

**GROWTH PERFORMANCE OF MELOCANNA BACCIFERA  
(ROXB.) NEES. AND DENDROCALAMUS LONGISPATUS  
(KURZ.) FOR. ALONG WITH GLYCINE MAX IN AN  
AGROFORESTRY SYSTEM OF MIZORAM.**

**BY**

**LALNUNTLUANGA**

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**NORTH EASTERN HILL UNIVERSITY  
MIZORAM CAMPURS**

Prof.L.K.Jha  
Head of Department

Department of Forestry  
School of Life Sciences  
Tel : 0389-342182 (O)  
0389-326327 (R)  
Fax :0389-340313 (O)

I certify that the thesis entitled, "Growth Performance of *Melocanna baccifera* (Roxb.) Nees. and *Dendrocalamus longispathus* (Kurz.) For along with Glycine max in an Agroforestry System of Mizoram," submitted by Mr. Lalnuntluanga for the partial fulfilment of Master of Science in Forestry of the North Eastern Hill University, Shillong embodies the record of original investigation by him under my supervision. He has successfully completed for the award of the M.Sc. Degree. The work has not been submitted by any other degree of any other University.

Aizawl,  
The 25th November, 2000

  
( Prof. L.K.JHA )  
Supervisor

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**Dated. Aizawl,  
the 25th Nov. 2000.**

  
(LALNUNTLUANGA)

## LIST OF PLATES.

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# **INTRODUCTION**

Agroforestry is an applied science which is of recent origin. Agroforestry is the term used for the deliberate cultivation of trees in association with crops. An efficient Agroforestry System should aim at systematically developing integrated land use system and practices where the positive interaction between trees and crops is encouraged and maximized. This seek to achieve a more productive, sustainable and diversified output from the land than is possible with the conventional monocropping system. The current concept of Agroforestry implies integration of forestry with agriculture and vice versa. Historically the practised existed in the tropical and sub-tropical countries since long.

Lundgrean and Raintree (1983) defined Agroforestry as " a collective name for land use systems and technology where woody perennials ( trees, shrubs, bamboos, palms, 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 sequences ".

According to Rao ( 1989) , Agroforestry can be defined as , " the deliberate introduction of woody perennials on the same unit of land as agricultural crops and or animal, either in some form of spatial mixture or temporal sequence and there must be a significant interaction ( positive and or negative ) between the woody and non-woody components of the system, either ecological and or economical ".

Sinha ( 1985 ) , defined Agroforestry as, " an integrated land use planning system following the principle of generating multiple resources from the same unit of land ".

Forest constitute the basic life support system and are important in the socio-economic development of the society. Besides its importance for the society, forests resources have been declining very rapidly since the last century and today it has reached an alarming stage around the world.

In India, particularly the North-Eastern states forest resources have been destroyed through the age old practice of Shifting Cultivation ( Jhum) by the tribals. In the past, the Jhum cycle used to be 20 - 25 years which allowed sufficient growth of vegetation. During those period the vegetation releases enormous nutrients to the soil which is to be utilised for the new Jhum cycle. Because of this long spell cycle there was hardly any nutrients loss or soil loss. However, with the increased in population, much more pressure was exerted on the forests which will reduced the acreage of available land and also reduces or shorten the Jhum cycle to a mere 2 - 3 years. This will resulted in much loss of soil nutrients and soil microbes, reduced moisture content and decreased in crop productivity on the same unit of land.

Due to the ill effects of Jhuming or Shifting Cultivation on the soil as well as on the crop productivity, the Central Government has suggested several measures to tackle the above said problems in the North-East. Indian Council of Agriculture Research (ICAR), Barapani, for the North-Eastern Hill Region suggested a three tier system for replacing the Shifting Cultivation. In this system, cultivation of tree at the hill top (33.0%), cultivation of horticultural crops in the middle portion (33.5%) and forming terraces at the lower portion of the hill slopes for cultivation of field crops (33.5%). Another system called, " *New Contour Farming System*" has also been evolved. In this system trenches are dug along the contour across the 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. The objective of this system is to wean away Shifting Cultivation and switch over to permanent cultivation on 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. The objective of this system is to wean away Shifting Cultivation and switch over to permanent cultivation on the hill slopes by conserving soil and water and recycling the top soil so lost so as to attain sustainable agriculture.

In Mizoram, the practice of Jhumming is still in vogue. Jhumming which is still today common in Mizoram and is becoming less sustainable as cultivation cycles are shortened due to population pressures. A reduction in the length of Jhum cycles has a number of adverse environmental consequences. It reduces Biodiversity and it increases the rate of soil erosion, apart from its unfavourable economic consequences for the cultivator. About 80% of population of the state engaged in Jhumming and were living in the rural areas. For the control of Shifting Cultivation the state government formulated a policy under the banner of New Land Use Policy (NLUP), from the state budget in 1990. Under the NLUP, land were allotted to the selected families of the size of 2 hectares per family from different Developmental Blocks.

The trade under the policy or scheme included agriculture and allied sector, A.H. and Vety, Industries are also included special packages to help the poor farmers. In spite of these benefits, the policy could not make much impact or head way to the farmers and the quantum of success fall far below the expectations of the Government. Factors which can be attributed to the failure of the innovated policy are -

- (1) Poor extension approach.
- (2) Lack of sincere desire to motivate the farmers.
- (3) Frequent transfer of Officers associated with implementation of NLUP.
- (4) Poor coordination of Government Departments.
- (5) Poor technology.

Though the aim of NLUP was quite good, but the implementing agency as well as the farmers were somewhat fail. With the passage of time, farmers were becoming more and more aware of the Agroforestry practices and they have introduced various Multipurpose Trees in their farms along with crops. The intercropping of paddy (*Oryza sativa*) and teak (*Tectona grandis*) is the most common and successful practices of Agroforestry in Mizoram.

In the absence of any major wood resources in Mizoram due to over exploitation of forests, Jhum burning and degradation of forests, bamboo which is available in plenty has occupy and important place in rural economy. Almost 30% of the revenue is realised from bamboo. The important commercial species are recognised, viz., *Melocanna baccifera*, *Dendrocalamus longispathus*, *Bambusa tulda*. The predominant species is non-clump forming, while others are found in small proportion (Anon. 1998).

*Melocanna baccifera* (Roxb.) Nees. is an evergreen bamboo with diffused clump. The height of the culms is 10-20m and 3-7cm in diameter. The colour of the pole is green when young and straw coloured when old. The longest internodes is 20-25cm long and the culm sheath is 10-15cm long, yellowing green when young and yellowish brown on maturity, brittle, striate, truncate or

concave at tip, glabrous or sparsely with whitish appressed hairs on the back. The species can be recognised easily by defused clump habit, having culm sheath straight for about two-third of the way up, than once or twice transversely waved with subulate flagelliform blade (Alam, 1982).

Flowering of *Melocanna baccifera* has been reported during 1863, 1866, 1892, 1893, 1900-1902, 1910-1912, 1933 and 1960 (Chatterjee, 1960; Vaid, 1972). Sporadic flowering was reported in Cachar and Manipur in 1967 (Nath, 1968). Sharma (1992), reported flowering at FRI, Dehradun. Flowering and fruiting was observed at Pune during 1933. Length of flowering period according to Gamble (1896), is 30 years, according to Kurz (1876), it is 30-35 years, according to Troup (1921), is about 45 years, culms and rhizome die after flowering. Profused Natural Regeneration has been observed.

*Dendrocalamus longispathus* (Kurz) For. is a handsome tufted bamboo. Culms height ranges from 10-18 m. with a diameter of 6-10 cm. when young they are glaucous green in colour, on maturity, the colour changes to greyish green.

Flowering of *Dendrocalamus longispathus* has also been reported from different parts of the country. It has been reported to have flowered in different years in Bangladesh and in Myanmar. Blatter (1931), points out that it comes under the class irregularly flowering, gregariously and often sporadically.

Both the species *Melocanna baccifera* and *Dendrocalamus longispathus* have widespread uses viz., young shoot as vegetable or chutney or curry, mature culms for construction of houses, fencing, flooring roof, drinking water channel or pipe, fuelwood, (Weda, 1981), tabashir or banslochan of bamboo (water accumulated in the hollow internodes) as cooling tonic to cure asthma, cough, etc., outermost green portion of culm to stop bleeding from the wound or cut and also heals the wounds, fruits of *Melocanna* as nutritious feed for wild animals and increases milk production (Lalramnghinglova, J.H., 1997). Bamboos are also an important paper pulp sources in India and China (Maheshwari and Satpathy, 1990; Zhan Xing et al., 1990). By 1987, approximately 2,000,000 tonnes of raw bamboo, 62% of overall production was used as pulp.

The two bamboo species viz. *Melocanna baccifera* and *Dendrocalamus longispathus* are mostly found and obtained from the forest. Cultivation or growing of the bamboo with crops have been reported from some parts of the state. For the introduction of Agroforestry System, bamboos are planted and crops are grown in between the interspaces. Effort are being made on the cultivation of bamboo along with crops for meeting the ever increasing demand of bamboo. Plantation of bamboos along with agricultural crops is the only solution to meet the ever increasing demand of bamboo as well as crops. Thus the present work entitled, "*Study on Growth Performance of Melocanna baccifera and Dendrocalamus longispathus Species along with Glycine max,*" would help in knowing the -

- (1) Growth performance of bamboo species along with crops and without crops.
- (2) Impact of fertilizers on the growth of bamboo species in control (pure bamboo) as well as in bamboo based Agroforestry System.

# **REVIEW OF LITERATURE.**

Many research have been carried out on various or different aspects of of Agroforestry which includes Agroforestry as alternative to Jhum or Shifting Cultivation(Jha, 1995), alleviation of economic condition of the rural community (Kerketa and Jha, 1989), upgradation of women skills (Sharma et al., 1989; Chen et al., 1986 and Sreen et al.,1992), economic and ecological benefits (Hsiung, 1986), improvement of tree seeds (El-Lakany, 1986), genetic improvement of tree species ( Mandal and Subramanian, 1992 ), nursery pest management ( Thakur, 1993 ), soil management (Dhar and Jha, 1993), alley cropping (Wilson and Karg, 1981), biomass and nutrient distribution ( Gupta et al., 1992 ), etc. Growth behaviour of trees have been carried out by many researchers like Mohan (1992), Osman et al., 1997, Reddy et al., 1992, Shanmuganathan et al., 1980 etc.

Agroforestry have been given top priority in most of the developing countries ( Singh and Tewari, 1996 ). Research have been carried out in the field of Agroforestry because of its importance in meeting the challenge of growing food and employment problems. In India, Agroforestry programmes are carried out in various states like West Bengal, Bihar, Karnataka, Tamil Nadu, Kerela, etc.

### **PERFORMANCE OF MULTIPURPOSE TREES (MPTs)**

The performance of MPTs have been studied from the degraded forest areas of Western Ghats in Karnataka by several workers. Mohit Gera et al.,(1992) studied the performance of different seventeen MPTs for screening out the best adaptable species with desirable characteristics viz. Afforestation, Agroforestry., Social Forestry Programme, etc. under Semi-Arid Regions of Central India. Species like *Eucalyptus*, *Acacia*, etc. give promising result for converting degraded as well as non-productive forest areas into productive and protective areas (Jagadishchandra et al., 1995). In Tamil Nadu MPTs like *Eucalyptus* and *Casuarina* are used for converting wasteland into productive areas and good result have been obtained (K.Kareemula et al., 1994). Bamboo species like *Dendrocalamus strictus* have been raised in Uttar Pradesh for converting degraded land into productive land and as a result much of the landscape has been modified as a bamboo dominated savanna (Srivastava et al., 1986).

From the above studies MPTs like *Gmelina arborea*, *Azadirachta indica*, *Leucaena leucocephala*, *Acacia species* were among the fastest growing species with maximum Mean Annual Increment (MAI) which making them suitable for Agroforestry and Social Forestry Plantations . Sidhu (1985), compare the growth performance of *Eucalyptus hybrid* with Mysore gum. Biomass production of *Albizia lebbek* under Silvipastoral System have been studied by Deb Roy (1984), and revealed that the maximum growth is obtained in the third year of study. The growth performance of directly seeded leguminous tree, non-leguminous forbes, grasses and crops at a coal mine spoil at Jhingruda colliery, Singrauli indicates that the legumes have better growth performance than the non-legumes after one year of seedling growth (Jha and Singh, 1987).

### **BIOMASS PRODUCTION AND NUTRIENT STATUS.**

The bamboo standing crop biomass and shoot net production was distinctly lowered than the above-ground biomass and net production reported by Singh (1989), in natural Dry Deciduous Forest. In the bamboo influence zone, however, bamboo produced annually about 453-589 g/sq.m (4.5-5.8 t/ha) of fine roots which was substantially higher when compared to fine

root production in natural Dry Deciduous Forest of *Anogeissus latifolia* of about 2.4-2.8 t/ha/yr (Singh and Singh, 1981) and 19 year old teak plantations which is about 4.8 t/ha/yr as reported by Srivastava et al., 1986. Thus fine roots play a significant role in adding organic matter and nutrients to the soil in bamboo savanna. Similarly, a large litter layer is supported in the bamboo zone. The different components of annually recycled bamboo materials (leaf, seed, twig and root) are fairly rapidly through the annual cycle releasing significant quantities of nutrient in a phased manner (Tripathi and Singh, 1991).

Bamboo efficiently makes use of the available nutrients and builds up relatively fertile soil around the clump. Singh et al., (1989), reported higher levels of available nutrient pools through most part of the year in the savanna compared with grass savanna in the same region.

Hassan and Islam (1984), have reported that the bamboo species contributed 20 kg/ton/ha of organic matter to the soil whereas teak contribution was 27 kg/ton/ha. The soil of different bamboo species show wide variation in many physical and chemical characteristics and assume greater significance on account of the shallow root system of the species. The soil under *Bambusa tulda* possesses the highest fraction of clay, organic matter, nitrogen, calcium, potassium and phosphorus, whereas the soil under *Teinostachyum dullooa* and *Ochlandra nigrociliata* exhibits lowest reserve of magnesium, potassium, phosphorus and nitrogen (Qureshi et al., 1969). Dabral et al., (1969) had reported that both the air temperature and humidity were modified by the sheltering as well as the blanketing effect of vegetation cover, it was also observed that fair weather conditions induced the maximum difference in the temperature behaviour.

### TREE - CROP INTERACTION IN AGROFORESTRY.

Tree-crop interaction has been studied by many workers for finding out the suitable and appropriate combination. The intercropping of *Eucalyptus hybrid* with sorghum carried out in Orissa have shown that the net financial benefits are larger in Agroforestry System as compared to Monocropping System. Under Agroforestry System the land is utilised to its potential (Sharma and Mc Gregor, 1991). At the Doon Valley, study on tree-crop interaction on *Grewia optiva*, *Morus alba* and *Eucalyptus* with paddy and wheat were conducted and reported that tree species had depressing effect on the crop yield (Khybri et al., 1988).

According to the study conducted by Mann and Muthana (1984), on the growth of grasses by tree species *Holoptelia integrifolia*, no significant effect was not found out.

According to Pathak (1984), very high production of forage could be obtained by intercropping *Leucaena leucocephala* with guinea grass and berseem.

Nadagoudar (1988), mention that an experiment involving two field crops (groundnut, sorghum, chilli, finger millet), *Tectona grandis* (teak), *Carica papaya* (papaya) a fruit crop and two pasture crops were started in July 1984, at the main research station, University of Agricultural Sciences, Dharwad, under rainfed conditions. Biomass production increased but crop yield lowered probably as a consequence of competition for moisture.

Intercropping of *Acacia albida* with maize (*Zea mays*) and bean (*Phaseolus vulgaris*) were studied at Morogoro, Tanzania, and the studies reported that the intercropping did not significantly influenced volume and biomass of the tree, nor the yield of maize and beans (Okorio et al., 1991).

## EFFECT OF FERTILIZER

The growth and biomass production of tree species have been greatly influenced by fertilizers. According to Shanon et al., (1990), alley cropping research in Zaire with a component of *Leucaena leucocephala* and maize (*Zea mays*) resulted in the increased in the yields with the application of fertilizer. Kwoke (1990), reported that *Calliandra calothyrsus* and *Flemingia congesta* responds well to the fertilizer application, which resulted in increased in yield and biomass production.

According to Mohan (1992), the fertilizer application was respond well by *Terminalia myriocarpa* and their seedling growth was enhanced when treated with urea, superphosphate and muriate of potash. Nitrogen application increased biomass in all parts of the plant and the application of phosphorus showed significant effect on leaf and biomass (Koul et al., 1995).

Anon. (1966), reported that the survival percentage of bamboo species like *Dendrocalamus strictus*, *Dendrocalamus longispathus* and *Bambusa arundinacea* was higher in the pit filled with Farmyard Manure.

Sundararaju et al., (1981), reported that the application of fertilizer (NPK) help in boosting up the growth and reduced the nursery period of *Eucalyptus species* by about a month time. Growth of *Ailanthus excelsa*, with the fertilizer application increased by about 48% (Gupta et al., 1994). Chellamuthu et al., (1995), studied the effect of both organic and inorganic fertilizers on five different tree seeds and impact on survival as well as its establishment in the main field.

**DESCRIPTION OF SITE,**  
**CLIMATE AND METHODOLOGY.**

Mizoram has an area of about 21,087 sq. km. and lies between 21°56' - 24°31' North latitude and 92°16' - 93°29' East longitude with a height of about 1000m from the main sea-level and is situated in the North Eastern corner of the Indian Union ( Fig. 1). It is bounded by Cachar District of Assam and Manipur in the North , in the East and South by Chin Hills of Myanmar and Bangladesh (Chittagong Hill Tracts) and Tripura in the west. The study is carried out at the North West part of Zemabawk called as "Paite veng", about 6 km East of Aizawl the capital city of Mizoram. The area of the study site is about 288 sq.m.

The soil of the study site is clay-loam , acidic in nature and reddish to black in colour. The soil is having a pH of about 5.42. The soil has a phosphorus content of 18.4 kg/ha, potassium content of 160.9 kg/ha and organic-carbon percent is 0.68%.

The vegetation of the experimental site is dominated by weed species like *Imperata cylindrica*, *Ageratum conizoides*, *Mikania scandence*, etc. The weed species often causes great hazard on the growth of bamboos as well as soyabean by creating competition for sunlight, moisture, soil nutrients, etc.

The climate is hot and humid during summer and cold and dry during the winter season. The temperature in summer ranges between 21°C - 30°C, whereas winter temperature have a range of 11°C - 23°C. In the late summer the area receives heavy rainfall. During May to September , most of the rainfall have taken placed and account for about 55 - 60 % of the total rainfall. During the study period i.e. 1999 August - 2000 August, the area receives heavy rainfall in the month of June, July and August 2000 with a rainfall of about 310.33 mm., December 1999, January and February 2000 are the driest month with little or no rainfall.

The experimental site was selected in the month of July 1999. All the weeds and vegetation have been cleared after the selection of site. The whole site with an area of about 288 sq.m. was divided into two replicates with a size of 144 sq.m. each. The bamboos seedlings (rhizome) was procured from the nearby bamboo stands. The seeds of soyabean was procured from the state Agriculture Department. Planting of seedling was done in the month of August 1999. In the field, the experiment was laid out following the Randomized Block Design (RBD) with 16 sub-plots. Two different spacing for bamboos i.e. 2X2m and 3X3m and only one spacing for soyabean i.e. 25X25cm. The size of each sub-plot is 6X3m (18 sq.m.). Bamboos were planted at the middle portion of each sub-plots and soyabean around the bamboos.

The study on the growth behaviour of the two bamboo species viz. *Melocanna baccifera* and *Dendrocalamus longispathus* was done from the month of August 1999 till September 2000. The various growth attributes such as height , number of leaves, etc. will be recorded at the monthly interval. Bamboo height was measured from the ground level to the tip of the plants. At the same time the number of leaves were also assessed at the monthly interval. Fertilizers (NPK) was applied in the month of planting in all the plots except the control plots. The growth attributes were also recorded to see the effect of NPK in the growth of bamboos. The mean yield of soyabean was also recorded at the harvest.

A complete analysis of soil was done in the Department of Forestry NEHU Mizoram Campus Laboratory Aizawl as well as in the Soil Testing Laboratory of the Department of

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Agriculture, Government of Mizoram , Aizawl. Various soil parameters such as soil temperature, moisture, pH, C:N ratio were carried out in the laboratory. Soil nitrogen content was tested by Potassium-permanganate Method, using Kjeldahl Digestion and Distillation Method.

Soil temperature was measured by Soil thermometer and the moisture content by Gravimetric Method. The soil pH was measured by pH meter (Digital pH meter). Phosphorus content was determined by Bray's No. 1 Method . Potassium content was observed by Flame photometer using Ammonium Acetate Method (Normal). Organic Carbon content was determined by Walkley and Black(1934) Rapid Titration Method.

The data obtained were subjected to ANOVA (Analysis of Variance) to see the effect of month on the growth behaviour of the bamboos on a particular treatment. f-test was made to compare the growth parameters between the bamboo species under fertilized as well as unfertilized plots. The data on the soyabean yield were also subjected to ANOVA to see the effect of fertilizer on the yield of soyabean.

## LAYOUT

### REPLICATION - I

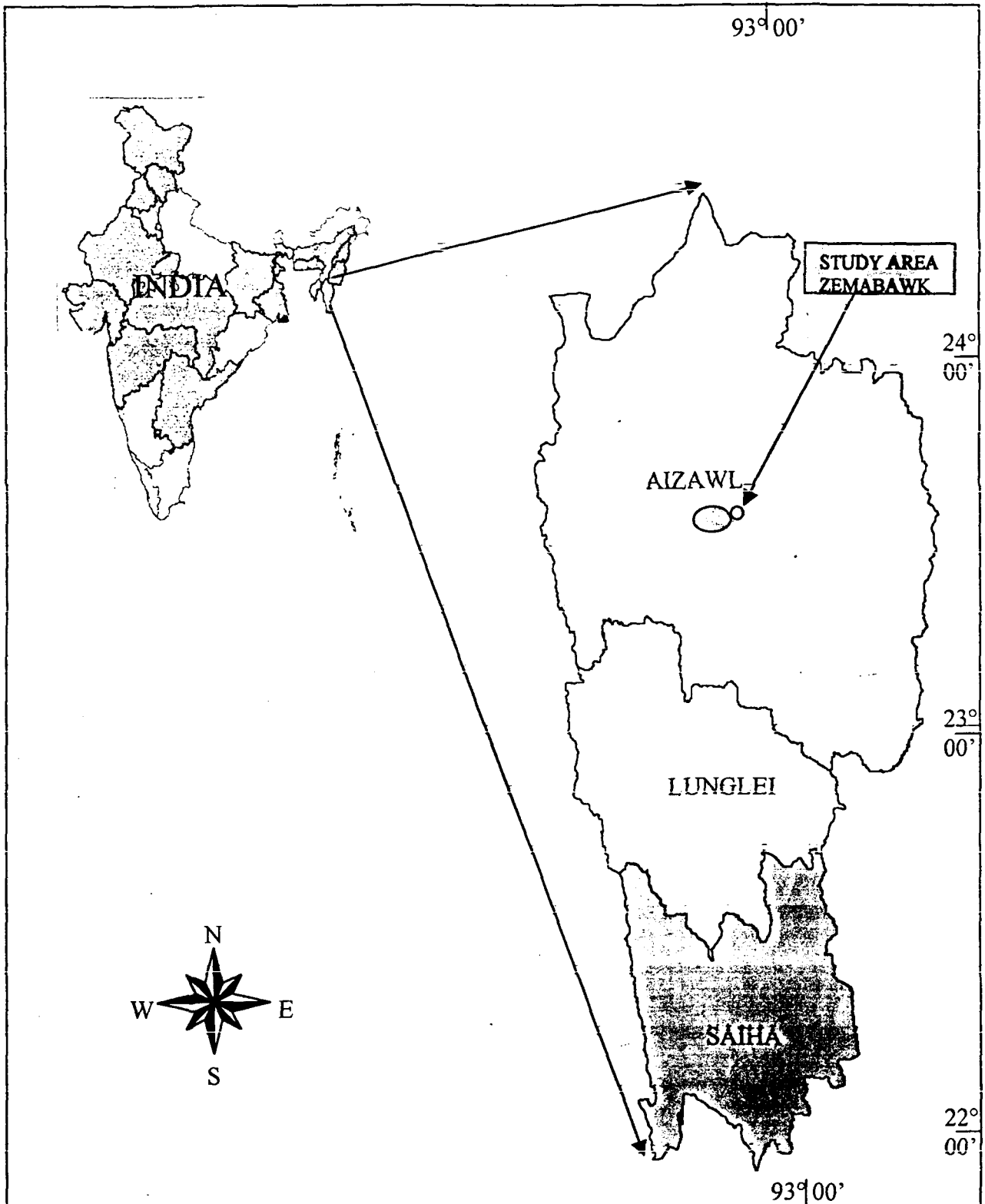
110	000	100	010
011	101	001	111

### REPLICATION - II

100	001	110	000
011	101	010	111

1. Species	<i>Dendrocalamus longispathus</i> (0)	<i>Melocanna baccifera</i> (1)
2. Spacing	2m (0)	3m (1)
3. Fertilizers	without (0)	With (1)

FIG.1. LOCATION MAP OF STUDY AREA (ZEMABAWK)



# RESULT

## **GROWTH BEHAVIOUR OF MELOCANNA BACCIFERA UNDER CONTROL PLOT**

The growth rate in height , number of leaves of *Melocanna baccifera* increased significantly with the increased in time. Faster growth rate in height and increased in the number of leaves have been experienced in the initial few months. Lack of moisture causes slow growth in its growth during January to May ( Table-1 ). After the arrival of monsoon growth rate speeded up and increased in height as well as number of leaves have been noticed. The growth rate was significant.

## **GROWTH BEHAVIOUR OF MELOCCANA BACCIFERA UNDER FERTILIZED PLOT.**

The growth rate in height, number of leaves of *Melocanna baccifera* under fertilized plot was significant in the initial few months. Growth was slowing down during the dry season. Significant growth was noticed after the monsoon (i.e. from June; Table-2 & 3).

It was observed that the fertilized plots gives better result in comparison with the control plot.



Plate -1: Melocanna baccifera  
under Control Plot

Plate -2: Melocanna baccifera  
under Fertilized Plot



### **GROWTH BEHAVIOUR OF DENDROCALAMUS LONGISPATUS UNDER CONTROL PLOT.**

The growth rate in height, number of leaves was moderate in the initial months due to the late monsoon rain in the area. Increased in height was slow during November 1999 to April 2000, because of less moisture. Faster growth in height, increased in the number of leaves have been noticed after the monsoon rain (Table-4).

### **GROWTH BEHAVIOUR OF DENDROCALAMUS LONGISPATUS UNDER FERTILIZED PLOT.**

The growth rate in height, number of leaves was fast in the initial few months due to late monsoon. Growth was slow down during the dry month of November to January. After the arrival of monsoon rain growth rate was increased significantly (Table-5&6).

It was observed that the fertilized plot shows better growth in comparison with the control plot.



Plate -3:

Dendrocalamus longispathus  
under Control Plot



Plate -4:

Dendrocalamus longispathus  
under Fertilized Plot

## **YIELD OF SOYABEAN.**

### ***Melocana baccifera + Soyabean.***

The yield of soyabean (kg/ha) under fertilized plot was differs from the control plot. The yield of soyabean was around 2458 kg/ha. whereas the yield of soyabean under control plot was about 2073 kg/ha.

From the above yield, it was observed that the fertilized plot gave better yield because of the fertilizers application.

### ***Dendrocalamus longispathus + Soyabean.***

The yield of soyabean was comparatively higher in the fertilized plot as compared with the control plot. The mean yield of soyabean under fertilized plot was 2435 kg/ha compared with the control plot 2041.5 kg/ha.

Table 1:- Monthly variation in height (cm) and number of leaves of *Melocanna baccifera* under control plot.

Month and Year	Growth Mean height	Parameters Number of leaves
Sept. 1999	18.5	2.5
Oct	25.45	7.0
Nov	29.75	9.0
Dec	38.5	11.5
Jan. 2000	45.5	14.5
Feb	51.25	16.0
March	60.7	17.5
April	71.35	20.5
May	76.4	21.0
Jun	90.15	27.0
Jul	106.2	33.5
Aug	123.05	42.0
C.D. at 5%	8.98	4.02
S.E. $\pm$	3.22	1.44

**ANOVA TABLE  
(Height)**

S.V	Df	SS	MSS	F ratio	F value at 5%
Block	1	160.17	160.17	15.4	
Month	11	23947.19	2177.01	209.33***	2.79
Error	11	114.46	10.40		
Total	23				

\*\*\* Significant.

**ANOVA TABLE**  
**(Leaves)**

<b>S.V.</b>	<b>Df</b>	<b>SS</b>	<b>MSS</b>	<b>F.Ratio</b>	<b>F Value at 5%</b>
<b>Block</b>	<b>1</b>	<b>4.167</b>	<b>4.167</b>	<b>2.01</b>	
<b>Month</b>	<b>11</b>	<b>2821.00</b>	<b>256.45</b>	<b>123.89***</b>	<b>2.79</b>
<b>Error</b>	<b>11</b>	<b>22.83</b>	<b>2.07</b>		
<b>Total</b>	<b>23</b>				

**\*\*\*Significant**

Table 2 :- Monthly variation in height (cm) and number of leaves of *Melocanna baccifera* under fertilized plot with a spacing of 2X2m.

Month and Year	Growth Mean height	Parameters Number of leaves
Sept. 1999	15.45	2.5
Oct	24.1	5.5
Nov	33.1	5.5
Dec	43.65	7.5
Jan. 2000	51.35	13.0
Feb	64.55	17.5
Mar	74.3	23.0
Apr.	82.55	27.0
May	88.9	31.0
Jun	104.85	42.5
Jul	119.45	50.5
Aug	128.45	59.0
C.D. at 5%	14.56	58.45
S.E. $\pm$	5.22	20.95

**ANOVA TABLE  
(Height)**

SV	Df	SS	MSS	F ratio	F value at 5%
Block	1	170.67	170.67	6.26	
Month	11	30221.95	2747.45	100.86***	2.79
Error	11	299.69	27.24		
Total	23				

\*\*\* Significant.

**ANOVA TABLE**  
**(Leaves)**

<b>S.V.</b>	<b>Df</b>	<b>SS</b>	<b>MSS</b>	<b>F.Ratio</b>	<b>F Value at 5%</b>
<b>Block</b>	<b>1</b>	<b>117.04</b>	<b>117.04</b>	<b>0.267</b>	
<b>Month</b>	<b>11</b>	<b>7819.46</b>	<b>710.86</b>	<b>1.62NS</b>	<b>2.79</b>
<b>Error</b>	<b>11</b>	<b>4876.46</b>	<b>438.76</b>		
<b>Total</b>	<b>23</b>				

**NS = Non Significant**

Table 3 :- Monthly variation in height (cm) and number of leaves of *Melocanna baccifera* under fertilized plot with a spacing of 3X3m.

Month and year	Growth Parameters	
	Mean height	Number of leaves
Sept. 1999	19.75	1.5
Oct	27.35	3.5
Nov	34.5	5.5
Dec	40.7	9.0
Jan. 2000	50.8	11.5
Feb	62.7	15.0
Mar	71.8	17.0
Apr	80.7	19.0
May	98.05	22.5
Jun	118.05	29.5
Jul	135.2	35.5
Aug	149.6	42.5
C.D. at 5%	10.52	3.15
S.E. $\pm$	3.77	1.13

**ANOVATABLE**  
(Height)

SV	Df	SS	MSS	Fratio	F value at 5%
Block	1	83.63	83.63	5.88	
Month	11	40967.14	3724.28	261.9 ***	2.79
Error	11	156.47	14.22		
Total	23				

\*\*\* Significant.

**ANOVA TABLE**  
**(Leaves)**

<b>S.V.</b>	<b>Df</b>	<b>SS</b>	<b>MSS</b>	<b>F.Ratio</b>	<b>F Value at 5%</b>
<b>Block</b>	<b>1</b>	<b>6.00</b>	<b>6.00</b>	<b>4.72</b>	
<b>Month</b>	<b>11</b>	<b>3661.33</b>	<b>332.85</b>	<b>262.08***</b>	<b>2.79</b>
<b>Error</b>	<b>11</b>	<b>14.00</b>	<b>1.27</b>		
<b>Total</b>	<b>23</b>				

**\*\*\*Significant**

Table 4 :- Monthly variation in height (cm) and number of leaves of *Dendrocalamus longispathus* under control plot.

Month and year	Growth Parameters	
	Mean height	Number of leaves
Sept. 1999	14.75	1.5
Oct	21.4	3.5
Nov	30.55	6.0
Dec	40.75	8.5
Jan. 2000	48.85	10.0
Feb	56.65	13.5
Mar	65.6	16.0
Apr	76.35	19.0
May	89.75	20.5
Jun	104.75	24.5
Jul	125.75	29.0
Aug	153.45	32.0
C.D. at 5%	15.73	1.84
S.E. $\pm$	5.64	0.66

**ANOVA TABLE**  
(Height)

SV	Df	SS	MSS	F ratio	F value at 5%
Block	1	11.62	11.62	0.36	
Month	11	40340.06	3667.27	115.28***	2.79
Error	11	349.92	31.81		
Total	23				

\*\*\* Significant.

**ANOVA TABLE**  
**(Leaves)**

<b>S.V.</b>	<b>Df</b>	<b>SS</b>	<b>MSS</b>	<b>F.Ratio</b>	<b>F Value at 5%</b>
<b>Block</b>	<b>1</b>	<b>28.16</b>	<b>28.16</b>	<b>64.00</b>	
<b>Month</b>	<b>11</b>	<b>2172.33</b>	<b>197.48</b>	<b>448.82***</b>	<b>2.79</b>
<b>Error</b>	<b>11</b>	<b>4.84</b>	<b>0.44</b>		
<b>Total</b>	<b>23</b>				

**\*\*\*Significant**

Table 5:- Monthly variation in height (cm) and number of leaves of *Dendrocalamus longispathus* under fertilized plot with a spacing of 2X2m.

Month and year	Growth Parameters	
	Mean height	Number of leaves
Sept. 1999	16.3	0.5
Oct	25.25	2.5
Nov	31.4	4.5
Dec	45.85	5.5
Jan. 2000	59.65	8.0
Feb	70.05	9.5
Mar	79.3	11.0
Apr	87.35	12.5
May	100.55	15.5
Jun	115.7	21.0
Jul	138.65	27.5
Aug	161.05	35.5
C.D. at 5%	13.87	3.29
S.E. $\pm$	4.97	1.18

**ANOVA TABLE**  
(Height)

SV	Df	SS	MSS	F ratio	F value at 5%
Block	1	244.48	244.48	9.91	
Month	11	45574.38	4143.12	167.94***	2.79
Error	11	271.36	24.67		
Total	23				

\*\*\* Significant.

**ANOVA TABLE  
(Leaves)**

<b>S.V.</b>	<b>Df</b>	<b>SS</b>	<b>MSS</b>	<b>F.Ratio</b>	<b>F Value at 5%</b>
<b>Block</b>	<b>1</b>	<b>1.04</b>	<b>1.04</b>	<b>0.74</b>	
<b>Month</b>	<b>11</b>	<b>2445.46</b>	<b>222.31</b>	<b>15.87***</b>	<b>2.79</b>
<b>Error</b>	<b>11</b>	<b>15.46</b>	<b>1.405</b>		
<b>Total</b>	<b>23</b>				

**\*\*\*Significant**

Table 6:- Monthly variation in height (cm) and number of leaves of *Dendrocalamus longispatus* under fertilized plot with a spacing of 3X3m.

Month and year	Growth Parameters	
	Mean height	Number of leaves
Sept. 1999	17.25	2.5
Oct	25.25	4.5
Nov	37.35	6.5
Dec	47.6	7.5
Jan. 2000	56.25	9.5
Feb	66.15	11.5
Mar	75.0	13.5
Apr	82.3	16.0
May	91.45	18.0
Jun	112.55	23.0
Jul	137.9	26.0
Aug	161.45	33.5
C.D. at 5%	10.41	3.35
S.E. $\pm$	3.73	1.2

**ANOVA TABLE**  
(Height)

SV	Df	SS	MSS	Fratio	F value at 5%
Block	1	51.04	51.04	3.67	
Month	11	43126.02	3920.59	281.45***	2.79
Error	11	153.22	13.93		
Total	23				

\*\*\* Significant.

**ANOVA TABLE**  
**(Leaves)**

<b>S.V.</b>	<b>Df</b>	<b>SS</b>	<b>MSS</b>	<b>F.Ratio</b>	<b>F Value at 5%</b>
<b>Block</b>	<b>1</b>	<b>4.16</b>	<b>4.16</b>	<b>2.89</b>	
<b>Month</b>	<b>11</b>	<b>1943.33</b>	<b>176.67</b>	<b>122.68***</b>	<b>2.79</b>
<b>Error</b>	<b>11</b>	<b>15.84</b>	<b>1.44</b>		
<b>Total</b>	<b>23</b>				

**\*\*\*Significant**

Table 7 :- Mean yield of Soyabean under each treatment combination (kg/ha) with *Melocanna baccifera*.

Treatments		Yield (kg/ha)
T <sub>1</sub>	R <sub>1</sub>	2465
	R <sub>2</sub>	2451
	Mean	2458
	S.E	± 3.5
T <sub>2</sub> Control	R <sub>1</sub>	2083
	R <sub>2</sub>	2064
	Mean	2073
	S.E	± 4.75

Table 8 :- Mean yield of soyabean (kg/ha) under each treatment combination with *Dendrocalamus longispathus*.

Treatments		Yield (kg/ha)
T <sub>1</sub>	R <sub>1</sub>	2430
	R <sub>2</sub>	2440
	Mean	2435
	S.E	± 2.5
T <sub>2</sub> Control	R <sub>1</sub>	2052
	R <sub>2</sub>	2031
	Mean	2041.5
	S.E	± 5.25

## **DISCUSSION**

## **GROWTH BEHAVIOUR OF MELOCANNA BACCIFERA.**

The climate and soil of the study site plays a very significant role in the growth of *Melocanna baccifera*. Growth varies from month to month. The rate of growth in the initial period was moderate due to the late monsoon rain. Growth was slowing down rapidly from the month of November 1999 upto March 2000. From the month of May 2000 onwards, monsoon rains arrived, growth rate was speeded up. The rainfall increases the soil moisture content which will enhanced the growth of the bamboo (Table-1).

## **GROWTH BEHAVIOUR OF MELOCANNA BACCIFERA UNDER FERTILIZED PLOT.**

Faster growth rate has been found in the fertilized plot in comparison with the unfertilized plot. This may be due to the effect of fertilizer. Fertilizers (NPK) enhanced the growth rate of the bamboo. The application of nitrogen and phosphorus fertilizers enhanced the growth performance as well as dry matter yield of *Sesbania sesban* (Kanyana et al., 1990). N,P and manure greatly influenced the initial growth of poplars (Gangoo et al., 1990).

## **GROWTH BEHAVIOUR OF DENDROCALAMUS LONGISPATHUS.**

The growth pattern of *Dendrocalamus longispathus* depends upon the prevailing climatic condition as well as soil conditions. In the first two months faster rate of growth have been experienced (October and November 1999) due to late rainfall. From the month of December 1999 upto May 2000 slower growth rate have been experienced. With the advent of Monsoon rain, growth rate fasten up from the month of May 2000 upto August 2000. Slowing down of growth rate during December 1999 to May 2000 can be attributed to long spell of dry period.

## **GROWTH BEHAVIOUR OF DENDROCALAMUS LONGISPATHUS UNDER FERTILIZED PLOT.**

Climate and soil plays a very crucial role in the successful growth of *Dendrocalamus longispathus*. Faster growth rate have been experienced in the first few months. Growth rate was slightly came down during January - May 2000 because of dry season. After monsoon, growth rate was increased as the plants received its moisture requirements. In comparison to control plot, fertilized plots do have better growth rate.

# **CONCLUSION**

From our investigation, it has been found out that the intercropping of soyabean with bamboos gives better result in comparison to pure bamboo forests. The growth rate of *Melocanna baccifera* and *Dendrocalamus strictus* were significant. The application of fertilizers (NPK) also have a significant effect on the growth of the bamboo species. The growth in height, increased in the number of leaves were significant in comparison to the pure bamboo plantations. Supplementation of fertilizers also increased the yield of soyabean as compared with the yield under the control plots.

*Melocanna baccifera* and *Dendrocalamus longispathus* are two of the most important and revenue earning bamboo species of Mizoram ( Lalramnghinglova, J.H. 1997 ). They have a potential to meet the requirements of the people. Because of Jhum Cultivation, bamboo forests have been depleted. Besides its importance for meeting the requirements of the people, these bamboo species are also used for reclamation of degraded lands ( Srivastava et al., 1986 ). Therefore, it is necessary to introduced these two bamboo species for Agroforestry System and Social Forestry plantation to meet the ever increasing demand of the people.

With limited time, our investigation did not gives all the important aspects of these species. Further studies are required for getting the details in growth behaviour as well as various aspects such as, the nutrient requirements, crop-management, biomass production, etc. to draw a suitable conclusion and for the recommendation of these species for sustainable crop yield in the Agroforestry System of Mizoram.

# **SUMMARY**

The study of bamboo-crop interaction was carried out at Zemabawk, about 6 km. East of Aizawl, the capital city of Mizoram. The study was conducted from August 1999 to August 2000. The study site was about 1100 m above sea-level and the climate is hot and humid during summer and cool and cold and dry in the winter. The area of the study site was about 288 sq.m.. The experiment was laid out following the Randomized Block Design (RBD) with two replicates. Each replicates have 8 different sub-plots. The size of each Sub-plot was 18 sq.m. (6X3m). Two different spacings was used for the bamboos i.e. 2X2m and 3X3m. and only one spacing for Soyabean i.e. 25X25cm.

Various growth attributes such as height, number of leaves etc. were recorded at monthly interval and the yield of soyabean at the harvest. The data obtained were subjected to ANOVA (Analysis of Variance) to see the effect of the month on the growth behaviour of bamboo on a particular treatment. The yield of soyabean was also subjected to ANOVA to see the effect of fertilizers on its yield.

The important findings of the present investigations were as follows -

- (1) Growth behaviour of bamboos were significantly varied over a month.
- (2) Growth behaviour of bamboos differ during the study period. *Melocanna baccifera* shows a height of 149.6 cm as the highest and 118.8 cm as the lowest height. *Dendrocalamus longispathus* reached 161.45 cm. as the highest height and 153.45cm. as the lowest height.
- (3) Growth rate differs between the bamboos, faster growth rate have been found under fertilized plot and slower growth rate under control plot.
- (4) Fertilizers (NPK) have significantly increased the growth rate.
- (5) Mean yield (kg/ha) of soyabean differs under the two bamboo species. *Melocanna baccifera* gives better yield of soyabean as compared with *Dendrocalamus longispathus*.
- (6) Yield of soyabean was higher under fertilized plot as compared with the control plot.

The result of the investigation shows that combination of bamboos with soyabean gives better result in comparison with control plot. Soyabean enriches the soil (being a nitrogen fixers). Due to the short study period clear conclusion cannot be drawn as which species combination was suitable. Further studies are necessary to have a best combination.

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