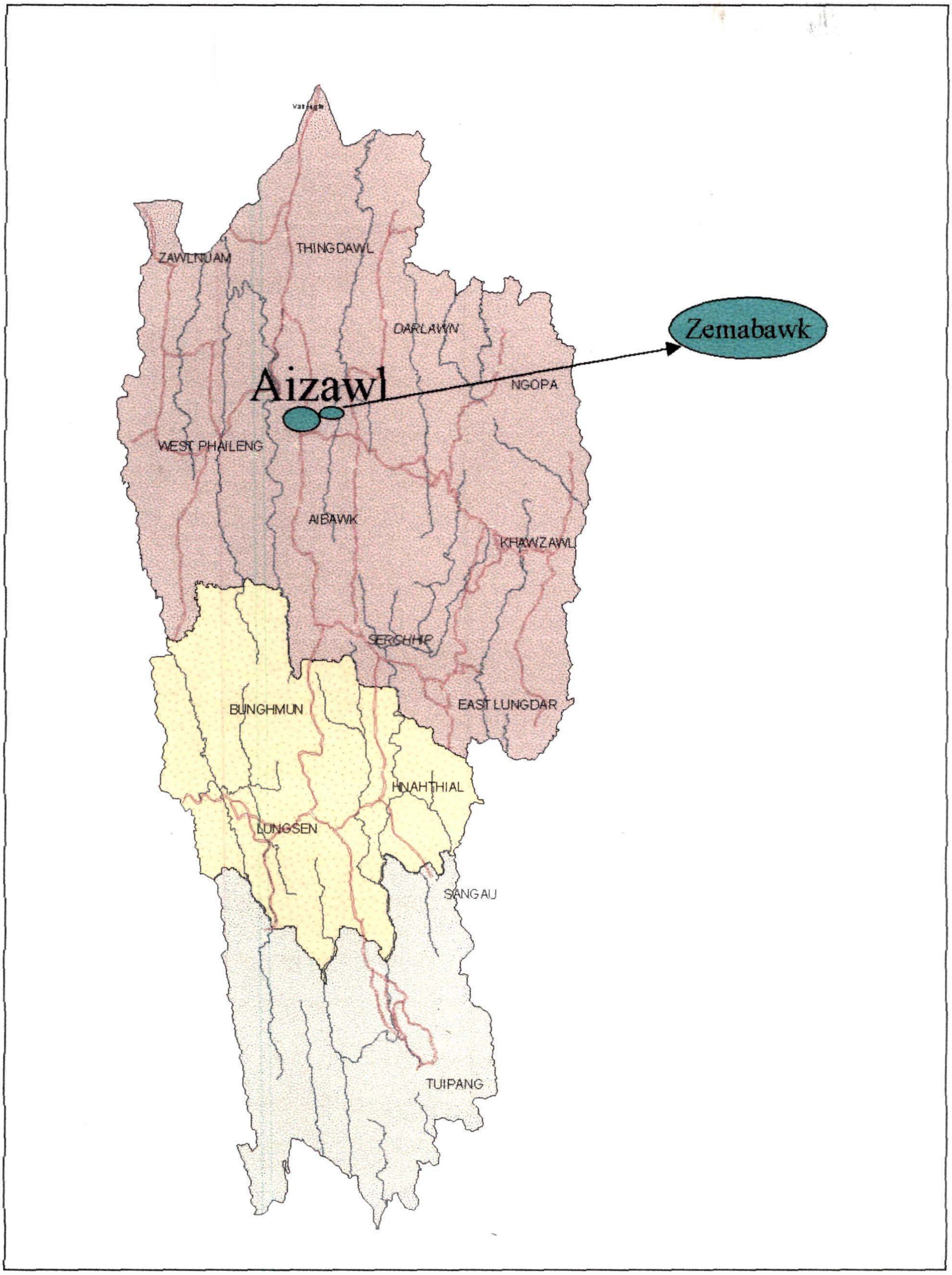
2.5.2. PARAMETERS COLLECTED ON MAIZE CROP :

(a) Maize plant height in centimetre at regular interval (30, 60 DAS and at harvest).
(b) Number of leaves at regular interval (30, 60 DAS and at harvest).
(c) No. of cobs at harvest
(d) Grain yield (kg/plot) after harvest.

2.5.3. STATISTICAL ANALYSIS :

The various data recorded during the course of study were statistically analysed by following Randomised Block Design as described by Panse and Sukhatme (1989). The significance was tested by calculating the critical difference (C.D) at 5 percent level, wherever 'F' test was found significant.

Fig - II Location Map of Experimental Site.



CHAPTER - III

REVIEW OF LITERATURE

3. REVIEW OF LITERATURE :

Agroforestry has been defined in different ways. An early definition of agroforestry in seventies considered agroforestry as a sustainable land management system, which increases the yield of the land, combines production of crops (including tree crops) and forest plants and/or animals simultaneously or sequentially, on the same unit of land, and applies management practice that are compatible with cultural practices of the local population (Bene *et al., 1977)*. Recently, agroforestry is defined as a landuse system that involves deliberate retention, introduction or mixture of trees or other woody perennials in crops/animal production to benefit from the resultant ecological and economic interactions (Nair, 1984).

Torres (1983) has stated that agroforestry can be defined as the deliberate combination of tree with crop plantation or pastures or both, in an effort to optimise the use of accessible resources to satisfy the objectives of the producer in a sustainable way. Lungdrean and Raintree (1983) have opined that agroforestry is a collective name for land use system and technology where woody perennials (trees, shrubs, palms, bamboo, etc.) are deliberately used on the same land management unit as agriculture crops and/or animals, either on the same form of spatial arrangement or on ecological and economical interactions between the different components.

In the past few decades the potential of tree legumes for improving agricultural and silvicultural productivity has been well recognised especially in the third world countries. The positive role of multi-purpose trees (MPTs) in mixed farming systems that have been frequently studied, may prove to be useful for agroforestry, particularly in traditional shifting cultivation wherein the lands are left fallow for a varying time period (Felker and Bandursky, 1978).

Singh *et al.*, (1978) reported reduced nitrogen leaching under legume intercropping with cereals. The practice of intercropping, particularly with MPT's besides reducing nutrient leaching, could also reduce the fallow cycle of traditional shifting agriculture to one-year period, which could mean an increase in arable crop land as well as crop (s) produced (Yadav, 1981).

A major tenet of agroforestry, that maintain soil fertility, is based primarily on observations of higher crop yields near trees or where trees were. Recently objective analyses or controlled experiments have addressed this topic. Palm *et al.* (1995) reported that the amount of nutrients provided by prunings are determined by the production rate and nutrient concentrations, both depending on climate, soil type, tree species, plant part, and tree density and pruning regime. A large number of screening and alley cropping trials in different climate - soil environments indicate that several tree species are able to produce sufficient nutrients to meet crop demand. Specific recommendation for the appropriates trees in a given environment await synthesis of existing data. currently only general guidelines can be provided.

Agroforestry intercropping system has been a traditional and popular culture practice. It is a system in which crops are grown in between rows of woody shrubs, which are pruned periodically during the cropping season to prevent shading and to provide green manure and / or mulch to the arable crops (Anon., 1982, Balasubramanian, 1983,Getahun, 1980, Kang *et al.*, 1981, Nair, 1984), helping in the recycling of nutrients from the subsoil back to the surface, by means of leaf drops and/or foliage pruning, where they can be utilised by shallow rooting crops such as Maize (Raintree, 1980).

According to Andrews (1972) , intercropping of tree species and agriculture crop has the following advantages :-

(1) Higher combined yields.
(2) Higher yield stability from season to season.
(3) Better spread production over the growth period.
(4) Improve quantity of products.
(5) Reduced adverse effects of pests.
(6) Higher returns.
(7) Better soil protection against erosion.

Aiyer (1949) also reported advantages of intercropping as listed below :-

(1) Additional income.
(2) Better use of growth resources.
(3) It is the small farmers of limited means who is most likely to benefited.
(4) Erosion control through providing continuous leaf cover over the ground surface.
(5) One crop provides physical support to the other crop.
(6) The under crop and its by-products are extra yield.
(7) Better control over weeds, pests and diseases.
(8) Greater stability of yield over different season.
(9) Maximum land used.

Wilson and Kang, (1981) stated that species ideal for agroforestry intercropping are those species having ability to established easily, fast growing, deep rooted coppicious and have ability to withstand frequent prunings and be able to produce heavy and easily degradable foliage. Guevarra, (1976) proposed the above properties with ability to fix nitrogen.

A large number of research works/research papers have been conducted and published on a number of aspects of agroforestry systems. Some of them are :

The growth performance of trees in various agroforestry systems have been conducted by many researchers (Mohan, 1992, Osman *et al.*, 1997), agroforestry model as alternative to shifting cultivation (Jha, 1995), biomass and nutrient distribution (Gupta *et al.*, 1992), alley cropping (Wilson and Kang, 1981), tree-crop interaction in agroforestry practices (Harsh and Tewari, 1993), soil management for agroforestry (Dhar and Jha, 1993), selection of plant species for agroforestry (Santra, 1993), nursery pest management under agroforestry (Thakur, 1993), agroforestry in north-eastern Region (Solanki and Bisaria, 2000), shifting cultivation : From a knowledge unsustainability can agroforestry remediate it (Mokhopadhyay, 2000), agroforestry - a sustainable land use system for shifting cultivation in north-eastern India (Singh and Singh, 2000), agroforestry as an alternative to hill farming (Nadagoudar et al., 2000), a productive agroforestry model for hill zone of Karnataka (Mutanal et al., 2000), tree-green hedge-crop farming system (Zo-Tech) an alternative to jhum cultivation (Jha, 2000), potential of agroforestry interventions in the humid hilly ecosystems of India (Singh, 2000), productivity of teak based agroforestry system in transitional zone of Karnataka (Madiwalar et al., 2000), agril-silviculture system with *Azadirachta indica - A. Juss* for eco friendly farming under prolematic soils (Munish, 2000), introduction of tree species of dipterocarpaceae as a component of agroforestry system : An approach (Thakur et al., 2000), agroforestry is an alternative land use system for the semi-arid dry tropical vindhyan zone of Mirzapur (Singh et al., 2000), effect of different tree species on associated field crops in vertisols (Mutanal et al., 2000), silvi-pasture system on ravinous land of kein river encatchment (Singh and Gupta, 2000), addition in tradition : Agroforestry in the arid zone of India (Arun et al., 2000), traditional agroforestry systems in Himachal Himalayan region of India (Verma and Kachru, 2000), Prospects of agroforestry systems in different agro - ecological zones of Himachal Pradesh (Sharma and Kumar, 2000), agroforestry : A potential source of socio economic upliftment of rural poors of NEH region (Bhatt et al., 2000), demand driven tree population dynamics agroforestry changing patterns (Mahendrarajah, 2000), growth and biomass production of seedlings of some multipurpose tree species under nursery conditions (Sahoo and Jha, 2000), inventory studies on the earthworm population in the agroforestry systems of Mizoram (Ramanujam et al., 2000), integrated management of insect pests of agroforestry system - some considerations (Sen and Sharma, 2000), integrated pest management in agroforestry systems (Paul et al., 2000),

Jagadishchandra *et al.,* (1995), reported that multipurpose tree species such as *Acacia, Eucalyptus* give promising results for converting the degraded and non-productive forest areas into productive as well as protective areas. The growth and biomass production of some species of *Acacia and Eucalyptus* in degenerated sal forest of Bangladesh were also reported to have performed better than the other species. (Hossain *et al.,*1997).

The growth & yield of *Acacia albida* intercropped with maize (*Zea mays)* and beans (*Phaseolus vulgaris)* were studied at Morogoro, Tanzania (Okorio *et al.,* 1991). The studies reported that the intercropping did not significantly influence volume and biomass of the tree, nor the yield of the intercops (maize and beans). Natarajan *et al.,* (1991) also studied the intercropping of Pegion pea (*Cajanus cajan)* with Maize, sunflower and groundnut in Zimbabwe. According to them Pigeon pea can be intercropped with Maize and sunflower without being detrimental to the grain yield of the corps. A study on tree-crop interaction on *Grewia optiva, Morus alba,* and *Eucalyptus* with paddy and wheat were conducted on a silty clay loam soil in Doon Valley (Khybri *et al.,* 1988). Their study reported that all the tree species had depressing effect on the crop yield with *Eucalyptus* having the greatest depressing effect on the crop yield.

CHAPTER - IV

EXPERIMENTAL FINDINGS

TABLE I: Plant Height of Maize (*Zea mays.)* in cm. as affected by various spacings of Tung (*Aleurites fordii.)*

TREATMENTS	DAYS AFTER SOWING		
	30	60	At harvest
A (6m x 6m)	90.5	196.5	208.75
B (6m x 5m)	82.5	196.25	202.5
C (5m x 4m)	76.5	193.25	204.75
D (Control)	101.25	200.75	231.75
SE.m±	4.80	5.22	6.43
CD at 5 %	15.35	NS	20.56

NS = Non - significant.

Fig 3 : Plant Height of Maize *(Zea mays)* in cm. as affected by various spacings of Tung (*Aleurites fordii*)

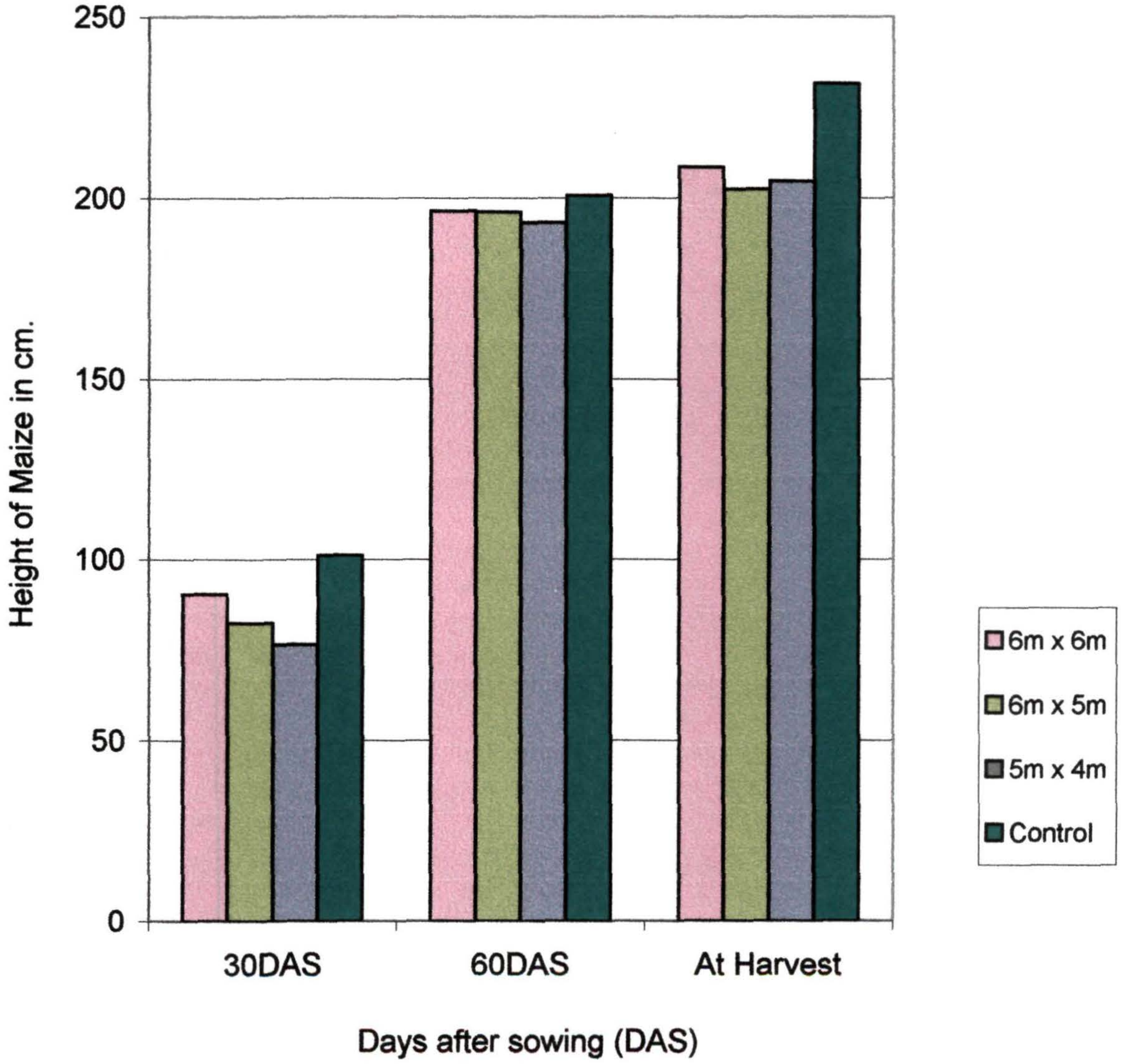
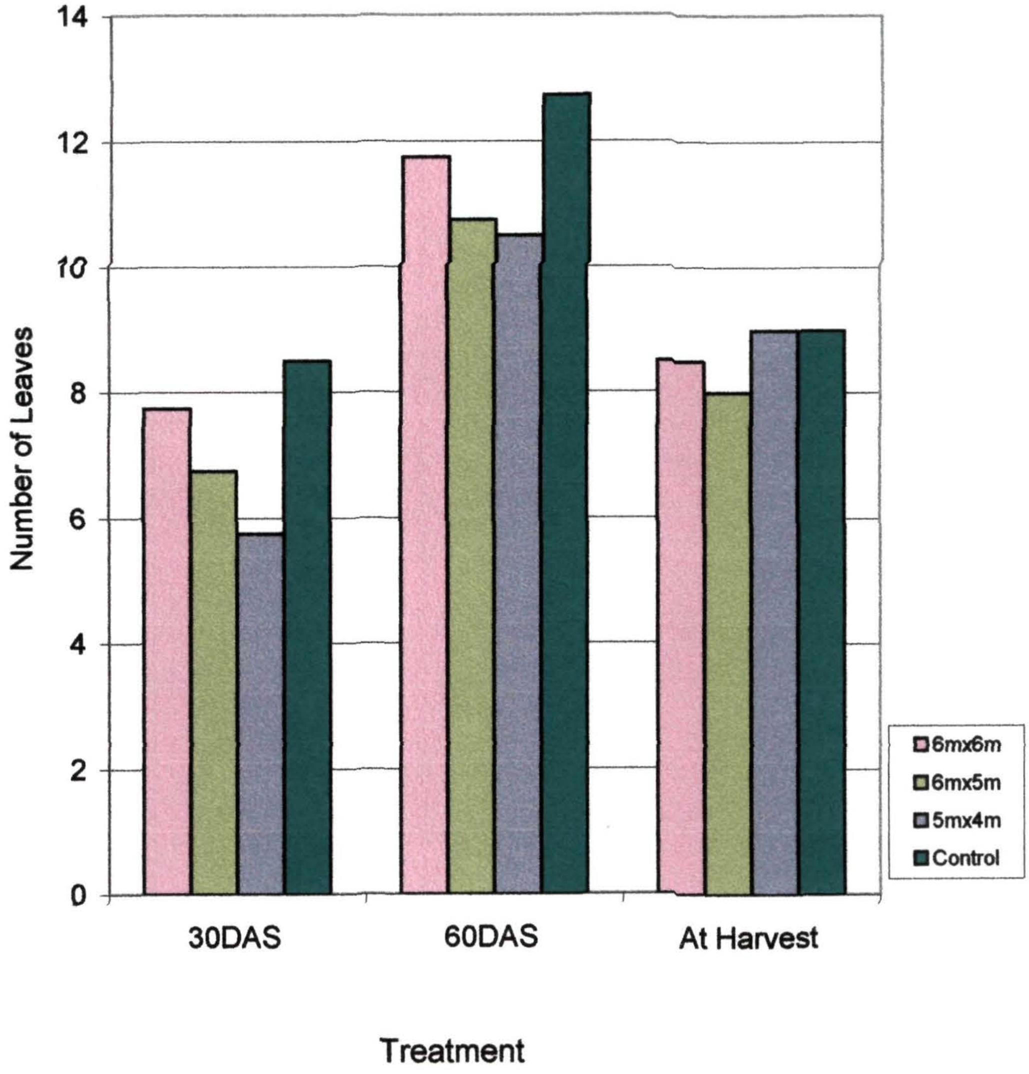


TABLE II : Number of Leaves per Plant of Maize *(Zea mays.)* as affected by various spacings of Tung *(Aleurites fordii.)*.

TREATMENTS	DAYS AFTER SOWING		
	30	60	At harvest
A (6m x 6m)	7.75	11.75	8.5
B (6m x 5m)	6.75	10.75	8.0
C (5m x 4m)	5.75	10.5	9.0
D (Control)	8.5	12.75	9.0
SE.m±	0.26	0.63	0.49
CD at 5 %	0.83	NS	NS

NS = Non - significant.

Fig. 4 : Number of leaves per plant of Maize (*Zea Mays*) as affected by various spacings of Tung (*Aleurites fordii*)



4. EXPERIMENTAL FINDINGS

In this chapter, an attempt is made to present the experimental findings obtained during the course of investigation. These are presented with the help of appropriate tables, figures and illustrations (plates) for easy understanding.

4.1 PLANT HEIGHT OF MAIZE :

A perusal of the data on plant height of Maize as affected by various spacings of Tung trees presented in table I and figure 3 revealed that after 30 DAS of Maize, maximum plant height was obtained in treatment D (101.25 cm) and minimum plant height was recorded in treatment C (76.5 cm). Treatment D and treatment A recorded significantly higher plant height as compare to treatment B and treatment C.

At 60 DAS, different treatments did not show any significant effect on the plant height of Maize. However, maximum plant height was recorded in treatment D (200.75 cm). Minimum plant height was recorded in treatment C (193.25 cm).

Finally, at harvest, treatment D (231.75 cm) was found highly significant over the rest of the treatments. On comparing the height of Maize plants in treatments A, B and C, the variations among them were almost negligible. However, the minimum plant height was obtained in treatment B (202.5 cm).

4.2 NUMBER OF LEAVES PER PLANT OF MAIZE :

The data on number of leaves per plant of Maize were presented in table II and figure 4. The data indicated that after 30 DAS, treatment D (8.5) and treatment A (7.75) were found to be significant over treatment B (6.75) and treatment C (5.75). Treatment B (6.75) was significant as compared to treatment C (5.75).

At 60 DAS, different treatments did not show significant variation on the number of leaves per plant of Maize. Maximum number of leaves per plant of Maize was recorded in treatment D (12.75), followed by treatment A (11.75). The minimum number of leaves was recorded in treatment C (10.5).

Finally, at harvest, treatment C (9.0) and treatment D (9.0) had the same number of leaves per plant of Maize. The minimum number of leaves recorded was in treatment B (8.0). It was observed that different treatments did not cause significant effect on the number of leaves.

4.3 NUMBER OF COBS PER PLANT OF MAIZE :

A perusal of the data presented in table III and figure 5 revealed that different treatments did not cause significant variations on the number of cobs per plant of Maize. The highest number of cob per plant was obtained in treatment D (1.5), followed by treatment A (1.25).

4.4. GRAIN YIELD PER PLOT OF MAIZE :

The data pertaining to grain yield per plot of Maize as affected by different treatments can be seen in the table IV and graphically presented in figure 6. Treatment D(52.0 kg.) was highly significant over the rest of the treatments. Treatment A (49.87 kg.) was also found to be significant as compare to treatment B (47.25 kg.) and treatment C (44.0 kg.). The minimum grain yield per plot of Maize was recorded in treatment C (44.0 kg.).

TABLE III : Number of Cobs per Plant of Maize *(Zea mays.)* as affected by various spacings of Tung *(Aleurites fordii.)*.

Treatments	No. of Cobs/Plant
A (6m x 6m)	1.25
B (6m x 5m)	1.0
C (5m x 4m)	1.0
D (Control)	1.5
SE.m±	0.20
CD at 5 %	NS

NS = Non - significant.

Fig. 5 : Number of Cobs per plant of Maize (*Zea mays*) as affected by various spacings of Tung (*Aleurites fordii*).

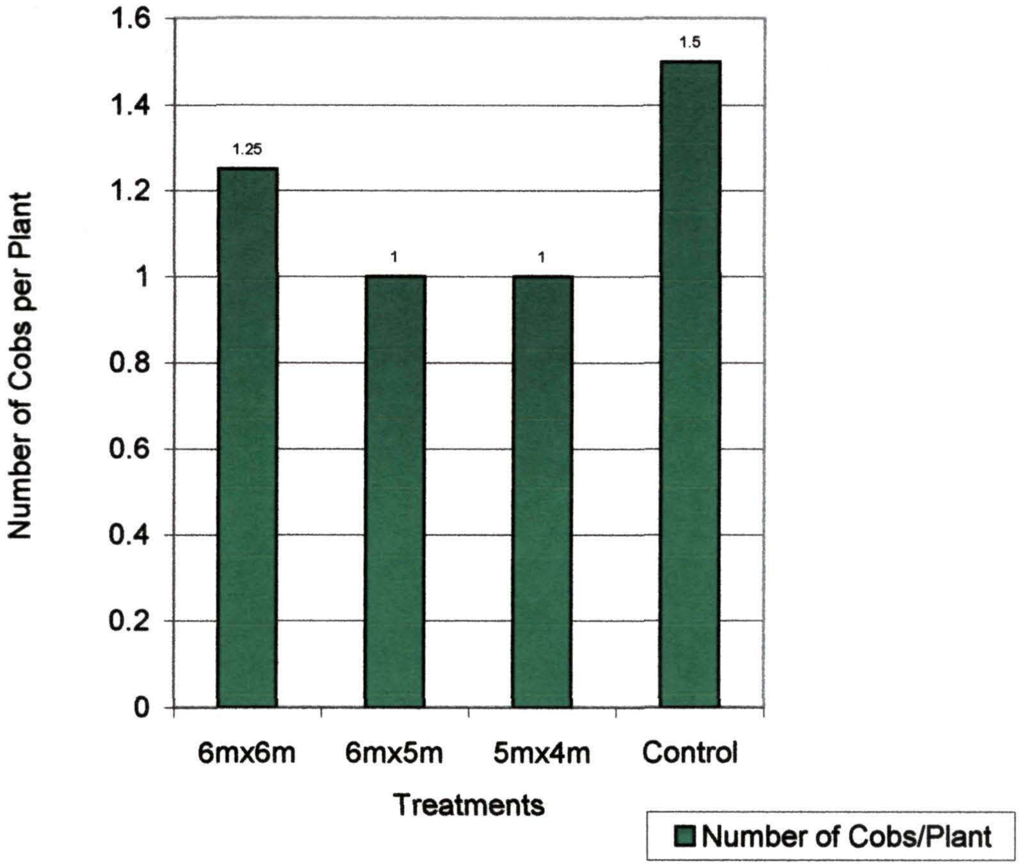


TABLE IV : Grain Yield (kg) per Plot of Maize *(Zea mays.)* as affected by various spacings of Tung *(Aleurites fordii.)*.

Treatments	Grain Yield/Plot (kg)
A (6m x 6m)	49.87
B (6m x 5m)	47.25
C (5m x 4m)	44.0
D (Control)	52.0
SE.m±	0.66
CD at 5 %	2.11

Fig. 6 :Grain Yield (Kg) per Plot of Maize (*Zea mays)* as affected by various spacings of Tung (*Aleurites fordii).*

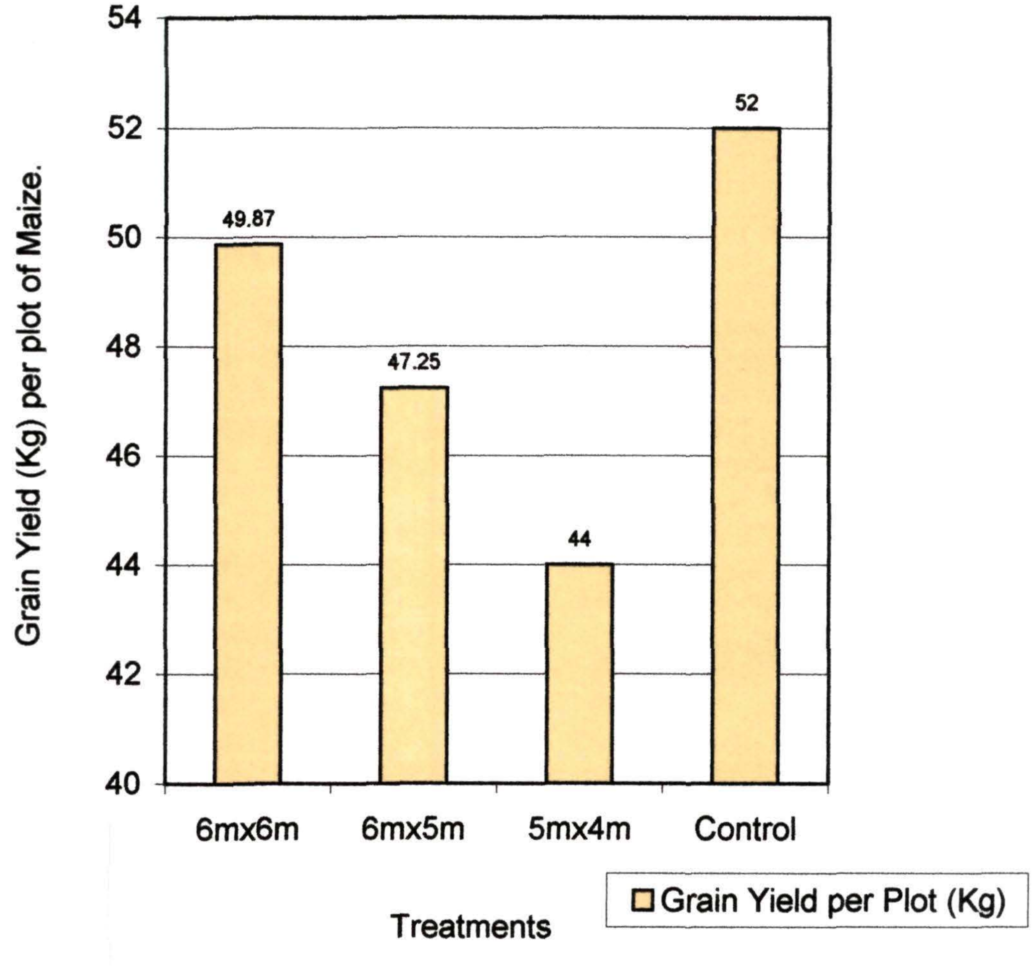


TABLE V : Height (m) of Tung Trees *(Aleurites fordii.)*as affected by various spacings.

TREATMENTS	INTERVAL OF DAYS							
	0	45	90	135	180	225	270	315
	19.11.99	05.01.2k	19.02.2k	04.04.2k	19.05.2k	03.07.2k	19.08.2k	28.09.2k
A (6m x 6m)	2.23	2.35	2.68	2.85	3.2	3.4	3.65	3.76
B (6m x 5m)	1.92	2.15	2.43	2.50	2.62	2.71	2.84	2.95
C (5m x 4m)	2.03	2.10	2.21	2.25	2.29	2.33	2.57	2.70
SE.m $\pm$	0.12	0.02	0.05	0.04	0.1	0.11	0.12	0.03
CD at 5 %	NS	0.06	0.17	0.13	0.34	0.38	0.41	0.10

NS = Non - significant

Fig. 7 : Height (m) of Tung (*Aleurites fordii)* as affected by various Spacings.

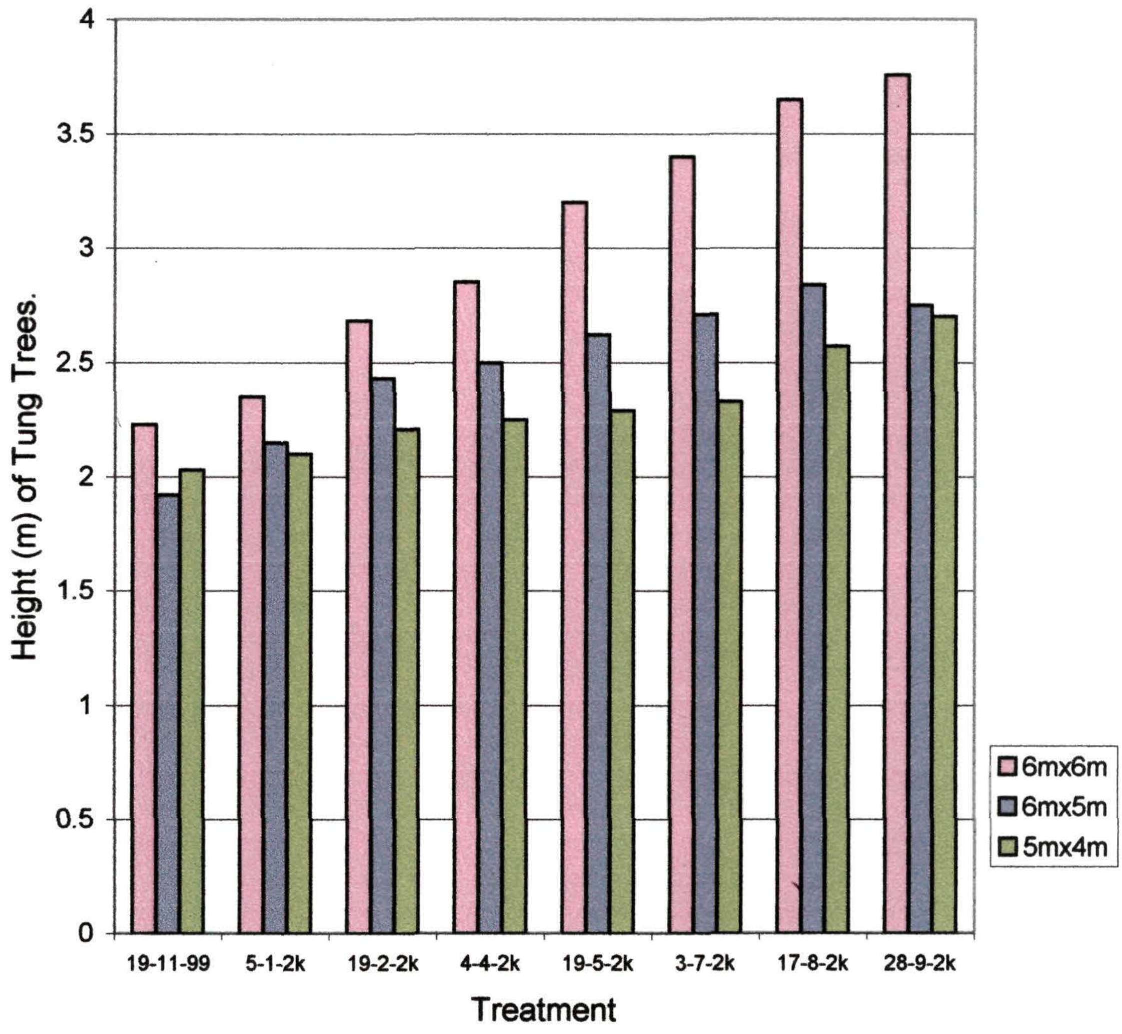
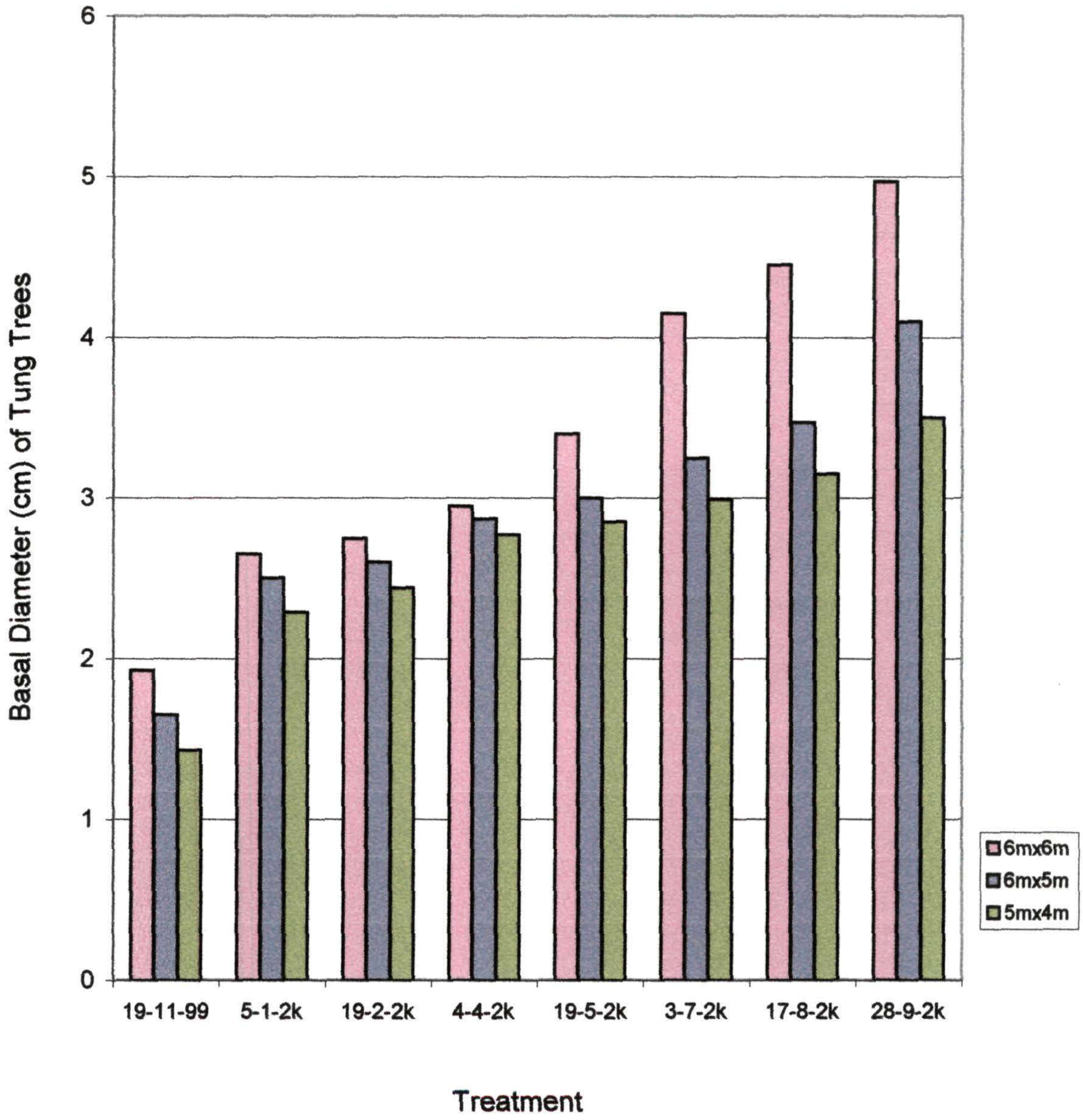


TABLE VI : Basal Diameter (cm) of Tung Trees *(Aleurites fordii.)* as affected by various spacings.

TREATMENTS	INTERVAL OF DAYS							
	0	45	90	135	180	225	270	315
	19.11.99	05.01.2k	19.02.2k	04.04.2k	19.05.2k	03.07.2k	19.08.2k	28.09.2k
A (6m x 6m)	1.93	2.65	2.75	2.95	3.40	4.15	4.45	4.97
B (6m x 5m)	1.65	2.50	2.60	2.87	3.00	3.25	3.47	4.10
C (5m x 4m)	1.43	2.29	2.44	2.77	2.85	2.99	3.15	3.50
SE.m±	0.03	0.05	0.05	0.01	0.20	0.07	0.15	0.23
CD at 5 %	0.10	0.17	0.17	0.03	0.69	0.24	0.51	0.79

Fig. 8 : Basal Diameter (cm) Of Tung Trees *(Aleurites fordii)* as affected by various Spacings.



4.5 HEIGHT OF TUNG TREES :

The height of Tung trees as affected by different treatments were also shown in tabular form as well as graphically in table V and figure 7. A critical examination of the above table and figure depicted that, at the time of first observation (21st November, 1999), different treatments did not show significance on Tung tree height. Nevertheless, treatment A (2.23 m) recorded the maximum height, closely followed by treatment C (2.03 m).

From 2nd to 8th observations, different treatments had shown significant influence on the height of the tree. Treatment A recorded highly significant over the other two treatments, B and C. Treatment C recorded minimum plant height.

4.6 BASAL DIAMETER OF TUNG TREES :

A critical analysis of the data presented in table VI and figure 8 indicated that at the time of 1st observation, treatment A (1.93 cm) was highly significant as compare to the other two treatments, viz. - treatment B (1.65 cm) and treatment C (1.43 cm). On comparing treatment B and treatment C, treatment B (1.65 cm) was also significant over treatment C (1.43 cm).

At 2nd and 3rd observations, treatment A (2.65 cm and 2.75 cm) and treatment B (2.50 cm and 2.60 cm) were significant and statistically at par with each other.

At 4th observation i.e. 4th April, 2000, there was significant variations among the treatments.Treatment A (2.95 cm) was highly significant over the other two treatments i.e. Treatment B (2.87 cm) and treatment C (2.77 cm).

At 5^{th} observations, i.e. 19^{th} May, 2000, all the treatments were found statistically significant. However, the variations among the treatments were almost negligible.

From 6^{th} to 8^{th} observations, i.e. 3^{rd} July - 28^{th} September, all the treatments showed significant variations. Treatment A recorded highly significant result over the two treatments i.e. B & C.

CHAPTER - V

DISCUSSION

5. DISCUSSION :

The present investigation entitled "Effect of various spacings on the growth behaviour of Tung (*Aleurites fordii.* Hemsl.) and the yield of Maize (*Zea mays. L)*" was carried out with the following two specific objectives.

(i) To investigate the effect of various spacings on the growth behaviour of Tung (*Aleurites fordii).*

(ii) To investigate the effect of various spacings of Tung on the growth and yield of Maize (*Zea mays).*

The experimental findings so obtained pertaining to the above listed objectives as presented in chapter IV are discussed below :-

5.1. GROWTH ATTRIBUTES OF MAIZE :

For sustainable yield and income from marginal land, introduction of cereal crop, intercropping with tree species was studied with different spacings viz - 6 m x 6m, 6 m x 5 m and 5 m x 4 m. Thus, an investigation was carried out to find out an appropriate viable alternative to shifting cultivation through Tung based agroforestry system, in terms of yield advantage and ideal spacing of Tung trees.

Growth rate in terms of height (cm) and number of leaves per plant of Maize crop was observed to be significant under different treatments at 30 DAS (Table I and II, Fig. 3 and 4). Maize was observed to be fast growing crop in association with Tung. The maximum height and number of leaves per plant of Maize were observed from treatment D (Control). This may be due to the absence of intercrop competition in sole Maize. Behera et al., (1998) also obtained taller plants in sole Maize than that of intecropping. However, when intercropped with Tung trees, the maximum growth attributes were recorded in treatment A (6 m x 6m). This may be due to the wider spacings of Tung trees.

Number of leaves per plant of Maize were recorded at 30, 60 DAS and at harvest. Maximum number of leaves per plant was recorded at 60 DAS. However, declining trend in the number of leaves per plant was observed and minimum at the harvest of the crop.

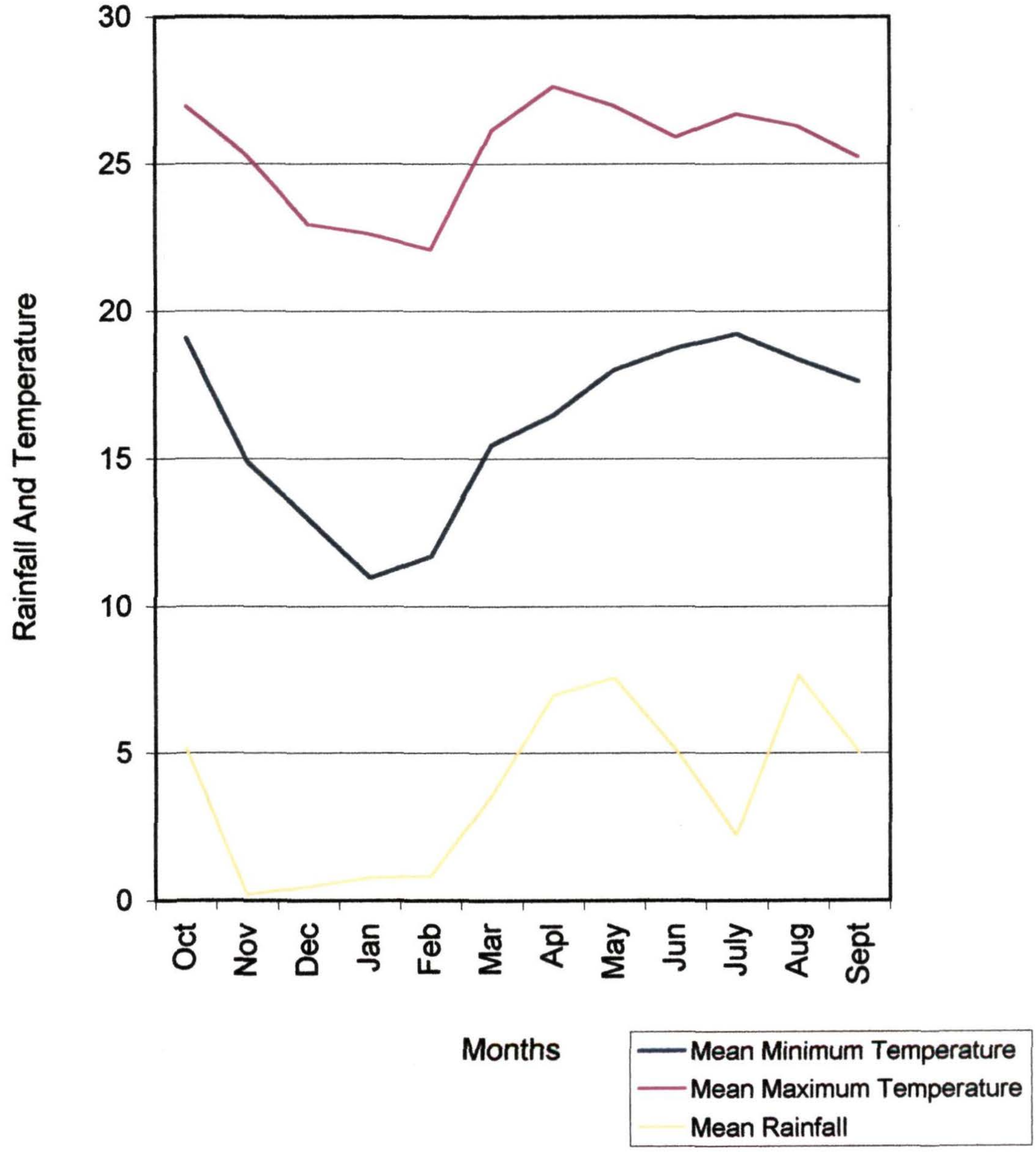
5.2. YIELD AND YIELD ATTRIBUTE OF MAIZE :

Number of cobs per plant of Maize and grain yield per plot of Maize were recorded at the harvest of the crop and were presented in table III and IV, Fig. 5 and 6 respectively. Maximum number of cobs per plant was observed in treatment D (Control), followed by treatment A (6 m x 6 m). Treatment B (6 m x 5 m) and treatment C (5 m x 4 m) recorded equal number of cobs per plant. This may be due to the absence of competition for space, moisture, nutrient and light in sole Maize. Mahapatra and Pradhan (1992) also reported reduction in cob yield of Maize as intercrop with Ricebean compared to sole crop of Maize.

The yield of a crop ultimately depends on the yield attributing factors. The highest grain yield of Maize were obtained in sole Maize (Table IV and Fig. 6) as there was minimum competition for space, moisture, nutrient and light in sole cropping as compared to intercropping. The grain yield per plot was 52.00 kg. which is equivalent to 36.11 qt/ha. in treatment D (Control). This result confirm the findings of Thakur and Bora (1987) who obtained more grain and stover yields in sole cropping than intercropping Maize and Blackgram.

When Maize was intercropped with Tung trees, maximum grain yield (49.87 Kg/plot) was recorded in treatment A (6 m x 6 m), which is equivalent to 34.63 qt/ha. This may be due to minimal shading effect of Tung trees on the intercrops as cropped with Tung trees, maximum grain yield per plot was recorded in treatment A (6 m x 6 m) i.e., 49.87 Kg. which is equivalent to 34.63 qt/ha. This may be due to minimal shading effect of Tung trees on the intercrops as compared to other two spacings ie. 6 m x 5 m and 5 m x 4 m.

Fig.9 : Monthly Variation in Mean Maximum and Mean Minimum Temperature °C and Monthly Mean Rainfall (cm) from Oct 1999 to Sept 2000 of Aizawl,



5.3. GROWTH BEHAVIOUR OF TUNG TREES

Tree growth in agri - silviculture system depends on site edaphic conditions coupled with biotic interaction of crops and weeds competing at the below ground and above ground level. It is also important to note that the climate (temperature and rainfall) of the site played a significant role in the growth of the trees.

Height of Tung trees (m) and basal diameter (cm) were recorded at a regular interval of 45 days for a period of approximately one year, starting from 21st November, 1999 upto 28th September, 2000. The data on the height (m) of Tung trees and basal diameter (cm) of Tung trees were presented in Table V and VI, Fig. 7 and 8. During November, 1999 till February, 2000, the growth of trees were found to be comparatively slower. The absence of rainfall and low temperature hindered the growth of the trees. However, from March onwards, the trees attained better growth in their growth attributes. The monsoon shower and increase in temperature could have influenced such a trend in the growth behaviour. As shown in the Fig. 9, the rainfall was negligible during November, 1999 to February, 2000. The Figure also indicated low temperature as compared to other months. This could have influenced the growth pattern of Tung trees. James (1993) also stated that Tung tree requires long, hot summer with abundant moisture, where day and night temperatures are uniformly warm. Much variation reduces the growth and fruit size.

The hindrance of the growth of Tung trees during November, 1999 to February, 2000 could also be due to the heavy infestation of grassy and broad-leaved weed species. It is important to note that three weeding were done in between March, 2000 to early July, 2000 i.e. during the cultivation of intercrop Maize. Those weeding could also reflect the growth pattern of Tung trees in a positive trend.

Results from the analysed data presented in Table V, Fig. 7 and Table VI, Fig. 8 revealed that total tree height and basal diameter were maximum in treatment A (6 m x 6 m) at the time of last observation, followed by treatment B (6 m x 5 m) spacings. Treatment A (6 m x 6 m) was significantly differing from treatment B (6 m x 5 m) and treatment C (5 m x 4 m). The variation in growth were ranked based on parameters studied. The lowest score is given to a character with treatment C (5 m x 4 m) and highest score to a character with treatment A (6 m x 6 m). It is evident from the table that treatment B (6 m x 5 m) and treatment C (5 m x 4 m) performed almost equal in growth parameters studied.

Biswas (1946) recommended that for proper growth, 20 feet (6.09 m) each way is sufficient space. Distance of 25 ft. x 30 ft. (7.61 m x 9.14 m) or even 30 ft. x 30 ft. (9.14 m x 9.14 m) may be adopted with reference to the nature of the growth of individual tree in a plantation. James (1983) suggested that in contour planting, distances between rows and total number of trees per hectare vary; rows 10 m apart, trees spaced 3.4 m to 4 m apart in rows, 250 to 350 trees/ha. According to Potter and Crane (1957), the orchard recommendation include 100 to 140 per acre which is equivalent to 247 to 346 trees/ha., with suggested spacings ranging from 12 ft. x 30 ft. (3.65 m x 9.14 m) to 15 ft. x 40 ft. (4.57 m x 12.19 m).

It may be too early to make conclusion based on the growth of trees during the period of only one year. However, the result revealed that there is variation in growth in respect to all the spacings studied. But from present study, it is inferred that treatment A (6 m x 6 m) performed better in both height and basal diameter than the other two treatments.

In contrary to the findings of some researchers listed earlier, in the present investigation, growth behaviour of Tung trees under three different spacings (6 m x 6 m), (6 m x 5 m) and (5 m x 4 m) were studied. So far, it can be mentioned that Tung trees at a spacing of 6 m x 6 m can be successfully grown with Maize in an agroforestry system of Mizoram.

Plate No. 1 : One Year Old Tung Tree before sowing of Intercrop Maize (6mx6m)

Plate No. 2 : One Year Old Tung Tree before sowing of Intercrop Maize (6mx5m)

Plate No. 3 : Maize Crop (Control)

Plate No. 4 : Maize + Tung Intercropping (6mx6m)

Plate No. 5 : Tung + Maize Intercropping (6m x 5m)

Plate No. 6 : Harvested Maize Cobs

CHAPTER - VI

SUMMARY AND CONCLUSION

5.1 SUMMARY :

The study on effect of various spacings on the growth behaviour of Tung (*Aleurites fordii.*) and the yield of Maize (*Zea mays.*) under Agroforestry system of Mizoram was carried out at Zemabawk. The site of the field experiment is about 4 km. away from Aizawl Eastern side, the capital city of Mizoram. The altitude of Zemabawk is 1,132 m i.e. 3,715 feet from the mean sea level and the average rainfall is 235 cm. The temperature during summer varies from 21^0 c to 30^0 c and the winter temperature varies from 11^0 c to 23^0 c. The texture of the soil in the experimental site was analysed at Soil Testing Laboratory, Directorate of Agriculture and Minor Irrigation, Government of Mizoram, Aizawl. It was found that the soil is sandy clay having 61.96 % sand, 7.21 % silt and 30.84 % clay with and average p^H of 5.3.

The area of the experimental field was approximately 2,304 sq.m. The experiment was conducted on a well established plantation of Tung trees which were planted at the spacings of 6 m x 6 m, 6 m x 5m and 5m x 4m in July, 1998. Improve variety of Maize (G-11) was sown at a spacing of 60 cm x 40 cm in the interspace of Tung trees covering the entire experimental area during the 2^{nd} week of April. The size of each plot measured 12 m x 12 m. As the trees were already established, management of the trees were not necessary. However, three weedings were done; one before the sowing of Maize i.e. during March, 2000. After the emergence of grassy and broad-leaved weeds, the 2^{nd} weeding was done in late April and completely by early May, 2000. The 3^{rd} weeding was completed by early July, 2000.

The experiment was laid out following randomised block design (RBD) with four replications and four treatments, viz - A (6 m x 6 m), B (6 m x 5 m), C (5 m x 4 m) and Control. They were allocated in each replications. Thus there were 16 number of plots.

The various growth attribute of Maize such as plant height in cm and number of leaves per plant were recorded at a regular interval of 30, 60 DAS and at harvest. Number of cobs per plant of Maize and grain yield (kg/plot) were recorded after the harvest. On the growth attribute of Tung, tree height (m) and basal diameter (cm) were recorded at a regular interval of 45 days, starting from 21st November, 1999 upto 28th September, 2000. The data obtained were subjected to ANOVA (Analysis of variance) to see the effect of various spacings on the growth of Tung and the yield of Maize. The significance was tested by calculating the critical difference (CD) at 5 % level, wherever 'F' test was found significant.

The prominent findings can be summarised as follows :

1. GROWTH PERFORMANCE OF MAIZE :

In respect to the height of Maize and number of leaves observed at a regular interval of 30 days, treatment D (Control) recorded the best performance followed by treatment A (6 m x 6 m). Nevertheless, on comparing treatment A and treatment D, the difference in the height of Maize and the number of leaves were almost negligible.

Treatment D (Control) recorded maximum number of cobs and grain yield per plot as observed at the harvest of the crop, closely followed by treatment A (6 m x 6 m).

2. GROWTH BEHAVIOUR OF TUNG TREES :

Height and basal diameter of Tung trees observed for the period of one year starting from 21st November, 1999 to 28th September, 2000 indicated that the performance of treatment A (6 m x 6 m) was found to be the best. On comparing treatment B and treatment C, there was no noticeable difference in regard to the height and basal diameter of the trees.

CONCLUSION :

From our present investigation, the following conclusions were drawn :-

(1) Treatment A (6 m x 6 m) was the best spacing in respect to the growth behaviour of Tung trees.

(2) Treatment D (Control) recorded maximum growth attributes and grain yield of Maize. However, when intercrop with Maize crop, Treatment A (6 m x 6 m) was found to be the best treatment.

The present findings are based on one year observation only. So, further studies may be required to corroborate the present findings. Since the performance of Tung trees in (6 m x 6 m) spacing was observed to be the best, this spacing may be adopted.

The retrospective perusal of agroforestry research in the north-eastern hill region exhibits its wide spectral potential in sustenance of agriculture as these systems provide food, fodder, fruit, vegetables, fuel wood, timber, medicines, fibre, etc. from the same piece of land at a time which not only fulfils the demand of people but also elevate their socioeconomic status and standard of life.

The apparent high potential of agroforestry systems, its applicability to control soil erosion, soil improvement, creation of congenial and conducive micro climate for trees and understorey crops and reduction in the accumulation of green house gases in the atmosphere. In the present situation it is the first and foremost duty of agriculturists, ecologists, plant physiologists, agroforesters and policy makers to launch agroforestry programmes in Mizoram State where suitable land for such system is available.

Agroforestry technologies will play a major role in the synthesis of sustainable farming systems for economic prosperity of the people living in Mizoram. It may take some more time to make it popular through development agencies. It is essential that expectations about the outcome and output level of agroforestry be continue to vary due to its location specification, appropriate choices and a number of local factors.

There is a dynamic flux transforming theory and practices of agroforestry. Much of the conventional wisdom has been challenged by recent research and farming experiences in context of adoption of a perfected technology. There is a serious revision on many fronts. It is not certain that technique/technology perfected today will stand the test of experience tomorrow. Hence, a continue of interaction of research efforts and farm experience should flow to realize the potential of agroforestry.

A tree planted today is really for next generations use. If we accept that premise, agroforestry will work.

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