STUDIES ON VEGETATIVE GROWTH, FLOWERING AND FRUITING PATTERN OF SAPOTA (*Manilkara achras)* (Mill.) (Forsberg)

By
R. PHANI CHAKRAVARTHY
B. Sc. (HORTICULTURE)

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CERTIFICATE

Mr. R. PHANI CHAKRAVARTHY has satisfactorily prosecuted the course of research and that the thesis entitled **"STUDIES ON VEGETATIVE GROWTH, FLOWERING AND FRUITING PATTERN OF SAPOTA (*Manikara achras*) (Mill.) (Forsberg)"** submitted, is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that he thereof has not previously submitted the thesis or part for a degree of any University.

Date :
Place : Hyderabad

(Dr. Y. N. REDDY)
Major Advisor

CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON VEGETATIVE GROWTH, FLOWERING AND FRUITING PATTERN OF SAPOTA (*Manikara achras*) (Mill.) (Forsberg)"** submitted in partial fulfilment of the requirements for the degree of "**MASTER OF SCIENCE IN HORTICULTURE"** for Acharya N.G. Ranga Agricultural University, Hyderabad, is a record of the bonafide research work carried out by **Mr. R. PHANI CHAKRAVARTHY** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma. The published part has been fully acknowledged. All assistance and help received during the course of the investigation have been duly acknowledged by the author of the thesis.

(Dr. Y. N. REDDY)
Chairman of the Advisory Committee

Thesis approved by the Student's Advisory Committee.

Chairman : **(Dr. Y. N. REDDY)** _____
Professor & Univ. Head (Horticulture)
Department of Horticulture,
College of Agriculture, Rajendranagar,
Hyderabad-500 030.

Member : **(Dr. D. SRI HARI)** _____
Associate Professor
Department of Horticulture,
College of Agriculture, Rajendranagar,
Hyderabad-500 030.

Member : **(Dr. T. Y. MADHULETY)** _____
Professor and Head
Depart of Plant Physiology,
College of Agriculture, Rajendranagar,
Hyderabad-500 030.

DECLARATION

I, **Mr. R. PHANI CHAKRAVARTHY** here by declare that the thesis entitled **"STUDIES ON VEGETATIVE GROWTH, FLOWERING AND FRUITING PATTERN OF SAPOTA (*Manikara achras*) (Mill.) (Forsberg)"** submitted to Acharya N.G.Ranga Agricultural University for the Degree of **MASTER OF SCIENCE IN HORTICULTURE** is a result of original research work done by me. It is further declared that the thesis or any part there of has not been published earlier in any manner.

Date :

(R. PHANI CHAKRAVARTHY)

Place : Hyderabad

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Author : **R. PHANI CHAKRAVARTHY**

Title of the thesis : **"STUDIES ON VEGETATIVE GROWTH, FLOWERING AND FRUITING PATTERN OF SAPOTA (*Manikara achras*) (Mill.) (Forsberg)"**

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Faculty : **AGRICULTURE**

Department : **HORTICULTURE**

Major Advisor : **Dr. Y. N. REDDY**
Professor & Univ. Head (Horticulture)
Department of Horticulture,
College of Agriculture, Rajendranagar,
Hyderabad-500 030.

University : **ACHARYA N.G.RANGA AGRICULTURAL UNIVERSITY**

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ABSTRACT

The present investigations were aimed at to understand the process of branching, flowering and fruiting pattern in Sapota. Attempts were made to correlate the architecture of Sapota to that of Aubreville (1964) model, which described the ecological significance of the model. These Studies were aimed at understanding the branching pattern, flowering and to identify the branching up to which maximum flowering and productivity occurs. These experiments were carried out in Agricultural Research Institute, Rajendranagar, Hyderabad during August 2003 to November 2004.

In these Studies it was revealed that in Sapota in all the five varieties studied, observed more or less same trend of branching with more mean

number of branches produced at lower orders and decreasing number of branches at higher order levels.

Branch bifurcation ratios are found to be more for shorter branches of branch extension in all the varieties indicating that with increase in the length of the branch the number of branches produced at lower orders decrease with lower branch bifurcation ratios.

Maximum attributes of flowering and fruit set was observed in the terminal branch orders, to specify, up to N-4 level in all the varieties, in all the strata of the tree canopy regardless of range of extension.

The branch growth extension in relation to number of branches produced at 6^{th} order revealed that if more number of branches were produced at 6^{th} order the branch extension would be less. In other words with increase in branch extension the number of branches produced at 6^{th} order will be less.

Possibility of pruning is suggested by above studies by containing the branch growth and inducing the more new growth at subtended orders since most of the flowering was confined to terminal portions *i.e.* up to N-4 level.

LIST OF ABBREVIATIONS

%	:	Per cent
A.V.	:	Actual value
CD	:	Critical difference
cm	:	Centimeter
Cv	:	Cultivar
et al.	:	and Co-workers
F	:	Degree Farhen heat
g	:	Gram
HCl	:	Hydrochloric acid
HPO_3	:	Metaphosphoric acid
HWD	:	Hot water dip
i.e.	:	that is
kGy	:	KiloGray
m	:	Meter
mg	:	milligram
ml	:	milliliter
^oC	:	Degree centigrade
PLW	:	Physiological loss in weight
ppm	:	Parts per million
RH	:	Relative humidity
S. I.	:	Sustainable Index
S.Em $\pm$	:	Standard error of mean
TSS	:	Total soluble solids

CHAPTER I

INTRODUCTION

Sapota (*Manilkara achras*) (Mill.) Forsberg) (Syn. *Achras sapota* L., *Manilkara zapotilla* Jacq. Gilly) or chiku, is a hardy tree of tropics adaptable to wide variations in soil and climatic conditions. It is presently cultivated commercially in India, Phillipines, Sri Lanka, Malaysia, British Handuras, Guatamala, Mexico and West Indies (Indian Agriculture, 2003).

In India, it is produced in an area of 0.7 lakh hectares with 9.0 lakh MT output. Its productivity on an average is estimated to be 12.8 MT/ha. It flourishes both in heavy rainfall region of Western and Southern India as well as drier regions of peninsular India such as Karnataka, Gujarat, Andhra Pradesh, Orissa, West Bengal, Maharashtra, Tamil Nadu etc.

In Andhra Pradesh, Sapota is grown in an area of 4800 hectares with 0.57 lakh MT output and productivity is 12 MT/ha (Indian Agriculture, 2003).

In India, sapota is cultivated mainly for its delicious fruit for table purpose. But, in other countries it is cultivated for its chickle the “gutta parcha” which is used as base material for chewing gum. It is becoming an important adjunct in ice creams and milk shake in its fresh form. Fruit can also be used for preparing liquor and alcohol because of its richness in sugar. There is plenty scope for “sapota fig”. Recently sapota is used in making chiku halwa, shrikand, industrial glucose, and pectin, the other tested sapota products are canned pulp or slices, jam, jelly, fruit bar or leather, ready to serve beverages.

Popularity of this fruit is on increase due to high production per unit area, liking to Indian palate, continuous flowering and fruiting throughout the year and very little incidence of pest and diseases. Besides it is mite hardy and can tolerate salinity and water stress to a very great extent.

Botanically sapota is a medium sized spreading evergreen tree with milky sap grows to a height of 20 m, tender parts rusty hairy, bark brown to blackish brown rough, longitudinally fissured, stem short, branching from lower part forming umbrella shaped crown, leaves elliptic oblong or oblong lanceolate, leathery, pale green beneath. Shining dark green glabrous above, 5 – 15 x 0.5 x 6 cm flowering occurs throughout the year in tropics (April – October, May – June).

Flowers dull white axillary, solitary, small but 1 cm in diameter, calyx – sepal 6, 3 larger than others in two whorls tomentose, free, corolla imbricate, stamens 6, opposite to corolla lobes, alternating with petaloid staminodes, ovary superior, 10-12 celled, style bifid, fruit is berry globose or egg shaped, 5-10 cm in diameter.

Even though the crop is commercially important studies related to growth habit, branching pattern and their relation to flowering and productivity have not been done. Branching pattern in sapotaceae family was reported by Aubreville (1964). He reported that is sapotaceae “The architecture is determined by a monopodial trunk with rhythmic growth and spiral or decussate phyllotaxis, bearing whorled branch tiers with similar phyllotaxis.

Branches grow rhythmatically but are modular. Each branch is plagiotropic by apposition. Since inflorescences are lateral the modules grow indefinitely".

The plagiotropic branches are sympodial by apposition growth, there terminal meristems are evicted periodically by a lateral sylleptic branch, become erect, and effectively function as short shoots grow rhythamatically like the monopodial main trunk, as is often evident in the distribution of leaf scars. The biological aspect of this seemingly trifling growth feature is very important since each branch tier consists of a series of leafy rosettes distributed throughout the complex and not restricted more or less to periphery.

Similar studies were carried out on Ber (Ravikumar 1992) Pomegranate (Reddy 1990), Aonla (Raviprakash 2001) gave deep insight into plant physiology and ecology and helped understanding basic tree structure, flowering habit and their correlations.

Further, canopy management, which is of utmost importance in today's intensive cultivation, was overlooked for many years now in sapota, which has tremendous scope in high density planting.

Keeping in view the above lacunae it was felt necessary to carry out an extensive, holistic study of branching pattern, flowering habit, fruit set and correlations between them. The approach in the current study is mainly to identify new areas, which would be of great benefit in understanding and perhaps improving the plant productivity in sapota. The investigation to understand the vegetative growth, flowering and fruiting pattern of different

cultivars in sapota. Therefore, the present investigation was undertaken with the following objectives.

Objectives

1) To understand the branching pattern in different varieties of sapota.

2) To understand the bearing habits *i.e.*, to study the flowering pattern on current and old shoots in different varieties of sapota.

3) To identify the branching order up to which maximum flowering and productivity occurs.

4) To study and to understand the fruit set in relation to age of the shoots in different varieties of sapota.

CHAPTER II

REVIEW OF LITERATURE

Trees as multi cellular organisms are highly integrated in which one structure are related to another and the structure is related to function. Trees grow by adding relatively few structural elements – branches, buds, leaves and roots – to the existing organs over prolonged periods and many correlations exist between these structures. From an organizational and functional point of view, trees must be considered as much more than an aggregate of twigs and branches attached to a common axis.

In an attempt to understand the branching pattern, flowering and fruiting pattern of Sapota, the literature on branching, apical dominance bud dormancy, flowering habit and fruit set have been reviewed. Since, the work on Sapota on the above aspects is scarce, a review of literature available on other plants and partly information on Sapota is presented here.

2.1 STUDIES ON BRANCHING PATTERN

The single apical shoot meristem of the seedling may give rise to a tree in four ways (Halle, Oldemann and Tomilinson (1978).

1. By its continued activity alone;
2. By multiplication to produce further meristems all of equal potential and therefore, not differentiated into trunk and branch;

3. By multiplication to produce further meristems of unequal potential, some meristems giving rise to branches, and one or more giving rise to branches and one or more giving rise to the trunk.

4. By multiplications to produce further meristems of equal but mixed potential *i.e.,* each meristem giving rise first to a trunk segment, then to a branch segment, or even the inverse in certain examples. (Halle, Oldemann and Tomilinson (1978).

Tomlinson (1978), elaborated these modules in that trees built by one meristem is the simplest condition the seedling meristem is the only aerial meristems active through out the life of the tree. Since it produces a single axis, which remains unbranched in the vegetative phase

The trees with modular construction, the seedling meristem proliferates by sympodial branching (rarely by true dichotomy, *i.e.,* equal division of the shoot apex) with the new meristems repeating the construction of the parent meristems precisely in a morphologically quantitative sense.

2.2 SYLLEPTIC AND PROLEPTIC BRANCHES

Halle *et al.* (1978) redefined that the syllepsis in the continuous development of a lateral from a terminal meristem to establish a lateral from a terminal meristem without a evident intervening period of rest of the lateral meristem and prolepsis in the discontinuous developed of a lateral from a terminal meristem to establish a branch with same intervening period of rest of the lateral meristems Wheat (1980 and 1981) has extensively investigated the

sylleptic branching in *Myrisine floridana* and Rhizophora mangle of tropical origin.

Reddy (1983a), Ravi Prakash Rao (2001) noticed the presence of 'Sylleptic branching' in dry land fruits like Ber, Anola which, are responsible for maximization of yield. Reddy (1990) reported the similar branches in pomegranate. Reddy (1983a) and Ravi Kumar (1992) reported the same branches (sylleptic branches) in Ber and the similar branching was recognized by Kurian and Reddy (1999) in Ber.

In trees with trunk branch differentiation category meristems of the tree are no longer equivalent, since their differentiation leads to a distinction between trunk and branch. Thus trunk and branch are fundamental organizational features of the tree. The trunk has the principal architectural role, it determines the overall stature of the tree, is the control system of communication between roots and growth.

While trees with changes in orientation of axis recognizes with trees with meristems which give rise to axis which may be recognized as 'mixed' since the same meristem contributes a trunk and a branch portion to the construction. This is possible because the geometric and physiological orientation of the axis changes during the activity of its meristem.

Further in their historic book "Tropical Trees and Forests" Halle *et al.* (1978) categorized sapota branching under Aubreville's model. The model is named after Andre Aubreville since he drew attention to it as being particularly common in the sapotaceae (Aubreville, 1964).

According to Halle *et al.* (1978). A monopodial trunk with rhythmic growth and spiral or decussate phyllotaxis, bearing whorled branch tiers with similar phyllotaxis, determines the architecture. Branches grow rhythmically but are modular, each branch plagiotrophic by apposition. Since inflorescences are lateral the modules grow indefinitely.

According to Aubreville (1964), the branch modules, which are indeterminate since they do not produce a terminal inflorescence. However, because the plagiotrophic branches are sympodial by apposition growth, these terminal meristems are evicted periodically by a lateral sylleptic branch which become erect and effectively function as short shoots grow rhythmatically like the monopodial main trunk, as is often evident in the distribution of leaf scars. The biological aspect of this seemingly trifling growth feature is very important since each branch tier consists of a series of leaf rosettes distributed throughout the complex and not restricted more or less to the periphery.

A lucid impression of this plagiotropic branching system is given by Corner (1952). A tier can be likened to a dense mat of foliage composed of rosettes of leaves set closely together the same level on the upturned ends of slow growing twigs which are produced in a particular order to fill the spaces that repeatedly arise at the out growing edge of the mat.

The genus Terminalia is a large widely distributed and commercially important one since it includes several tall forest timber trees representing Aubreville's model.

The seedling axis is orthotrophic and grows rhymically, each flush separated by a series of close-set leaf scars. Eventually a pattern of monopodial branching is initiated. Intimately related to this rhythm phyllotaxis is spiral and a series of four to eight sylleptic shoots from the axis of the upper most congested leaves of each flush produces a pseudo whorled branch tier (Halle, Oldeman, Tomilinson (1978).

Consequently branches are developed towards the end of a cycle of extension. Separation of the successive branch tiers is achieved by the long internodes, which occur in early stages of each trunk axis flush.

Each branch complex consists of short modules 40 – 50 cm long each consists of a basal 'hypopodium' or first internode, which is more or less horizontal in orientation. Distally the spiral of leaves is produced with progressively shorter internodes and at the same time the orientation of the apical meristem becomes erect.

By syllepsis one or two lateral branches develop from the axils of the leaves (usually third, fifth) on the lower side of the shoot at the level where the axis is bent upward. These branches in turn produce an initial long hypopodium and the process is repeated.

Since the reorientated terminal meristern continues its rhythmic growth with short internodes with lateral inflorescences the result is a long-lived erect short shoot new rosettes are added as the tier expands laterally and the result in the flat branch complex, which characterizes this model.

The sapotaceae, according to Halle (1979) provide many examples among large forest trees. Reorientation of lower branch complexes is well shown in early stages of development when the architecture is precisely expressed.

Reddy (1990) reported sylleptic branching pattern in pomegranate, His study revealed that the vigorous shoots had 26.33 cm length, 11.29 nodes and 7.43 first order sylleptic branches. Sylleptic branches produced at successive nodes are at right angles to each other. The normal shoots and spur type shoots were completely devoid of any sylleptic branches.

Number of sylleptic branches produced on vigourous shoot were 9.26, 7.68, 7.56, 6.74 and 5.90 respectively in P-13, Kandhari, Bassein Seedless, Alandi and Ganesh. These results clearly indicated that P-13 had a tendency to produce more number of sylleptic branches followed by Kandhari and Bassein Seedless. Percentage of nodes on the main axis having two sylleptic branches per node, produced in opposite directions, varied from 19.13 to 32.95 per cent with a mean of 23.87 per cent and one sylleptic branch per node was produced on an average in 19.06 per cent of nodes.

In pomegranate the shoots produced the first sylleptic branch mostly at 3rd node (42.09%) or 4th node (25.01%) however, the sylleptic branch production at 2nd node, 5th node and 6th and above nodes was 7.99 per cent 14.81 per cent and 10.09 per cent respectively. These figures depict the mean of five varieties studied. Percentage of nodes on main axis with sylleptic branches produced at every node varied from 23.21 percent to 39.87 percent

with a mean 30.39 per cent. This percentage for two, three, four and five or more internodes interval was 3.64 per cent, 3.89 per cent, 2.47 per cent and 2.23 percent respectively.

Further, Reddy (1983a) found that sylleptic branching up to third order could occur on the new growth of zizyphus plants and that the branching pattern was distinct for each species. In *Z. mauritiana* the shoots produced the first sylleptic branch from 6^{th} to 9^{th} node as the main axis and the subsequent branches at a regular interval of three internodes (94.17%) whereas the second order branching started from third node of the first order branches (84.86%) or on 6^{th} node (10.55%) and subsequently at a regular interval of three internodes (94.59%).

The pattern of third order branching was similar to that of second order branching in *Z. oenoplia* shoots, the first sylleptic branch appeared from one to three nodes on main axis and subsequently branches appeared at every node. The second order branching mostly started from the 6^{th} (or) 9^{th} node and then appeared at three internodes interval. Kurian (1985) also studied extensively the characteristic branching habits of two *zizyphus* species.

Ravi Prakash Rao (2001) documented two kinds of shoots in Anola. The indeterminate shoot type is similar to long shoots and determinate branches to short shoots. Branch polymorphism with three kinds of shoots has been recorded in *Zizyphus mauritiana* by Kurian (1985). He observed that the vigorous shoots (long) contributed to about 98 per cent of the yield and normal shoots to two per cent as any pruned axis in Ber. The same phenomenon of

branch polymorphism has been recorded in pomegranate by Reddy (1990). He observed that the variety Ganesh produced more number of vigorous shoots per shoot and Ganesh was identified to be better suited for drought situations as it had strong potential to produce denser canopy and rapid morphogenetic adjustments to tide over drought.

Differentiation of the shoot systems within one tree into long shoots and short shoots produces a useful division of labour (Brown, 1971).

The long shoots produce growth in height and their proliferation adds to the overall framework of the tree. Long shoots are defined as 'branches that elongate more than two cm per year and normally bear lateral branches if more than one year old.

The study on sylleptic branching patterns in Aonola revealed that the all determinate branches produced an current season in determinate shoots can be regarded as a sylleptic branches since the sylleptic branch is synchronous in its development with its parent axis of vigorous branches.

Determinate branches produced a six months or one-year-old indeterminate shots (Previous seasons growth) after the abscission of determinate branches (shedding) can be considered as proleptic branch. This is, may be due to resting buds which might have been present in the indeterminate branches which get activated after shedding of determinate branches (Raviprakash Rao, 2001).

Bruguiera.sexanga a member of sapotaceae family, a viviparous seedling, produces an axis, which results in a regularly branched tree reaching a height of 30 m; phyllotaxis is bijugate. The tree develops tiers of branches about 40 cm apart, as a result of rhythmic growth of the terminal bud. In the resting stage this bud is enveloped by the stipules of the youngest pair of exposed leaves, as it characteristic of all rhizophoraceous mangroves and no bud-scales are produced. During subsequent shoot extension a tier of two to four branches is produced by syllepsis. Growth of plagiotropic branch modules is rhythmic and sympodial by apposition; the evicted terminal short shoot produces lateral flowers. Bruguiera betrays its habitat in its basal stilt roots and its pneumatophores which develop by the periodic upward arching of plagiotropic roots close to growth and development of the epicotyl axis of Manilkara Sapota seedlings from germination to bud development was characterized on orthotropic, monopodic and continuous. The juvenile phase lasted for about 18-24 months. Branching started after nine months and was greatest between 14 and 15 months. (Meza and Bautista, 1999).

The grafting, growth and branching of the main axis of Sapodilla (*Manilkara zapota*) were studied in the cultivars Santiago and Delfina. The trial was carried out in the experimental field of the graduate school of Horticulture, in Tanabana, Lara State (100 01'N, 500 MS L) Venezuela.

The rootstocks were sown plants and the scion consisted of a small terminal piece, in which the apical bud remained in a state of rest. The healing of the grafted union was 100 per cent in the two cultivars after 35 days. The

growth of the main axis of Delfina was longer (40 to 50 cm) than the Santiago, which reached about 20 to 25 cm. The number of leaves was similar in both cultivars, while the number of branches was significantly higher in the Santiago (3.9) than Delfina (2.9). The lateral shoots in Delfina were located mainly at the intermediate third of the axis, while in Santiago; they were located at the terminal third of the axis. The branching type observed in both cultivars is frequent in tropical plants. The vegetative characteristics of Santiago would allow the creation of orchards with smaller plants than delfina.(Mezajn and Bantista, 2002).

2.3 STUDIES ON APICAL DOMINANCE IN WOODY PLANTS

The differential elongation of buds and branches determines the form of wooly plants, and the expression of a particular growth habit is usually associated with the phenomenon of apical dominance.

However it seems that the form of woody perennials cannot be interpreted by the mere translation of Thimman and Skoog (1933, 1934) concept that apical dominance is directly mediated through the inhibiting action of polarity transported auxin from the shoot apex as in *Vicia faba*. Many workers have expressed conflicting views regarding the applicability of direct auxin theory to explain the mechanism of apical dominence in higher plants.

Went (1936, 1939) and Van Over beek (1938) suggested that the inhibitory action of auxin was an indirect one in that the organic nutrients, food and other growth factors were diverted or translocated to terminal regions, high in auxin concentration and growth activity.

Brown *et al.,* (1967) observed that in young vigorous trees, many lateral buds at the base of the current year's shoot were released from inhibition. But in most cases they never quite gained dominance over the terminal leader. In older, slower growing trees as vigorous decreased concomitant with problems of mobilization and long-range transport. The current year's lateral buds remained inhibited so that the following spring the upper most lateral buds elongated and in competition with the terminal they eventually suppressed it. They pointed out that the interpretations of form in woody plants on the basis of strong or weak apical dominance was incorrect and suggested the use of the term "apical control" to describe the physiological condition governing different types of branching. Accordingly, excurrent habit of growth could be explained in terms of strong apical control made possible by the initial expression of weak apical dominance, so that the terminal leader always maintained complete control over the particularly suppressed branches below. On the contrary, decurrent and deliquescent trees lost apical control very early in life. Primarily because of their inherent tendency to express strong apical dominance along the currently elongating main leader.

The large well formed uppermost lateral buds on the current year's shoot after undergoing a period of summer rest or winter dormancy could successfully compete with the terminal bud during period of extensions growth leading to loss of apical control.

2.4 STUDIES ON FLOWERING AND FRUIT SET PATTERN

A study was carried out on 13-year old sapota (Sapodilla) cv. Kalipatti trees during 1982-83 (Relekar *et al.,* 1991). The effects of hand pollinations, self-pollination and open pollination on fruit set, and the timing of fruit set and fruit drop in open. Pollinated trees were investigated. Highest percentage fruit set (28%) was obtained with open pollination highest mean percentage fruit set (22.7%) occurred in February. The major fruit drop occurred in the first five weeks after fruit set (18 Feb – 10 Mar 1983) and was highest (27.49%) during the first week after fruit set. Of the total 171 fruits set on 150 shoots (17.59%) fruitset), only 9.36 per cent were retained to maturity. Average annual yield/tree was 80.92 kg. (Relekar *et al.,* 1991).

Two distinct peak flowering periods were observed in studies at Bhubaneswar in 1993-94 on five *Manilkara achra* (*M. zapota*) cultivars (Feb-Apr and Oct-Nov). The crop requires 55.3 – 60 days from flower bud initiation to anthesis. The percentage of flower buds, which developed into flowers, ranged from 50.00 in Cricketball to 72.72 in Kalipatti. The peak period of anthesis was at 04.00 and continued upto 08.00 Fruit weight was greatest in cv. CO-2 (Len ka *et al,* 1996).

Further, flowering and fruit set characteristics were examined in the popular commercial cultivar Magana, in an effort to elucidate the reproductive phenology of mamey sapote (Pouteria Sapota). Flowers opened during the night with anthesis beginning around Sunset. The duration of flower opening varied according to season, ranging from six days in winter to a single day in

summer. Of new flowers generally appeared in cycles of about seven days in declining numbers of flowers per burst until all the floral buds of a particular floral bud flush had flowered. Floral buds flowered randomly around the branch was a factor in fruit set. Flowers and small fruit lets encircled horizontal branches in great numbers, but immature fruits most often developed from flowers located on the upper branch quadrant.

The lower quadrant contained the fewest immature fruits. As fruits however, more upper quadrant fruits abscised these observations provide the first reported in depth insights into flowering and fruit set behaviour of mamey sapote (Davenport *et al.,* 2000).

The flowering and fruiting phenologies of five momey sapote, pouteria sapota (Syn. Calocarpum, sapota). Cultivars Tazumal, copan, pantin, Mayapan and magara were observed for one year (Dec' 1994 – Dec' 1995) in Florida, USA.

Floral buds developed in periodic busts beginning in May, June or July and ending in Feb-April the flowering year. The number timing and length of the bud formation period varied greatly among cultivars. Floral bud formation generally occurred proximal to foliage on branches of all cultivars. Floral anthers occurred in only a five buds at any one time with a minimum of one to a maximum of a five-month interval between floral bud formal and subsequent floral anthesis among cultivars.

Tazumal recorded the earliest (five) floral and formation while magana recorded the latest (October), with anthesis of flowers still occurring the

following march. Abscission rates were high resulting in less than one fruit per branch at maturity in all cultivars. (Devenport, Oneal and Ledesma, 2001).

Sapodilla cultivars grown in India were compared for fruit set, flower drop and yield. Cultivars differed significantly for the parameters studied. Highest percentage fruit set was observed in the July – August flush; fruit set was lower in March flush for all the cultivars. Highest fruit drop was noticed in Cricket Ball and lowest flower drop in DHS for all flushes. DHS-1 recorded highest yield per tree (104.97 kg) and Kalipatti recoded the lowest yield per tree (38.64 kg). (Gunaki *et al.,* 1999)

Similar studies on flowering and fruit set in 4 sapodila cultivars (DHS-1, DHS – 2, Kalipatti and Cricketball) were carried out under Dharwad conditions, India, during 1997 – 98 (Patnaik 1982). All cultivars and hybrids exhibited highest flowering during Nov – January flush, followed by July – August flush; the lowest flowering was observed in the M arch flush fruit set in all the cultivars and hybrids was highest during July – August (17.42 – 29.24%) followed by Nov – Jan. (13.2 – 15.1%). Fruit set was highest in DHS –1 followed by DHS-2; fruit set in the remaining cultivars was in the range 11.23 – 20.5 per cent.

CHAPTER III

MATERIALS AND METHODS

The present investigation entitled "Studies on vegetative growth, flowering and fruiting pattern in Sapota (*Manilkara achras*) (Mill.) Forsberg (Syn. *Achras sapota* L., *Manilkara zapotilla* Jacq. Gilly) was conducted at Agricultural Research Station, Rajendranagar, Hyderabad, Andhra Pradesh during November, 2003 to August, 2004. The details are presented under the following heads:

3.1 GEOGRAPHICAL LOCATION OF THE EXPERIMENTAL SITE

Agricultural Research Institute, Rajendranagar is situated at an elevation of 542.3 m above mean sea level on 17.19°N latitude and 78.23°E longtitude.

3.2 WEATHER CONDITIONS

Hyderabad falls under arid-subtropical climate zone with an average rainfall of 914 mm. The months of April to May are the hottest with mean maximum temperature of 36.8°C to 41.4°C. December to January are the coldest with minimum and mean temperature of 8.1°C to 19.4°C, but warm climate prevailed during the most of the year. The relative humidity fluctuated between 50-89 per cent. The meteorological data pertaining to rainfall, maximum and minimum temperatures, relative humidity and hours of sunshine were collected from the meteorological observatory located at Agricultural

Research Institute, Rajendranagar, Hyderabad, during the period of study and are presented in Appendix I.

3.3 SOIL CHARACTERISTICS

The soils of the orchard were a clay loam with a pH of 8.0 having good texture and possessing well drainage. The soils of the farm are black loams with pH of 8.0 and electrical conductivity of 0.45dSm^{-1}. It had 192 kg ha^{-1}, 23.70 kg ha^{-1} and 320.18 kg ha^{-1} respectively the available nitrogen, phosphorus and potassium.

3.4 SALIENT FEATURES OF THE CULTIVARS STUDIED

The Sapota (*Manilkara achras*) (Mill.) Forsberg (Syn. *Achras sapota* L., *Manilkara zapotilla* Jacq. Gilly) is a medium sized spreading evergreen tree grown to a height of 20 m. Stem short, branching from lower part forming umbrella shaped crown. Flowering occurs throughout the year in tropics (April – October, May – June).

3.4.1 Kalipatti

It is grown mainly in Maharashtra, Gujarat, and North Karnataka. It has dark, green, broad and thick leaves and spreading branches. Fruits are oval shaped, less seeded with a sweet, mellow flesh of excellent quality. Fragrance is mild. Each fruit has one to four seeds. Fruits appear singly. The fruits are borne in single, fruit quality high, main picking season winter.

3.4.2 Oval

This is mainly grown in Andhra Pradesh, Tamil Nadu. The fruits are small to medium sized and oval or egg shaped. Pulp is fine grained and very sweet. It is a shy bearing cultivar. It is having erect branching pattern.

3.4.3 Singapore

It is a popular variety in Andhra Pradesh. Tree medium in height, conical in shape, leaves elliptic, lanceolate, slightly folded, entire, acute. Fruits are elliptic small, snuff brown. Flesh is soft, not juicy, gritty, brown in color, aroma slight; flavor slight; tastes mild sweet; seeds are few in number.

3.4.4 Bombai

It is mainly grown in Maharashtra. This variety bears both round and oval fruits of different sizes and is perhaps identical to those grown in Bombay, Bihar and Bengal. It has spreading branching pattern. On the rind four to six ridges are seen, the apex is round; pulp is gold color with a tinge of muskmelon. In taste the fruits are medium sweet. The variety is also grown in some parts of Andhra Pradesh.

3.4.5 Cricket ball

It is also known as Calcutta large. It is grown in Tamilnadu, Karanataka, Maharashtra, West Bengal and Andhra Pradesh. The leaves are light green. This bears the largest sized fruit, which are round in shape. Pulp is gritty and

granular and not very sweet. It is a shy bearer, does well in mild climate and at elevations of 300 m.

3.5 ORDER TERMINOLOGY

The branches were ordered according to the orthodox botanical system. In botanical terms a branch is topographically is order higher than the axis on which it is inserted. Ordinal numbers were used to describe branch orders. Thus, the main axis was considered as zero order, the branches produced as main axis as first order, those produced as first order branch as second orders and those produced as second orders as third orders.

3.6 EXPERIMENTAL DETAILS

3.6.1 Studies on branching pattern in sapota

This investigation was aimed at studying some aspects of branching pattern in five varieties of sapota *viz.,* Kalipatti, Oval, Singapore, Bombai and Cricket Ball.

For this study 16 well grown, adult trees were selected in kalipatti variety. The canopy of the tree was divided into lower, middle and upper strata. The Tree canopy up to two meters height from the ground was selected as lower strata, and 160 branches with ten branches in each tree for all the 16 trees were observed for Kalipatti variety while 40 branches with ten branches each in other four cultivars viz. Oval, Singapore, Bombai and Cricket Ball were observed. two meters to four meters tree canopy was selected as middle strata

and 80 branches with five branches in each tree for all the 16 trees were observed for Kalipatti cultivar while, 20 branches with five branches each in other four cultivars were observed and four meters and above canopy was selected as upper strata and as mentioned above in the lower strata, 160 branches with 10 branches in each tree for all the 16 trees were observed for Kalipatti variety while, 40 branches with 10 branches in each of other four varieties were observed. In each tree as a whole 25 branches were observed in lower, middle and upper strata.

Branch orders for each branch were noted as per orthodox classification and the observations were taken from 6^{th} order onwards till the end of each branch in all the strata. The number of branches produced at each order for all the branches were noted and branch order presence in each order was also noted. Since, there was shedding of plant parts at lower order levels, which may be due to shade, or natural pruning as is common in the temperate trees (Cornell, 1976). The branches at lower order levels were discernable only from 6^{th} order onwards and below the branches contributed to the overall development of the tree *i.e.,* main trunk, scaffold and major limbs. Hence, in all the varieties in any given strata of the tree canopy the branch orders were taken from 6^{th} order onwards.

3.6.2 Observations recorded

3.6.2.1Number of branches at each order

The total number of branches produced at each node was counted carefully from 6^{th} order to the tip of the each branch.

3.6.2.2Branch order presence in each order

Presence of each order at every order level counted carefully from 6^{th} order to the tip of the each branch.

3.6.2.3Overall branching pattern of the variety

The branches of lower, middle and upper strata were pooled and overall branching patterns representing the cultivar were noted.

3.6.2.4Branching intervals of higher order branches on preceeding branch order

Out of selected branches number of branches producing higher order branches at any given level are counted for each strata of the all the five varieties.

3.7 STUDIES ON BRANCH EXTENSION

This investigation was aimed at studying some aspects of branch extension with reference to the number of branch produced at lower nodes to specify at 6^{th} order.

With the division of Strata as lower, middle and upper strata remained same as mentioned in the earlier chapter. This study was carried out only to know the extension of branch, in terms of number of order levels, with respect to the number of branches produced at 6^{th} order.

3.7.1 Observations recorded

3.7.2 Branch extension studies Lower strata

The number of branches, which have extended to higher orders in lower strata, was noted.

3.7.3 Branch extension studies in middle strata

The number of branches, which have extended to higher orders in middle strata, was noted.

3.7.4 Branch extension studies in upper strata

The number of branches, which have extended to higher orders in upper strata, was noted.

3.8 STUDIES ON FLOWERING INTENSITY

This investigation was aimed at studying some aspects of flowering index at various order levels in five varieties studied.

For this purpose, all the branches in the three strata were reckoned as one. And the branches were divided into various ranges depending up on the

branch order level up to, which the branch has extended its growth and the branches, which made higher extension growth, were grouped with three orders in each group/range. Similarly branches which made medium extension growth were grouped with three orders in each group/range .The remaining group consisted of branches which extended to lower levels in other words they are short branches. The number of flowers in each order level in all the group/range starting from tip to base *i.e.*6^{th} order was noted for each of five varieties studied. Further English alphabet 'N' was assigned to the tip of branch, what so ever it's length may be, and subsequent down order levels were given N-1, N-2, etc. till the base order level *i.e.*6^{th} order.

3.9 OBSERVATIONS RECORDED

3.9.1 Number of flowers produced at each order

The number of flowers produced at each order was observed and recorded.

3.9.2 Number of flower bearing units at each order

The number of branches that bore flowers out of total branches that had been produced at that order was noted.

3.9.3 Percentage of flower bearing units (branches)

Percentage of flower bearing branches out of total number of Branches produced was noted.

3.9.4 Studies on fruit set pattern

This investigation was aimed at studying some aspects of fruit set and fruiting intensity in five varieties studied.

As mentioned earlier the order was noted and the number of fruits produced at N^{th} order level to downwards was observed.

3.9.5 Observations Recorded

3.9.5.1 Total number of fruit set

The number of fruits that are set in each order was noted.

3.9.5.2 Percentage of fruit set

Percentage of fruits that are set out of total number of flowers was noted.

3.10 BRANCH BIFURCATION RATIOS

Branch bifurcation ratios (Rb ratios) were calculated by adopting Strahler's (1957) method of ordering the branch system *i.e.,* each ultimate branch was designated as first order, where two first order branches come together, the resulting proximal segment was designated as second order and so on down the system. The entire system was ordered in this manner. The basal branch or main axis was thus of highest order. The bifurcation ratios were calculated as proposed by Steingraber *et al*. (1979).

The number of branches of each order was totaled and the branch bifurcation ratio of the number of branches of one order to the number of branches of the next higher order was calculated using the formula.

$$Rb_{n\,:\,n+1} = \frac{Nn}{N_{n+1}}$$

Where

N is the total number of branches of an order

n is the order number

A bifurcation ratio for the entire systems was estimated by a formula derived from the work of Motomura (1947).

$$Rb = \frac{N - N_{max}}{N - N_1}$$

Where

N is the total number of branches of all order

N_{max} is the number of branches of highest order

N_1 is the number of branches of the first order

3.11 CORRELATION STUDIES

Correlation coefficients were worked out as per the procedure described by Snedecor and Cochran (1967) between the branch number and the number of branches flowering, flower number and fruit number. The test of significance for correlations was worked out by referring to the 'r' table of Fisher and Yates (1963) at (n-2) df.

3.12 STATISTICAL ANALYSIS

The data obtained during the investigation were subjected to statistical analysis by making use of analysis of variance technique as per procedure outlined by Panse and Sukhatme (1985). The sustainability index was computed in each case.

3.13 SUSTAINABILITY INDEX

Dr. M. N. Reddy first used this index and Dr. S. K. Dass in their paper presented in CRIDA (Central Research Institute For Dry Land Agriculture) in 1983. This was developed as a statistical tool to know the assured/guaranteed/sustained number of a variable.

This has no units and it is expressed in percentage.

$$S.I. = \frac{\mu - \sigma}{Y_{max}} * 100$$

Where

μ = Arithmatic mean

σ = Standard deviation

Y_{max} = max numerical value in the sample

CHAPTER IV

RESULTS

The results obtained from various studies and observations on sapota *i.e.* Studies on branching pattern, flowering and fruiting pattern are presented under respective heads in this chapter.

4.1 STUDIES ON BRANCHING PATTERN IN SAPOTA

Sapota is a hardy tree of tropics adaptable to wide variations in soil and climatic conditions. Though there have been some studies regarding its flowering and nutritional requirement, studies related to its branching pattern were not done. In order to understand the branching pattern of sapota the present study was carried out to know the number of branches produced at each order level starting from 6^{th} order. As the branches produced below the order have formed the framework of the tree and were not discernible. The tree canopies in all the cultivars studied have been divided in to lower, middle and upper strata and observations were taken under respective heads.

4.2 KALIPATTI

4.2.1 Lower Strata of canopy

The canopy from ground to two meters height was selected as lower strata and 160 branches with ten branches in each tree for all the 16 trees were observed. Each branch was noted as per the orthodox classification and the

observations were taken from 6th order onwards till the end. The number of branches produced at each order for all the ten selected branches in a tree was noted.

The number of branches at different orders from 6th to 12th order ranged between 1.0 to 5.1 in all the trees (Table 1).

Each branch from the main trunk at lower strata had a range of 1.1-4.7 number of 6th order branches with the mean number of branches 3.25.The sustainability index value at 6th order was 26.71 with average minimum number of branches 2.22. The coefficient of variation value for the number of branches in 6th order among all the trees was 31.78.

At 7th order 2.6-6.1 number of branches were produced with the mean number of branches 4.60.The sustainability index value was 42.85 with average minimum number of branches 3.56. The coefficient of variation value for the number of branches in 7th order among all the trees was 22.16.

While, at 8th order 3.4-8.2 number of branches were produced with the mean number of branches 5.14.The sustainability index value at this order level was 45.73 with average minimum number of branches 3.80. The coefficient of variation value for the number of branches in 8th order among all the trees was 26.21.

At 9th order, there were 1.6-8.3 number of branches were produced with the mean number of branches 4.71.The sustainability index value at 9th order

was 36.62 with average minimum number of branches 3.04. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 35.75.

At 10^{th} order, there were a range of 1.4-5.1 number of branches produced with the mean number of branches 2.90.The sustainability index value at 10^{th} order was 21.84 with average minimum number of branches 1.81. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 38.48.

While, in the 11^{th} order 0.2-3.5 number of branches produced with the mean number of branches 1.60.The sustainability index value at 11^{th} order was 6.90 with average minimum number of branches 0.57. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 63.56.

Whereas, the number of branches at 12^{th} order were in the range of 0.2-2.6 with the mean number of branches 1.0.The sustainability index value at 12^{th} order were 2.65 with average minimum number of branches 0.22. The coefficient of variation value for the number of branches in 12^{th} order among all the trees was 77.84.

In all trees there was extension growth up to 9^{th} order where as it was found in 15 trees out of 16 trees up to 10^{th} order. The occurrence of branches at 12^{th} order was 11 trees out of 16 trees.

The average number of branches at 6^{th} order was 3.25. There was an increase in average number of branches up to 8^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 9^{th} order and it increased gradually up to 12^{th} order. In contrast, the sustainability index was also high up to 8^{th} order for the minimum assured number of branches 2.22-3.80 and the index decreased drastically at higher orders with lower minimum assured number of branches.

4.2.2 Middle Strata of canopy

Here, the tree canopy from two meters to four meters was selected as middle strata and 80 branches, five branches in each tree for all the 16 trees, were observed. Each branch was noted as per the orthodox classification and the observations were taken from 6^{th} order onwards till the end. The number of branches produced at each order for all the branches were noted (Table 2).

The number of branches of different orders from 6^{th} to 11^{th} order ranged between 0.35 to 2.28 in all the sixteen trees.

Each branch from the main trunk at 6^{th} order had a range of 1.4-3.4 number of branches with the mean number of branches 2.19.The sustainability index value was 49.13 with average minimum number of branches 1.67. The coefficient of variation value for the number of branches in 6^{th} order was 23.86.

Whereas, in the 7^{th} order there were 1.5-3.3 number of branches were produced with the mean number of branches 2.28.The sustainability index value was 48.42 with average minimum number of branches 1.65. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 27.64.

While, at the 8^{th} order 0.2-3.4 number of branches were produced with the mean number of branches 1.74.The sustainability index value was 24.31 with average minimum number of branches 0.83. The coefficient of variation value for the number of branches in 8^{th} order among all these was 52.60.

At 9^{th} order there were 0.2-2.4 number of branches were produced with mean number of branches 1.09. The sustainability index value at 9^{th} order was 11.74 with average minimum number of branches 0.40. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 67.74.

At 10^{th} order 0.2-1.8 number of branches produced with the mean number of branches 0.81.The sustainability index value at 10^{th} order was 8.26 with average minimum number of branches 0.28. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 116.21.

At the 11^{th} order the number of branches produced were 0.2-0.6 with the mean number of branches 0.13.The sustainability index value at 11^{th} order was 6.24 with average minimum number of branches 0.21. The coefficient of

variation value for the number of branches at 11th order among all the trees was 105.02.

In all sixteen trees there was extension growth up to 8th order where as it was found in 15 trees out of 16 trees up to 9th order. The occurrence of branches at 11th order was 6 trees out of 16 trees.

The average number of branches at 6th order was 2.19. There was an increase in average number of branches up to 7th order and there was decline at higher orders.

The value of coefficient of variation was also high among the trees for the number of branches produced up to 10th order. While, the sustainability index value decreased gradually at higher orders with lower minimum assured number of branches.

4.2.3 Upper Strata of canopy

In this study the tree canopy over and above four meters was selected as upper strata and 160 branches, 10 branches in each tree for all the 16 trees, were observed and as mentioned above, each branch was noted as per the orthodox classification and the observations were taken from 6th order onwards till the end. The number of branches produced at each order for all the branches were noted (Table 3).

The number of branches of different orders from 6th to 11th order ranged between 1.30 to 4.76 in all the sixteen trees observed.

Each branch from the main trunk at upper strata at 6^{th} order had a range of 2.4-6.1 number of branches with the mean number of branches 4.02.The sustainability index value was 47.0 with average minimum number of branches 2.87. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 28.66.

Whereas, there were 3.6-6.0 number of 7^{th} order branches produced with the mean number of branches 4.76.The sustainability index value at this order were 66.20 with average minimum number of branches 4.04. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 15.1.

While, at the 8^{th} order there were 2.4-5.4 number of branches with the mean number of branches 4.31.The sustainability index value at 8^{th} order was 56.32 with average minimum number of branches 3.44. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 20.41.

At 9^{th} order there were 0.6-5.3 number of branches produced with the mean number of branches 2.89.The sustainability index value at 9^{th} order was 25.74 with average minimum number of branches 1.57. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 45.67.

Whereas, there were about 0.1-4.7 number of branches produced at 10^{th} order with the mean number of branches 1.68.The sustainability index value at

10^{th} order was 4.21 with average minimum number of branches 0.26. The coefficient of variation value for the number of branches at 10^{th} order among all the trees was 84.52.

And in the 11^{th} order branches were in the range of 0.2-2.9 with the mean number of branches 1.30.The sustainability index value at 11^{th} order was 3.87 with average minimum number of branches 0.24. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 81.50.

In all trees there was extension growth up to 9^{th} order whereas it was found in 11 trees out of 16 trees up to 10 order. The occurrence of branches at 11^{th} order was 8 trees out of 16 trees.

The average number of branches at 6^{th} order was 4.02. There was an increase in average number of branches up to 7^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among all the trees for the number of branches produced up to 8^{th} order and it increased up to 11^{th} order. In contrast, the sustainability index was also high up to 7^{th} order for the minimum number of assured branches 2.87 to 4.04 and the index decreased drastically at higher orders with lower minimum number of assured branches.

4.3 OVAL

As explained in Kalipatti, the tree canopy was divided into lower, middle and upper strata and observations were taken from 6^{th} order as per orthodox classification.

4.3.1 Lower Strata of canopy

The canopy from ground to two meters height was selected as lower strata and a total of 20 branches with 10 branches in each of the two meters trees were observed. The number of branches produced at each order for all the branches were noted and presented in the (Table 4).

The number of branches at different orders from 6^{th} to 11^{th} order ranged between 0.35to 3.30 in all the 16 trees.

Each branch at 6^{th} order from the main trunk at lower strata had a range of 2.6-3.6 number of 6^{th} order branches with the mean number of branches 3.1 the sustainability index value was 64.67 with average minimum number of branches 2.39. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 2.39.

Whereas, the number of branches produced at 7^{th} order were 2.9-3.7 with the mean number of branches 3.30.The sustainability index value at 7^{th} order was 73.90 with average minimum number of branches 2.73 The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 17.14.

While, in the 8th order there were 1.6 -2.0 number of branches with the mean number of branches 1.80.The sustainability index value at this order was 41.00 with average minimum number of branches 1.52 The coefficient of variation value for the number of branches in 8th order among all the trees was 15.71.

At 9th order there were 0.5-0.6 number of branches produced with the mean number of branches 0.55.The sustainability index value at 9th order was 12.86 with average minimum number of branches 0.48. The coefficient of variation value for the number of branches in 9th order among all the trees was 12.86.

At 10th order there were 0.4-0.5 number of branches produced with the mean number of branches 0.45.The sustainability index value at this order was 10.25 with average minimum number of branches 0.38. The coefficient of variation value for the number of branches in 10th order among all the trees was 15.71.

And in the 11th order 0.3-0.4 number of branches produced with the mean number of branches 0.35.The sustainability index value was 7.55 with average minimum number of branches 0.28. The coefficient of variation value for the number of branches in 11th order among all the trees was 20.20.

All the sixteen trees without fail have extended their branch growth up to 11th order. But, there was an increase in average number of branches up to only 7th order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 10^{th} order and it increased in 11^{th} order. As against this trend the sustainability index was also high up to 7^{th} order for the minimum number of assured branches 2.39 to 2.73 and the index decreased drastically at higher orders with lower minimum number of assured branches.

4.3.2 Middle Strata of canopy

Here, the tree canopy from two meters to four meters was selected as middle strata and 10 branches with five branches in each tree for all the two trees were observed. The number of branches produced at each order for all the branches were noted (Table 5).

It is clear from the table that in middle strata of tree canopy the number of branches of different orders from 6^{th} to 10^{th} order ranged between 1.5-1.55.

Each branch at 6^{th} order from the main trunk at middle strata had a range of 1.0-1.3 number of branches with the mean number of branches 1.15.The sustainability index value at 6^{th} order was 52.10 with average minimum number of branches 0.94. The coefficient of variation value for the number of branches in 6^{th} order among all these was 18.45.

Whereas, the number of branches at 7^{th} order ranged between 1.2-1.4 with the mean number of branches 1.30.The sustainability index value at 7^{th} order was 64.37 with average minimum number of branches 1.16. The

coefficient of variation value for the number of branches produced at 7^{th} order among all the trees was 10.88.

The 8^{th} order branches from the main trunk at middle strata had a range of 1.3-1.8 no of 8^{th} order branches with the mean number of branches 1.55.The sustainability index value at 8^{th} order was 66.37 with average minimum number of branches 1.20. The coefficient of variation value for the number of branches in 8^{th} order was 22.81.

At 9^{th} order the number of branches produced were 1.3-1.7 with the mean number of branches 1.5.The sustainability index value at 9^{th} order was 67.62 with average minimum number of branches 1.22. The coefficient of variation value for the number of branches in 9^{th} order was 18.86.

At 10^{th} order there were 0.7-0.8 no of branches produced with the mean number of branches 1.5.The sustainability index value was 37.74 with average minimum number of branches 0.68. The coefficient of variation value for the number of branches in 10^{th} order was 9.43.

In all trees there was extension growth up to 10^{th} order and trees had all the branches extended to 10^{th} order.

The average number of branches at 6^{th} order was 1.15 and there was an increase in average number of branches up to 9^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 7^{th} order and it increased up to 9^{th} order and decreased at 10^{th} order. The sustainability index, in contrast, was high up to 9^{th} order for the minimum number of branches 0.94-1.22 and the index decreased at higher orders with lower minimum number of branches (0.68).

4.3.3 Upper Strata of canopy

In this study the tree canopy over and above four meters was selected as upper strata and 20 branches, with 10 branches in each tree for all the two trees, were observed and as mentioned above, each branch was noted as per the orthodox classification and the observations were taken from 6^{th} order onwards till the end. The number of branches produced at each order for all the branches were noted (Table 6).

In the upper strata of tree canopy the number of branches of different orders from 6^{th} to 11^{th} order ranged between 0.65 to 3.75 in all the two trees.

Each branch from the main trunk at upper strata had a range of 2.0-2.1 number of 6^{th} order branches with the mean number of branches 2.05. The sustainability index value at 6^{th} order was 40.39 with average minimum number of branches 1.98. The coefficient of variation value for the number of branches in 6^{th} order was 3.4.

At 7^{th} order there were 2.2-2.5 number of branches produced with the mean number of branches 2.35.The sustainability index value was 43.63 with

average minimum number of branches 2.14. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 9.03.

Whereas, the branches of 8^{th} order had a range of 2.8-3.7 branches with the mean number of branches 3.25.The sustainability index value was 53.34 with average minimum number of branches 2.61. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 19.6.

At 9^{th} order there were 2.6-4.9 number of branches produced with the mean number of branches 3.75.The sustainability index value at 9^{th} order was 43.34 with average minimum number of branches 2.12. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 43.4.

While, in the 10^{th} order about 2.2-3.0 number of branches observed with the mean number of branches 2.60.The sustainability index value was 41.52 with average minimum number of branches 2.03. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 21.76.

At the 11^{th} order about 0.6-0.7 number of branches were produced with the mean number of branches 0.65.The sustainability index value at this order was 11.82 with average minimum number of branches 0.58. The coefficient of variation value for the number of branches produced at in 11^{th} order among all the trees was 10.9.

All the two trees have extended their growth up to 11th order and there was extension growth up to 11th order.

The average number of branches at 6th order was 2.05 and there was an increase in average number of branches up to 9th order and the value decreased gradually at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 8th order and it increased up to 10th order and again shown a decreasing trend at higher orders. The sustainability index was high up to 8th order for the minimum number of branches 1.98-2.61 and the index decreased drastically at higher orders with lower minimum number of branches.

4.4 SINGAPORE

In sapota variety Singapore for these study 50 branches *i.e.* 25 branches each of two sample trees with out damage were selected and the tree canopy was divided into lower, middle and upper strata. Observations were taken from 6th order onwards.

4.4.1 Lower Strata of canopy

The canopy from ground to two meters height was selected as lower strata and 10 branches in each tree for all the two trees were observed. Each branch was noted as per the orthodox classification. The number of branches

produced at each order for all the branches were noted and presented in the (Table 7).

The number of branches of different orders from 6^{th} to 11^{th} order ranged between 1.95 to 4.40 in all the two trees.

Each branch at 6^{th} order from the main trunk at lower strata had a range of 2.4-2.8 number of branches with the mean number of branches 2.6.The sustainability index value was 51.49 with average minimum number of branches 2.32. The coefficient of variation value for the number of branches in 6^{th} order was 10.88.

Whereas, in the 7^{th} order about a range of 2.8-3.1 number of branches were found with the mean number of branches 2.95.The sustainability index value was 60.84 with average minimum number of branches 2.74. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 7.19.

At 8^{th} order, the observed branches had a range of 3.8-3.9 no of branches with the mean number of branches 3.85.The sustainability index value was 83.98 with average minimum number of branches 3.78. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 1.84.

While, in the 9^{th} order about 4.3-4.5 no of branches were found with the mean number of branches 4.40.The sustainability index value was 94.64 with

average minimum number of branches 4.26. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 4.26.

Whereas, in the 10^{th} order there were about 4.0 number of branches were produced with the mean number of branches 4.0.The sustainability index value was 88.8 with average minimum number of branches 40.

While, in the 11^{th} order about 1.3-2.6 number of branches produced with the mean number of branches 1.95.The sustainability index value was 22.91 with average minimum number of branches 1.03. The coefficient of variation value for the number of branches in 11^{th} order among all these was 47.14.

All the two trees have extended their growth up to 11^{th} order and there was extension growth up to 11^{th} order.

The average number of branches at 6^{th} order was 2.6 and there was an increase in average number of branches up to 9^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 10^{th} order and it increased up to 11^{th} order. Similarly the sustainability index was also high up to 9^{th} order for the minimum number of branches 2.32-4.26 and the index decreased drastically at higher orders with lower minimum number of branches.

4.4.2 Middle Strata of canopy

Here, the tree canopy from two meters to four meters was selected as middle strata and 10 branches with five branches in each tree for all the two trees were observed. The number of branches produced at each order for all the branches were noted (Table 8).

In the middle strata of tree canopy the number of branches of different orders from 6^{th} to 11^{th} order ranged between 0.2-1.85 in all the two trees.

Each branch at 6^{th} order from the main trunk at middle strata had a range of 1.3-1.7 number of 6^{th} order branches with the mean number of branches 1.50.The sustainability index value at 6^{th} order was 57.96 with average minimum number of branches 1.22. The coefficients of variation value for the number of branches in 6th order among all the trees were 18.86.

While, in the 7^{th} order about 1.6-2.1 number of branches found with the mean number of branches 1.85.The sustainability index value was 71.26 with average minimum number of branches 1.50. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 19.11.

While, at 8^{th} order the number of branches found were 0.9-1.6 with the mean number of branches 1.25.The sustainability index value was 35.95 with average minimum number of branches 0.76. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 39.60.

At the 9^{th} order each branch from the main trunk at middle strata had a range of 0.8-1.1 number of branches with the mean number of branches 0.95.The sustainability index value was 35.14 with average minimum number of branches 0.74. The coefficient of variation value for the number of branches in 9^{th} order was 22.33.

At 10^{th} order about 0.2-0.6 number of branches found with the mean number of branches 0.4.The sustainability index value was 5.58 with average minimum number of branches 0.12. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 70.71.

In all trees there was extension growth up to 10^{th} order whereas it was found in one tree out of two trees up to 11^{th} order. The occurrence of branches at 11^{th} order was one tree out of two trees.

The average number of branches at 6^{th} order was 1.5 and there was an increase in average number of branches up to 7^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 7^{th} order and it increased up to 10^{th} order. In contrast, the sustainability index was also high up to 7^{th} order for the minimum number of branches 1.22-1.50 and the index decreased drastically at higher orders with lower minimum number of branches.

4.4.3 Upper Strata of canopy

In this study the tree canopy over and above four meters was selected as upper strata and twenty branches, with ten branches in each tree for all the two trees, were observed (Table 9).

In the upper strata of tree canopy the number of branches of different orders from 6^{th} to 11^{th} order ranged between 2.25 to 4.55 in all the two trees.

Each branch from the main trunk at upper strata had a range of 2.2-2.3 number of 6^{th} order branches with the mean number of branches 2.25.The sustainability index value at 6^{th} order was 40.36 with average minimum number of branches 2.18. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 3.14.

The 7^{th} order branch from the main trunk at upper strata had a range of 3.0-3.1 number of branches with the mean number of branches 3.05.The sustainability index value at 7^{th} order was 55.17 with average minimum number of branches 3.0. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 2.32.

At 8^{th} order about 3.1-4.2 no of branches produced with the mean number of branches 3.05.The sustainability index value was 57.41 with average minimum number of branches 2.87. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 2.87.

Whereas, the observed branches at 9th order produced 3.7-5.4 number of branches with the mean number of branches 4.55.The sustainability index value at 9th order was 62.00 with average minimum number of branches 3.35. The coefficient of variation value for the number of branches in 9th order among all the trees was 26.42.

While, in the 10th order about 3.8-5.3 number of branches found with the mean number of branches 4.55.The sustainability index value at 10th order was 64.62 with average minimum number of branches 3.50. The coefficient of variation value for the number of branches in 10th order among all the trees was 23.31.

At 11th order about 2.8-3.2 number of branches found with the mean number of branches 3.0.The sustainability index value was 50.32 with average minimum number of branches 2.72. The value of coefficient of variation for the number of branches in 11th order among all the trees was 9.43.

In all trees there was extension growth up to 11th order. The average number of branches at 6th order was 2.25. There was an increase in average number of branches up to 10th order and there was decline at higher orders.

The value of coefficient of variation was less among the trees for the number of branches produced in the lower orders and the value were not consistent at higher order levels. In contrast, the sustainability index value was also high up to 10th order for the minimum number of branches 2.18 to 3.50

and the index decreased at higher orders with lower minimum number of branches (2.72).

4.5 BOMBAY

In sapota variety Bombay for these study 50 branches *i.e.* 25 branches each of two sample trees with out damage were selected and the tree canopy was divided into lower, middle and upper strata. Observations were taken from 6^{th} order onwards.

4.5.1 Lower Strata of canopy

The canopy from ground to two meters height was selected as lower strata and 20 branches with 10 branches in each tree for all the two trees were observed (Table 10).

In the lower strata of tree canopy the number of branches of different orders from 6^{th} to 11^{th} order ranged between 0.80 to 3.70 number of branches in all the two trees.

Each branch at 6^{th} order from the main trunk at lower strata had a range of 2.0-2.7 no of 6^{th} order branches with the mean number of branches 2.35.The sustainability index value at 6^{th} order was 41.22 with average minimum number of branches 1.86. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 21.06.

Whereas, the range is about 2.6-3.4 for 7^{th} order branches with the mean number of branches 3.0.The sustainability index value was 54.10 with average

minimum number of branches 2.43. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 19.11.

While, in the 8^{th} order about 3.2-4.2 no of branches produced with the mean number of branches 3.70.The sustainability index value was 66.51 with average minimum number of branches 2.99. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 19.11.

At 9^{th} order, there were about 2.9-4.5 no of branches produced with the mean number of branches 3.70.The sustainability index value was 57.08 with average minimum number of branches 2.57. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 30.58.

At 10^{th} order the observed branches have produced 1.2-2.3 number of branches with the mean number of branches 1.75.The sustainability index value was 21.60 with average minimum number of branches 0.97. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 44.45.

At 11^{th} order, the number of branches the number of branches were 0.4-1.2 with the mean number of branches 0.8.The sustainability index value was 5.21 with average minimum number of branches 0.234. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 70.71.

In all trees there was extension growth up to 11^{th} order. The average number of branches at 6^{th} order was 2.35. There was an increase in average number of branches up to 9^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 8^{th} order and it increased up to 11^{th} order. As against this trend the sustainability index was high up to 8^{th} order for the minimum number of branches 1.86-2.99 and the index decreased drastically at higher orders with lower minimum number of branches.

4.5.2 Middle Strata of canopy

Here, the tree canopy from two meters to four meters was selected as middle strata and 10 branches with five branches in each tree for all the two trees were observed. The number of branches produced at each order for all the branches were noted (Table 11).

In the middle strata of tree canopy the number of branches of different orders from 6^{th} to 11^{th} order ranged between 0.9-1.75 in all the two trees.

Each branch at 6^{th} order from the main trunk at middle strata had a range of 1.0-1.6 no of 6^{th} order branches with the mean number of branches 1.30.The sustainability index value at 6^{th} order was 39.81 with average minimum number of branches 0.88. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 32.64.

While, in the 7th order about 1.3-2.2 number of branches with the mean number of branches 1.75.The sustainability index value was 50.62 with average minimum number of branches 1.11 The coefficient of variation value for the number of branches in 7th order among all the trees was 36.37.

At 8th order, each branch from the main trunk at middle strata had a range of 1.4-1.8 number of 8th order branches with mean number of branches 1.60.The sustainability index value at 8th order was 59.87 with average minimum number of branches 1.32. The coefficient of variation value for the number of branches in 8th order among all the trees was 17.68.

Whereas, the branches produced in the 9th order had a range of 0.7-1.3 no of branches with the mean number of branches 1.0.The sustainability index value was 26.17 with average minimum number of branches 0.58. The coefficient of variation value for the number of branches in 9th order among all the trees was 42.43.

At 10th order about 1.0 number of branches were produced with the mean number of branches 1.0.The sustainability index value was 45.45. The coefficient of variation value for the number of branches in 10th order among all the trees was 0.

At 11th order each branch from the main trunk had 0.9 number of branches with the mean number of branches 0.45. The sustainability index value was 0.0. The coefficient of variation value for the number of branches in 11th order among all the trees was 0.

In all trees there was extension growth up to 9th order. Where as, it was found up to 11th order in the 1st tree. The occurrence of branches at 11th order was one tree out of two trees.

The average number of branches at 6th order was 1.30. There was an increase in average number of branches up to 7th order and there was decline at higher orders.

The value of coefficient of variation was also high among the trees for the number of branches produced up to 7th order and it decreased in the 8th order and again increased in the 9th order. In contrast the sustainability index was also high up to 8th order for the minimum number of branches 0.88-1.32 and the value of index decreased drastically at higher orders with lower minimum number of assured branches.

4.5.3 Upper Strata of canopy

In this study the tree canopy over and above four meters was selected as upper strata and twenty branches, with ten branches in each tree for all the two trees, were observed (Table 12).

In the upper strata the number of branches of different orders from 6th to 11th order ranged between 2.3 to 8.0 in all the 02 trees.

Each branch from the main trunk at 6th order had a range of 2.2-2.4 number of 6th order branches with the mean number of branches 2.30.The sustainability index value at 6th order was 51.39 with average minimum number

of branches 2.16. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 6.15.

While, in the 7^{th} order about 2.4-3.4 number of branches were produced with the mean number of branches 2.90.The sustainability index value was 52.21 with average minimum number of branches 2.19.The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 24.38.

At the 8^{th} order, the observed branches had a range of 3.8-4.2 number of branches with the mean number of branches 4.0.The sustainability index value was 88.50 with average minimum number of branches 3.72. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 7.07.

Whereas, at 9^{th} order about 2.7-4.0 number of branches were produced with the mean number of branches 3.35.The sustainability index value was 57.88 with average minimum number of branches 2.43. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 27.44.

While, in the 10^{th} order about 2.2-3.0 number of branches were produced with the mean number of branches 2.60.The sustainability index value at 10^{th} order was 48.44 with average minimum number of branches 2.03.The coefficient of variations value for the number of branches in 10^{th} order among all the trees was 21.76.

At 11^{th} order the observed branches had a range of 0.7-1.6 no of 11^{th} order branches with the mean number of branches 1.15.The sustainability index value at 11^{th} order was 12.23 with average minimum number of branches 0.51. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 55.34.

In all trees there was extension growth up to 11^{th} order. The average number of branches at 6^{th} order was 2.3. There was an increase in average number of branches up to 8^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 10^{th} order and it increased up to 11^{th} order. In contrast, the sustainability index was also high up to 8^{th} order for the minimum number of branches 2.16-3.72 and the index decreased drastically at higher orders with lower minimum number of branches. (0.52).

4.6 CRICKET BALL

In sapota variety Cricket Ball for these study 50 branches *i.e.* 25 branches each of two sample trees with out damage were selected and the tree canopy was divided into lower, middle and upper strata. Observations were taken from 6^{th} order onwards.

4.6.1 Lower Strata of canopy

The canopy from ground to two meters height was selected as lower strata and 20 branches with ten branches in each tree for all the two trees were observed (Table 13).

The number of branches at different orders from 6^{th} to 11^{th} order ranged between 1.35 to 4.45 in the two trees.

Each branch from the main trunk at 6^{th} order had a range of 2.7-2.8 number of 6^{th} order branches with the mean number of branches 2.75.The sustainability index value at 6^{th} order was 57.01 with average minimum number of branches 2.68. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 2.57.

Whereas, at the 7^{th} order the observed branches had a range of 3.4-4.0 number of branches with the mean number of branches 3.70.The sustainability index value at was 69.70 with average minimum number of branches 3.28. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 11.47.

While, in the 8^{th} order about 4.2-4.7 number of branches were produced with the mean number of branches 4.45.The sustainability index value was 87.16 with average minimum number of branches 4.10. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 7.95.

Whereas, at the 9th order each branch from the main trunk had a range of 3.0-4.5 no of branches with the mean number of branches 3.75.The sustainability index value was 57.22 with average minimum number of branches 2.69. The coefficient of variation value for the number of branches in 9th order among all the trees was 28.28.

And at 10th order about 1.9-3.0 number of branches were produced with the mean number of branches 2.45.The sustainability index value at 10th order was 35.58 with average minimum number of branches 1.67. The coefficient of variation value for the number of branches in 10th order among all the trees was 31.75.

Whereas, at the 11th order about 1.0-1.7 number of branches produced with the mean number of branches 1.35. The sustainability index value at 11th order was 18.19 with average minimum number of branches 0.86. The coefficient of variation value for the number of branches in 11th order among all the trees was 36.66.

In all trees there was extension growth up to 11th order. The average number of branches at 6th order was 2.75. There was an increase in average number of branches up to 8th order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 8th order and it increased up to 11th order. Against this, the sustainability index was high up to 8th order for the

minimum number of branches 2.68 to 4.10 and the index decreased drastically at higher orders with lower minimum number of branches (0.86).

4.6.2 Middle Strata of canopy

The tree canopy of two meters to four meters height from the ground was a selected middle stratum and five branches in each tree for all the two trees were observed. The number of branches produced at each order for all the branches were noted (Table 14).

The branches of different orders from 6^{th} to 10^{th} order ranged between 0.4 to 2.30 in the two trees.

Each branch from the main trunk at middle strata had a range of 1.4-1.5 no of 6^{th} order branches with the mean number of branches 1.45.The sustainability index value at 6^{th} order was 57.47 with average minimum number of branches 1.38. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 4.88.

At 7^{th} order each branch from the main trunk had a range of 1.8-1.9 no of branches with the mean number of branches 1.85.The sustainability index value was 74.14 with average minimum number of branches 1.77. The coefficient of variation value for the number of branches in 7^{th} order was 3.82.

Whereas, at 8^{th} order about 2.2-2.4 no of branches produced with the mean number of branches 2.30.The sustainability index value was 89.94 with

average minimum number of branches 2.16 The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 6.15.

While, in the 9^{th} order about 0.9-1.1 no of branches were produced with the mean number of branches 1.00.The sustainability index value was 35.77 with average minimum number of branches 0.86. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 14.14.

In all trees there was extension growth up to 9^{th} order and there was an increase in average number of branches up to 8^{th} order and there was decline at higher orders.

The coefficient of variation was also less among the trees for the number of branches produced up to 8^{th} order and it increased up to 9^{th} order. In contrast, the sustainability index was also high up to 8^{th} order for the minimum number of branches 1.38-2.16 and the index decreased drastically at higher orders with lower minimum number of branches.

4.6.3 Upper Strata of canopy

In this study the tree canopy over and above four meters was selected as upper strata and twenty branches, with ten branches in each tree for all the two trees, were observed (Table 15).

In the upper strata of tree canopy the number of branches of different orders from 6^{th} to 11^{th} order ranged between 2.0 to 4.30 in the two trees.

Each branch from the main trunk at upper strata had 2.0 number of 6^{th} order branches with the mean number of branches 2.0.The sustainability index value was 42.5 with average minimum number of branches 2.0. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 0.0.

While, in the 7^{th} order about 2.8-3.1 number of branches were found with the mean number of branches 2.95.The sustainability index value was 58.25 with average minimum number of branches 2.74. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 7.19.

At 8^{th} order each branch from the main trunk had a range of 3.4-4.7 number of branches with the mean number of branches 4.05.The sustainability index value was 66.61 with average minimum number of branches 3.13. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 22.70.

At 9^{th} order about 4.2-4.4 number of branches were produced with the mean number of branches 4.30.The sustainability index value was 88.48 with average minimum number of branches 4.16 The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 3.29.

While, in the 10^{th} order about 2.3-4.2 number of branches were found with the mean number of branches 3.25.The sustainability index value was 40.56 with average minimum number of branches 1.91. The coefficient of

variation value for the number of branches in 10th order among all the trees was 41.34.

At 11th order about 1.8-2.2 no of branches produced with the mean number of branches 2.0.The sustainability index value at 11th order was 36.54 with average minimum number of branches 1.72. The coefficient of variation value for the number of branches in 11th order among all the trees was 14.14.

In all trees there was extension growth up to 11th order. The average number of branches at 6th order was 2.0. There was an increase in average number of branches up to 9th order and there was decline at higher orders.

The Value of coefficient of variation was also less among the trees for the number of branches produced up to 9th order and it increased in 10th order. In contrast, the sustainability index was also high up to 9th order for the minimum number of branches 2.0 to 4.16 and the index decreased drastically at higher orders with lower minimum number of branches.

4.7 STUDIES ON EXTENT OF BRANCH GROWTH

Earlier studies were undertaken to know the branching pattern of sapota. Whilst, the present study was proposed to know the extent of branch growth in terms of order level presence in all the cultivars studied. For this study for all the cultivars, with stratification of canopy as lower, middle, and upper strata remained same, order presence at each order starting from 6th order was studied and tabled.

4.7.1 KALIPATTI

4.7.1.1 Lower strata of canopy

It is clear from the table that in the lower strata of tree canopy almost all branches have grown up to 8th order. Whereas, the branch order presence has shown a decreasing trend from 9th order. Further, there was drastic reduction up to 13th order (Table 16).

Mean values of 16 trees decreased right from the 9th order (8.6) to 13th order (1.33). Coefficient of variation values increased right from 9th order (15.9) to 12th order (55.8). Sustainability index values, which are inverse of coefficient of variation, decreased from 8th order (93.02) to 13th order (37.7) with actual values of 9.3 and 3.77, respectively.

4.7.1.2 Middle strata of canopy

It is clear from the table that up to 8th order almost all branch order presence was assured. Whereas, the branch order presence has shown a decreasing trend from 9th order. Further, there was drastic reduction from 11th order onwards (Table 17).

Mean values of sixteen trees decreased right from 8th order (4.6) to 13th order (1.0). Coefficient of variation values increased right from 8th order (13.38) to 12th order (34.99). Sustainability index values, which are inverse of coefficient of variation values, are increased from 8th (80.11) to 12th order (37.9) with actual values of 4.0 and 1.89, respectively.

4.7.1.3 Upper strata of canopy

It is clear from the table that in the upper strata of tree canopy up to 8th order almost all branch orders are assured. Whereas, the branch order presence has shown a decreasing trend from 9th order. Further, there was drastic reduction from 13th order onwards (Table 18).

Mean values of 16 trees decreased right from the 8th order (9.8) to 13th order (2.6). Coefficients of variation values increased from 8th order (4.1) to 12th order (79.35). Sustainability index values, which are inverse of coefficient of variation values, decreased 8th order (94.09) to 12th order (8.02) with actual values of 9.4 and 0.8, respectively.

4.8 OVAL

4.8.1 Lower strata of canopy

It is clear from the table that in the lower strata of tree canopy up to 6th orders almost all branch orders are assured. Whereas, the branch order presence has shown a decreasing trend from 7th order. Further, there was drastic reduction from 11th order onwards (Table 19).

Mean values of two trees decreased from the 7th order (9.0) to 12th order (1.0). Coefficient of variation values increased from 7th order (15.7) to 11th order (94.2). Sustainability index values, which are inverse of Coefficient of variation, decreased from 7th (75.8) to 11th order (3.43) with actual values of 7.58 and 0.34, respectively.

4.8.2 Middle strata of canopy

It is clear from the table that in the middle strata of tree canopy up to 8th orders almost all branch orders are assured. Whereas, the branch order presence has shown a decreasing trend from 9th order (Table 20).

Mean values of two trees for branch order presence decreased from the 9th order (4.5) to 10th order (2.0).

4.8.3 Upper strata of canopy

It is clear from the table that in the upper strata of tree canopy Mean values of two trees decreased from the 9th order (9.5) to 11th order (3.0) (Table 21).

4.9 SINGAPORE

4.9.1 Lower strata of canopy

It is clear from the table that in the lower strata of tree canopy mean values of two trees decreased from the 9th order (9.5) to 13th order (3.0). Coefficient of variation values and sustainability index values are not consistent (Table 22).

4.9.2 Middle strata of canopy

It is clear from the table that in the middle strata of tree canopy mean values of two trees decreased from the 8th order (3.5) to 10th order (1.5) Coefficient of variation values increased right from 8th order (20.2) to 10th

order (47.1). Sustainability index values, which are inverse of Coefficient of variation decreased from 8th order (69.8) to 10th order (39.6) with actual value 3.45 and 1.98, respectively (Table 23).

4.9.3 Upper strata of canopy

It is clear from the table that in the upper strata of tree canopy mean values of two trees decreased from 8th order (9.5) to 13th order (1.5). Coefficients of variation values increased right from 8th order (7.44) to 13th order (47.14). Sustainability index value, which is inverse of coefficient of variation, decreased from 87.9 to 15th order (39.6) with actual value 8.79 and 3.96, respectively. (Table 24).

4.10 BOMBAY

4.10.1 Lower strata of canopy

It is clear from the table that in the lower strata of tree canopy mean values decreased from the 9th order (8.0) to 12th order (1.5). Coefficients of variation values increased right from 9th order (17.6) to 11th order (101.01). Sustainability index values, which are inverse of Coefficient of variation, decreased from 9th order (73.1) to 11th order (0.59) with actual value 7.31 and 0.59, respectively (Table 25).

4.10.2 Middle strata of canopy

It is clear from the table that in the middle strata of tree canopy mean values decreased from the 8th order (4.0) to 11th order (3.0). Coefficient of

variation values increased from 35.35 to 9th order (60.6). Sustainability values, which are inverse of coefficient of variation, decreased from 8th order (51.7) to 9th order (27.5) with actual value 2.58 and 1.37 (Table 26).

4.10.3 Upper strata of canopy

It is clear from the table that in the upper strata of tree canopy mean values of two trees decreased from the 9th order (9.5) to 11th order (3.5). Coefficients of variation values increased right from 9th order (7.44) to 11th order (20.2). Sustainability index values, which are inverse of Coefficient of variation, decreased from 9th order (87.9) to 11th order (69.8) with actual value 8.79 and 6.98, respectively (Table 27).

4.11 CRICKET BALL

4.11.1 Lower strata of canopy

It is clear from the table that in the lower strata of tree canopy mean values decreased from the 9th order (8.0) to 12th order (2.0). Coefficient of variation values increased towards 12th order. Sustainability index values increased from 9th order to (10.0) to 11th order (100) with actual value 7.31 and 10.0 (Table 28).

4.11.2 Middle strata of canopy

It is clear from the table that in the middle strata of tree canopy means values are decreasing from the 8th order (4.0) to 10th order (2.0). Sustainability index values and coefficient of variation values are not consistent (Table 29).

4.11.3 Upper strata of canopy

It is clear from the table that in the upper strata of tree canopy mean values decreased from the 9^{th} order (9.5) to 12^{th} order (1.0). Coefficients of variation values increased from 7.4 to 11^{th} order (23.5). Sustainability index values decreased from 9^{th} order to (87.9) to 11^{th} order (65.5) with actual values 8.79 and 6.55 respectively (Table 30).

4.12 STUDIES ON OVERALL BRANCH ORDER CONTRIBUTION

For this study all the branches which were divided into lower, middle and upper strata for individual observations were combined in order to have a true representation of the variety. The number of the branches present in each order level of the branch from the 6^{th} order level was calculated and presented below.

4.12.1 Kalipatti

The number of branches at different orders from 6^{th} to 11^{th} order ranged between 0.43 to 4.48 in all the two trees (Table 31).

Each branch from the main trunk at 6^{th} order had a range of 2.48 to 5.0 number of branches with the mean number of branches 3.79.The sustainability index value at 6^{th} order was 48.24 with average minimum number of branches 3.11. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 17.92.

While, at the 7th order there were 3.0 to 5.84 number of branches produced with mean number of branches 4.35.The sustainability index value was 55.41 with average minimum number of branches 3.57. The coefficient of variation value for the number of branches in 7th order among all the trees was 17.88.

At 8th order each branch from the main trunk at had a range of 2.92 to 6.44 number of branches with the mean number of branches 4.48.The sustainability index value was 54.72 with average minimum number of branches 3.52. The coefficient of variation value for the number of branches in 8th order among all the trees was 21.34.

While, at the 9th order there were about 1.28 to 5.76 number of branches with the mean number of branches 3.46.The sustainability index value was 32.24 with average minimum number of branches 2.14. The coefficient of variation value for the number of branches in 9th order among all the trees was 38.13.

At the 10th order about 0.64 to 4.12 number branches were produced with the mean number of branches 1.91.The sustainability index value at 10th order was 13.49 with average minimum number of branches 0.87. The coefficient of variation value for the number of branches in 10th order among all the trees was 54.51.

While, at the 11th order about 0.20 to 3.60 number of branches were produced with the mean number of branches 0.92.The sustainability index

value at 11th order was 073 with average minimum number of branches 0.05. The coefficient of variation value for the number of branches in 11th order among all the trees was 94.87.

In all trees there was extension growth up to 9th order whereas it was found in 14 trees out of 16 trees up to 11th order. The occurrence of branches at 12th order was 11 trees out of 16 trees.

The average number of branches at 6th order was 3.79. There was an increase in average number of branches up to 8th order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 9th order and it increased up to 12th order. In contrast, the sustainability index was also high up to 8th order for the minimum number of branches 3.11 to 3.52 and the index decreased drastically at higher orders with lower minimum number of branches.

4.12.2 Oval

The number of branches of different orders from 6th to 11th order ranged between 0.40 to 2.64 in all the two trees (Table 32).

Each branch from the main trunk at 6th order had a range of 2.24 to 2.80 number of 6th order branches with the mean number of branches 2.52.The sustainability index value at 6th order was 70.80 with average minimum number

of branches 2.12. The coefficient of variation value for the number of branches in 6^{th} order among all these was 15.71.

At 7th order there were 2.56 to 2.60 number of branches produced with the mean number of branches 2.58.The sustainability index value at 7^{th} order was 85.05 with average minimum number of branches 2.55. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 1.10.

At 8^{th} order each branch from the main trunk at had a range of 2.28 to 3.00 number of branches with the mean number of branches 2.64.The sustainability index value at 8^{th} order was 71.02 with average minimum number of branches 2.13. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 19.28.

While, at 9^{th} order about 1.76 to 2.36 number of branches produced with the mean number of branches 2.06.The sustainability index value at 9^{th} order was 54.52 with average minimum number of branches 1.64. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 20.60.

At 10^{th} order about 1.36 to 1.68 number of branches were produced with the mean number of branches 1.52.The sustainability index value at 10^{th} order was 43.12 with average minimum number of branches 1.29. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 14.89.

At 11^{th} order, each branch from the main trunk had 0.4 number of branches with the mean number of branches 0.40. The sustainability index value was13.34 with average minimum number of branches 0.40. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 0.0.

In all trees there was extension growth up to 11^{h} order. The average number of branches at 6^{th} order was 6.3. There was an increase in average number of branches up to 8^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 8^{th} order and it increased up to 11^{th} order. As against this trend the sustainability index was high up to 8^{th} order for the minimum number of branches 2.12 to 255 and the index decreased drastically at higher orders with lower minimum number of branches (13.33).

4.12.3 Singapore

For this study the number of branches which were observed individually in all the three strata were combined and observations were taken from 6^{th} order onwards as per orthodox classification (Table 33).

The number of branches of different orders from 6^{th} to 11^{th} order ranged between 2.54 to 3.76.

Each branch from the main trunk at 6^{th} order had a range of 2.40 to 2.68 number of 6^{th} order branches with the mean number of branches 2.54.The

sustainability index value at 6^{th} order was 55.76 with average minimum number of branches 2.34. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 7.79.

While, in the 7^{th} order about 3.20 to 3.08 number of branches was produced with the mean number of branches 3.14. The sustainability index value at 7^{th} order was 72.74 with average minimum number of branches 3.06. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 2.70.

Whereas, in the 8^{th} order about 3.12 to 3.88 number of branches were produced with the mean number of branches 3.50. The sustainability index value was 70.54 with average minimum number of branches 2.96. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 15.35.

While, each branch from the main trunk had a range of 3.32 to 4.20 number of 9^{th} order branches with the mean number of branches 3.76.The sustainability index value was 74.71 with average minimum number of branches 3.14. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 16.55.

Whereas, at 10^{th} order 3.20 to 3.96 number of branches produced with the mean number of branches 3.58. The sustainability index value was 72.44 with average minimum number of branches 3.04. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 15.01.

While, at 11^{th} order about 1.64 to 2.40 number of 11^{th} order branches were produced with the mean number of branches 2.02. The sustainability index value at 11^{th} order was35.30 with average minimum number of branches 1.48. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 26.60.

In all trees there was extension growth up to 11^{h} order. The average number of branches at 6^{th} order was 2.54 and there was an increase in average number of branches up to 9^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 10^{th} order and it increased up to 11^{th} order. In contrast, the sustainability index was also high up to 9^{th} order for the minimum number of branches 2.34 to 3.14 and the index decreased at higher orders with lower minimum number of assured branches.

4.12.4 Bombay

As indicated in the above variety the observations were recorded for the total number of branches in lower, middle and upper strata together and the number of the branches present in each order level of the branch from the 6^{th} order level was calculated and presented in the (Table 34).

The number of branches of different orders from 6^{th} to 11^{th} order ranged between 1.18 to 3.72 in all the two trees.

Each branch from the main trunk had a range of 2.16 to 2.60 number of 6^{th} order branches with the mean number of branches 2.38.The sustainability index value at 6^{th} order was 52.78 with average minimum number of branches 2.07. The coefficient of variation value for the number of branches in 6^{th} order among all the trees was 13.07.

At 7^{th} order 2.92 to 3.20 number of branches produced with the mean number of branches 2.86.The sustainability index value at 7^{th} order was 73.01 with average minimum number of branches 2.86. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 6.47.

At 8^{th} order about 3.52 to 3.92 number of branches produced with the mean number of branches 3.72.The sustainability index value at 8^{th} order was 87.68 with average minimum number of branches 3.44. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 3.44.

Whereas, in the 9^{th} order about 3.08 to 3.40 number of branches were produced with the mean number of branches 3.24.The sustainability index value at 9^{th} order was 76.88 with average minimum number of branches 3.01. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 6.98.

Whereas, in the 10^{th} order about 1.64 to 2.40 number of branches were produced with the mean number of branches 2.02.The sustainability index value at 10^{th} order was 37.82 with average minimum number of branches 1.48.

The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 26.60.

At the 11^{th} order 1.04 to 1.32 number of branches were produced with the mean number of branches 1.18. The sustainability index value at 11^{th} order was25.05 with average minimum number of branches 0.98. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 16.78.

In all trees there was extension growth up to 11^{th} order. The average number of branches at 6^{th} order was 2.38. There was an increase in average number of branches up to 8^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 9^{th} order and it increased up to 11^{th} order. The sustainability index values were high up to 9^{th} order for the minimum number of branches 2.07 to 3.44 and the index decreased at higher orders with lower minimum number of branch (0.98).

4.12.5 Cricket Ball

For this study 50 branches which were divided into lower, middle and upper strata for individual observations were combined and the number of the branches present in each order level of the branch from the 6^{th} order level was calculated and presented in the (Table 35).

The number of branches of different orders from 6^{th} to 11^{th} order ranged between 1.34 to 4.32 in all the two trees.

Each branch from the main trunk at 6^{th} order had a range of 2.44 to 2.52 number of 6^{th} order branches with the mean number of branches 2.48.The sustainability index value at 6^{th} order was 54.58 with average minimum number of branches 2.42. The coefficient of variation value for the number of branches in 6^{th} order among all these was 2.28.

At the 7^{th} order about 3.20 to 3.60 number of branches were produced with the mean number of branches 3.40.The sustainability index value at 7^{th} order was 70.21 with average minimum number of branches 3.12. The coefficient of variation value for the number of branches in 7^{th} order among all the trees was 8.32.

While, at the 8^{th} order 4.20 to 4.44 number of branches were produced with the mean number of branches 4.32.The sustainability index value at 8^{th} order was 93.48 with average minimum number of branches 4.15. The coefficient of variation value for the number of branches in 8^{th} order among all the trees was 3.93.

Whereas, in the 9^{th} order about 3.24 to 4.00 number of branches were produced with the mean number of branches 3.62.The sustainability index value at 9^{th} order was 69.43 with average minimum number of branches 3.08. The coefficient of variation value for the number of branches in 9^{th} order among all the trees was 14.85.

While, in the 10^{th} order about 1.84 to 2.88 number of branches were produced with the mean number of branches 2.36.The sustainability index value at 10^{th} order was 36.59 with average minimum number of branches 1.62. The coefficient of variation value for the number of branches in 10^{th} order among all the trees was 31.16.

Whereas, branches at 11^{th} order from the main trunk had a range of 1.12 to 1.56 number of branches with the mean number of branches 1.34. The sustainability index value at 11^{th} order was 23.17 with average minimum number of branches 1.03. The coefficient of variation value for the number of branches in 11^{th} order among all the trees was 23.22.

In all trees there was extension growth up to 11^{h} order. The average number of branches at 6^{th} order was 2.48. There was an increase in average number of branches up to 8^{th} order and there was decline at higher orders.

The value of coefficient of variation was also less among the trees for the number of branches produced up to 8^{th} order and it increased up to 11^{th} order. The sustainability index was high up to 8^{th} order for the minimum number of branches 2.42 to 4.15 and the index decreased at higher orders with lower minimum number of branches (1.03).

4.13 STUDIES ON EFFECT OF EXTENT OF BRANCHING AT 6TH ORDER ON PRODUCTION OF BRANCHES AT SUBSEQUENT ORDERS

In this study with the division of Strata as lower, middle and upper strata remained same as mentioned in the earlier chapter, this study was aimed only to know the extension of branch, in terms of number of order levels, with respect to the number of branches produced at 6th order for all the cultivars studied. The results are presented below.

4.14 KALIPATTI

4.14.1 Lower strata

It is clear from the table that if there were two branches produced at 6th order a maximum of 30 branches out of 160branches had extended their growth up to 9th order and the number of branches making further growth declined with 12 branches extended up to 11th order (Table 36).

If there were three branches produced at 6th order a maximum of 28 branches out of 160 branches had extended their growth up to 8th order and the number in general decreased with 13 branches extended up to 11th order.

4.14.2 Middle strata

It is clear from the table that if there were two branches produced at 6th order a maximum of 12 branches out of 80 branches extended their growth up

to 9th order and the number of branches making Further growth decreased with 8 branches extended up to 10th order (Table 37).

If there were three branches produced at 6th order a maximum of 15 branches extended their growth up to 8th order and the number decreased with three branches extended up to 10th order.

4.14.3 Upper strata

It is clear from the table that if there were two branches produced at 6th order a maximum of 32 branches out of 160 branches had extended their growth up to 10th order and the number of branches making further growth decreased with 12 branches extended up to 11th order (Table 38).

If there were three branches produced at 6th order a maximum of 20 branches extended their growth up to 9th order and the number in general decreased with 17 branches extended up to 10th order.

If there were four branches produced at 6th order a maximum of seven branches out of 160 branches had extended their growth up to 8th order.

If there were five branches produced at 6th order a maximum of three branches extended their growth up to 8th order.

4.15 OVAL

4.15.1 Lower strata

The branch extension growth with reference to the number of branches produced in the 6^{th} order was studied and presented in the (Table 39).

If there were two branches produced at 6^{th} order a maximum of six branches extended their growth up to 11^{th} Order and the number in general decreased with 1 branch extended up to 12^{th} order.

4.15.2 Middle strata

The branch extension growth with reference to the number of branches produced in the 6^{th} order was studied and presented in the (Table 40).

If there were two branches produced at 6^{th} order a maximum of five branches extended their growth up to the 10^{th} order.

4.15.3 Upper strata

The branch extension growth with reference to the number of branches produced in the 6^{th} order was studied and presented in the (Table 41).

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of eight branches extended their growth up to 10^{th} order and the number of branches making further growth decreased with five branches extended up to 12^{th} order.

4.16 SINGAPORE

4.16.1 Lower strata

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of eight branches extended their growth up to 11^{th} order and the number of branches making further growth decreased with three branches extended up to 12^{th} order (Table 42).

If there were three branches produced at 6^{th} order a maximum of two branches extended their growth up to 10^{th} order.

4.16.2 Middle strata

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of two branches extended their growth up to 10^{th} order and the number of branches making further growth decreased with two branches extended up to 10^{th} order (Table 43).

If there were three branches produced at 6^{th} order a maximum of four branches extended their growth up to 7^{th} order.

If there were four branches produced at 6^{th} order a maximum of one branches extended their growth up to 8^{th} order.

4.16.3 Upper strata

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of five branches extended their growth up to 11^{th} order and

the number of branches making further growth decreased with four branches extended up to 12^{th} order (Table 44).

If there were three branches produced at 6^{th} order a maximum of two branches extended their growth up to 11^{th} order.

4.17 BOMBAY

4.17.1 Lower strata

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of five branches extended their growth up to 11^{th} order and the number of branches making further growth declined with three branches extended up to 12^{th} order (Table 45).

If there were three branches produced at 6^{th} order a maximum of two branches extended their growth up to 9^{th} order.

4.17.2 Middle strata

It is clear from the table that if there were two branches produces at 6^{th} order a maximum of four branches extended their growth up to 10^{th} order and the further growth decreased with one branch extended up to 11^{th} order (Table 46).

If there were two branches produced at 6^{th} order a maximum of three branches extended their growth up to 8^{th} order and the further growth decreased with two branches extended up to 11^{th} order.

4.17.3 Upper strata

It is clear from the table that if there were two branches produces at 6^{th} order a maximum of eight branches extended their growth up to 10^{th} order. And the further growth decreased with three branches extended up to 11^{th} order (Table 47).

If there were three branches produced at 6^{th} order a maximum of four branches extended their growth up to 9^{th} order and the number, in general decreased with one branch extended up to 10^{th} order.

4.18 CRICKET BALL

4.18.1 Lower strata

It is clear from the table that if there were two branches produces at 6^{th} order a maximum of nine branches extended their growth up to 11^{th} order and the number of branches making further growth decreased with two branches extended up to 12^{th} order (Table 48).

If there were three branches produced at 6^{th} order a maximum of three branches extended their growth up to 12^{th} order.

4.18.2 Middle strata

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of five branches extended their growth up to 9^{th} order.

If there were three branches produced at 6^{th} order a maximum of four branches extended their growth up to 9^{th} order and the number of branches making further growth decreased with one branch extended up to 10^{th} order.

4.18.3 Upper strata

It is clear from the table that if there were two branches produced at 6^{th} order a maximum of eight branches extended up to 11^{th} order and the number of branches making further growth decreased with two branches extended up to 12^{th} order (Table 50).

If there were three branches produced at 6^{th} order a maximum of three branches extended up to 9^{th} order.

4.19 STUDIES ON BRANCH BIFURCATION RATIOS

For this study the branch extension up to the maximum order level was noted and the order levels up to which the branches have extended were divided into three ranges with three consecutive order levels in each range. The ranges were named higher medium and lower range of branch extension. The numbers of branches that are being produced at that order levels were noted and starting from the highest order level the number of branches from the highest order level the number of branches in each order was noted down wards. The highest order level was noted as N, whereas, the subsequent order levels were noted as N-1, N-2, and N-3 etc.

4.19.1 Kalipatti

Branch bifurcation ratio decreased towards the tip in the 13-15 range of branch extension with ratios at N-8 level and N level being 2.29 and 0.81. In the 10-12 range of branch extension also same trend was observed with ratios at N-6 level and N level being 9.50 and 0.94 (Table 51).

Branch bifurcation ratios in the 7-9 range of branch extension also have indicated the decreasing trend with ratios at N-4 level and N level being 13.00 and 1.27.

4.19.2 Oval

Branch bifurcation ratios decreased towards the tip in the 10-12 range of branch extension with ratios at N-5 level and N level being 5.50 and 1.10.Same trend is evident in the 7-9 range of branch extension with ratios at N-2 level and N level being 1.92 and 1.73.while, in the 7-9 range of branch extension Rb ratios behaved as same with ratios at N-4 level and N level being 13.00 and 1.27 (Table 52).

4.19.3 Singapore

It is clear from the table that branch bifurcation ratios decreased towards the tip in the 13-15 range of branch extension with ratios at N-7 level and N level being 7.00 and 0.74. In the 10-12 range of branch extension also same trend is indicated with ratios at N-5 level and N level being 3.25 and 0.99. In

the 7-9 range of branch extension the Rb ratios behaved as same with ratios at N-2 level and N level being 2.29 and 1.94 (Table 53).

4.19.4 Bombay

It is clear from the table that branch bifurcation ratio decreased towards the tip in the 11-13 range of branch extension with ratios at N-6 level and N level being 3.00 and 1.62. In the 8-10 range of branch extension also same trend is indicated with ratios at N-4 level and N level being 7.00 and 1.63 (Table 54).

4.19.5 Cricket ball

It is clear from the table that branch bifurcation ratio decreased towards the tip in the 12-14 range of branch extension with ratios at N-7 level and N level being 1.00 and 0.91 (Table 55).

Branch bifurcation ratio in the 9-11 range of branch extension behaved as same with ratios at N-5 level and N level being 13.00 and 1.03. Same is the case with Rb ratios observed in the 7-8 range of branch extension with ratios at N-2 level and N level being 7.00 and 1.43.

4.20 STUDIES ON FLOWERING PATTERN

For this study, all the branches in the three strata were reckoned as one and the branches were divided into various ranges depending up on the branch order level up to which the branch has extended its growth and the branches which made higher extension growth were grouped with three orders in each

group/range. Similarly branches which made medium extension growth were grouped with three orders in each group/range .The remaining group consisted of branches which extended to lower levels in other words they are short branches. The number of flowers in each order level in all the group/range starting from tip to base *i.e.* 6^{th} order was noted for each of five varieties studied. Further English alphabet 'N' was assigned to the tip of branch, what so ever it's length may be, and subsequent down order levels were given N-1, N-2, etc. till the base order level *i.e.* 6^{th} order.

4.21 KALIPATTI

4.21.1 Lower range of branch extension:

It is clear from the table that there were higher number of total branches produced up to N-2 level with the branch number ranged from 218-476. The number of branches flowering was also maximum up to N-2 with a range of 102-374 branches. The percentage of branches flowering decreased from top to bottom (Table 56).

The total number of flowers produced the number of fruit set and percentage fruit set was higher up to N-2 level.

Correlation coefficient between total branches produced and branches bearing flowers was significant with 'r' value 0.97.

Correlation coefficient between total branches produced and total number of flowers was significant with 'r' value 0.98.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.94.

Correlation coefficient between total branches bearing flowers total number of flowers produced was significant with ‘r’ value 0.99.

Correlation coefficient between total branches bearing flowers and total fruit set was significant in the higher range with ‘r’ values 0.98.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.98.

4.21.2 Medium range of branch extension

It is clear from the table that the total number of branches produced was maximum up to N-3 level (707-880). The number of branches flowering was also maximum up to N-3 level with 484-688 number of branches. The percentage of branch flowering was decreased from top to bottom (Table 57).

The total number of flowers produced the number of fruit set and percentage was higher up to N-3 level in the higher range branches.

Correlation coefficient between total branches produced and total branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.93.

Correlation coefficient between total branches produced and total number of fruits set was significant with ‘r’ value 0.90.

Correlation coefficient between total branches bearing flowers and total flowers produced was significant with ‘r’ value 0.97.

Correlation coefficient between total branches bearing flowers and total fruit set was significant with ‘r’ values 0.95.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.99.

4.21.3 Higher range of branch extension

It is clear from the table that there was higher number of total branches up to N-4 level with the branch number ranged from 69-92. The number of branches flowering was also maximum up to it is clear from the table that N-4 with a range of 42-51 branches. The percentage of branches flowering varied and was not consistent (Table 58).

The total number of flowers produced the number of fruit set and percentage of fruit set was higher up to N-4 level.

Correlation coefficient between Total branches produced and Total branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.93.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.90.

Correlation coefficient between total branches bearing flowers and total flowers produced was significant with ‘r’ value 0.97.

Correlation coefficient between total branches bearing flowers and total fruit set was significant with ‘r’ values 0.95.

Correlation **c**oefficient between total flowers produced and total fruits set was significant with ‘r’ value 0.99.

4.22 Oval

4.22.1 Lower range

It is clear from the table that there was higher number of total branches up to N-1 level. The branch number ranged from 1-15. The number of branches flowering was also maximum up to N-1 with a range of 1-14 branches. The percentage of branches flowering decreased from top to bottom (Table 59).

The total number of flowers produced the number of fruit set and percentage fruit set was higher up to N-1 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers were significant with ‘r’ value 1.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 1.

Correlation coefficient between total branches produced and total number of fruits set was significant with ‘r’ value 1.

Correlation coefficient between total branches bearing flowers and total flowers produced was significant in the higher range with ‘r’ value 1.

Correlation coefficient between total branches bearing flower and total number of fruit set was significant in the higher range with ‘r’ values 1.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 1.

4.22.2 Medium range of branch extension

It is clear from the table that there was higher number of total branches up to N-2 level. The branch number ranged from 23-57. The number of branches flowering was also maximum up to N-2 with a range of 19-55 branches. The percentage of branches flowering varied and decreased to bottom (Table 60).

The total number of flowers produced the number of fruit set and percentage was higher up to N-2 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 1.0.

Correlation coefficient between total branches produced total number of flower was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced total number of fruits set was significant with ‘r’ value 0.99.

Correlation coefficient between total branches bearing flowers and total flowers produced were significant with ‘r’ value 0.99.

Correlation coefficient between total branches bearing flower and total number of fruit set was significant with ‘r’ values 0.99.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 1.0.

4.22.3 Higher range of branch extension

It is clear from the table that there was higher number of total branches up to N-3 level. The branch number ranged from 36-90. The number of branches flowering was also maximum up to N-3 with a range of 30-86 branches. The percentage of branches flowering varied and decreased top to bottom (Table 61).

The total number of flowers produced the number of fruit set and percentage of fruit set was higher up to N-3 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.97.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.96.

Correlation coefficient between total branches bearing flowers and total flowers produced was significant in the higher range with ‘r’ value 0.98.

Correlation coefficient between total branches bearing flowers and total number of fruit set were significant in the higher range with ‘r’ values 0.97.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.99.

4.23 Singapore

4.23.1 Lower range of branch extension

It is clear from the table that there was higher number of total branches up to N-2 level. The branch number ranged from16-33. The number of branches flowering was also maximum up to N-2 with a range of 12-31 branches. The percentage of branches flowering varied and was not consistent (Table 62).

The total number of flowers produced the number of fruit set and percentage fruit set was higher up to N-2 level.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.96.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.96

Correlation coefficient between total branches bearing flowers and total flowers produced was significant with ‘r’ value 0.98.

Correlation coefficient between total branches bearing flower and total fruit set was significant with ‘r’ values 0.98.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.99.

4.23.2 Middle range of branch extension

It is clear from the table that there was higher number of total branches up to N-2 level. The branch number ranged from 83-97. The number of branches flowering was also maximum up to N-2 with a range of 79-92 branches. The percentage of branches flowering varied and was not consistent (Table 63).

The total number of flowers produced the number of fruit set and percentage was higher up to N-2 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.97.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.94

Correlation coefficient between total branches bearing flowers and total flowers produced was significant with ‘r’ value 0.97.

Correlation coefficient between total branches bearing flowers and total fruit set was significant with ‘r’ values 0.94.

Correlation coefficient between total flowers produced and a total fruit set was significant with ‘r’ value 0.98.

4.23.3 Higher range of branch extension

It is clear from the table that there was higher number of total branches up to N-2 level. The branch number ranged from 22-40. The number of branches flowering was also maximum up to N-2 with a range of 19-35 branches. The percentage of branches flowering varied and was not consistent (Table 64).

The total number of flowers produced and the number of fruits set and percentage was higher up to N-2 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.98.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.95

Correlation coefficient between Total branches bearing flowers and total flowers produced were significant with ‘r’ value 0.99.

Correlation coefficient between total branches bearing flower and total number of fruit set was significant in the higher range with ‘r’ values 0.96.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.97.

4.24 Bombay

4.24.1 Middle range of branch extension

It is clear from the table that there was higher number of total branches up to N-2 level. The branch number ranged from 63-129. The number of branches flowering was also maximum up to N-2 with a range of 47-104 branches. The percentage of branches flowering varied and decreased top to bottom (Table 65).

The total number of flowers produced the number of fruit set and percentage fruit set was higher up to N-2 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.98.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.96.

Correlation coefficient between Total branches bearing flowers and total flowers produced were significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced bearing flower and total number of fruit set were significant with ‘r’ value 0.97.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.99.

4.24.2 Higher range of branch extension

It is clear from the table that there was higher number of total branches up to N-4 level. The branch number ranged from 22-42. The number of branches flowering was also maximum up to N-4 with a range of 13-34 branches. The percentage of branches flowering varied and was not consistent (Table 66).

The total number of flowers produced the number of fruit set and percentage was higher up to N-4 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.98

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.90.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.95.

Correlation coefficient between total branches bearing flowers and total flowers produced were significant with ‘r’ value 0.95.

Correlation coefficient between total branches produced bearing flower and total number of fruit set were significant with ‘r’ value 0.95.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.97.

4.25 Cricket Ball

4.25.1 Lower range of branch extension

It is clear from the table that there was higher number of total branches up to N-1 level. The branch number ranged from 21-30. The number of branches flowering was also maximum up to N-1with a range of 17-25 branches. The percentage of branches flowering varied and was not consistent (Table 67).

The total number of flowers produced the number of fruit set and percentage fruit set was higher up to N-1 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.98.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.98.

Correlation coefficient between total branches produced bearing flowers and total flowers produced were significant with ‘r’ value 0.98.

Correlation coefficient between total branches produced bearing flower and total number of fruit set was significant with ‘r’ values 0.99.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.95.

4.25.2 Middle range of branch extension

It is clear from the table that there was higher number of total branches up to N-3 level. The branch number ranged from 55-119. The number of branches flowering was also maximum up to N-3 with a range of 48-101 branches. The percentage of branches flowering varied and was not consistent (Table 68).

The total number of flowers produced the number of fruit set and percentage was higher up to N-3 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.98.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.98.

Correlation coefficient between total branches bearing flowers and total flowers produced were significant in the higher range with ‘r’ value 0.98.

Correlation coefficient between total branches bearing flowers and total number of fruit set was significant in the higher range with ‘r’ values 0.99.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.95.

4.25.3 Higher range of branch extension

It is clear from the table that there was higher number of total branches up to N-1 level. The branch number ranged from 21-23. The number of branches flowering was also maximum up to N-1 with a range of 19-20 branches. The percentage of branches flowering varied and was not consistent (Table 69).

The total number of flowers produced the number of fruit set and percentage was higher up to N-1 level in the higher range branches.

Correlation coefficient between total branches produced and branches bearing flowers was significant with ‘r’ value 0.99.

Correlation coefficient between total branches produced and total number of flower was significant with ‘r’ value 0.91.

Correlation coefficient between total branches produced and total number of fruit set was significant with ‘r’ value 0.95.

Correlation coefficient between total branches produced bearing flowers and total flowers produced were significant with ‘r’ value 0.93.

Correlation coefficient between total branches produced bearing flower and total number of fruit set were significant in the higher range with ‘r’ values 0.97.

Correlation coefficient between total flowers produced and total fruit set was significant with ‘r’ value 0.95.

Table 1: Mean number of branches at a given branch order in Kalipatti lower strata of canopy

Tree No.	Branch order						
	6	**7**	**8**	**9**	**10**	**11**	**12**
1	3.8	4.0	4.8	5.9	4.5	3.5	1.9
2	2.1	3.7	4.8	4.0	3.4	2.1	1.7
3	3.0	4.7	6.1	6.0	2.4	0.5	
4	4.5	5.5	5.9	3.1			
5	2.8	4.1	3.0	1.6	1.6	0.9	0.2
6	4.7	5.4	4.7	3.9	2.2		
7	4.1	4.7	6.3	7.1	1.7	1.5	0.5
8	4.1	5.0	6.3	5.3	2.1	1.5	
9	3.2	6.1	8.2	8.3	4.1	1.9	1.0
10	3.2	5.4	6.6	6.3	5.1	2.4	0.6
11	4.2	5.8	4.6	4.1	2.5	0.8	0.4
12	2.9	4.3	4.5	4.0	3.1	2.1	1.0
13	1.6	2.6	3.4	5.1	4.3	0.2	
14	1.1	3.0	3.9	3.2	2.8	3.1	2.6
15	2.8	3.6	4.0	4.3	3.0	1.0	0.8
16	3.9	5.2	5.2	3.5	1.4	0.5	0.2
Total	52.0	73.1	82.3	75.7	44.2	22.0	10.9
Mean	3.25	4.6	5.1	4.7	2.9	1.6	1.0
S.D.±	1.03	1.01	1.35	1.69	1.13	1.00	0.77
C.V.%	31.78	22.16	26.21	35.75	38.48	63.56	77.84
S.I%	26.71	42.85	45.73	36.62	21.84	6.90	2.65
A.V.	2.22	3.56	3.80	3.04	1.81	0.57	0.22

Table 2: Mean number of branches at a given branch order in Kalipatti middle strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2	3.3	3.4	2.4	1.1	0.4
2	2.3	2.5	0.9	0.6		
3	2	2.2	1	0.6		
4	2.2	1.7	1	0.2		
5	2.4	3.1	1.9	1		
6	1.4	1.6	0.2			
7	1.4	1.7	3	2	1.8	0.3
8	2.4	2.3	2.4	1.2	0.5	0.3
9	2.7	3.1	2.7	1.5	0.7	0.6
10	2.7	3.3	2.9	2.3	0.3	
11	2.3	2.2	1.2	0.6		
12	3.4	1.6	0.8	0.7	0.4	
13	2.1	2.4	1.9	1.2	1	0.3
14	2.5	1.9	1.5	0.2		
15	1.7	1.5	1.4	1.1	1.3	0.2
16	1.6	2	1.7	0.8	0.2	
Total	35.10	36.40	27.90	16.40	7.30	2.10
Mean	2.19	2.28	1.74	1.09	0.81	0.35
S.D.±	0.52	0.63	0.92	0.69	0.53	0.14
C.V.%	23.86	27.64	52.60	67.74	116.21	105.02
S.I%	49.13	48.42	24.31	11.74	8.26	6.24
A.V.	1.67	1.65	0.83	0.40	0.28	0.21

Table 3: Mean number of branches at a given branch order in Kalipatti upper strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.4	4.4	4.9	4.5	4.7	2.9
2	4.7	4.6	4.9	1.7	0.3	
3	3.6	3.9	3.4	2.4	0.4	0.4
4	4	4.8	4.6	2		
5	6.1	6	2.4	0.6		
6	4.2	5.4	4.6	1.3		
7	3.2	4.8	5.1	5.3	0.1	1.4
8	6	5.8	4.3	2.2		
9	3.5	5.3	5.2	4.5	3	2.6
10	5.9	5.6	4.9	3	1.6	0.5
11	3	4.3	3.3	2.9	1	0.5
12	4.1	4.4	5.4	3.6	3.3	1.9
13	3.3	4.8	5	4.3	1.8	
14	2.6	3.7	4.2	3.8	1.5	
15	3.5	3.6	3.2	2.2	2.1	0.2
16	4.2	4.7	3.6	2	0.3	
Total	64.30	76.10	69.00	46.30	20.10	10.40
Mean	4.02	4.76	4.31	2.89	1.68	1.30
S.D.±	1.15	0.72	0.88	1.32	1.42	1.06
C.V.%	28.66	28.66	28.66	28.66	28.66	28.66
S.I%	47.00	66.20	56.32	25.74	4.21	3.87
A.V.	2.87	4.04	3.44	1.57	0.26	0.24

Table 4: Mean number of branches at a given branch order in oval lower strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	3.6	3.7	1.6	0.5	0.4	0.4
2	2.6	2.9	2	0.6	0.5	0.3
Total	6.20	6.60	3.60	1.10	0.90	0.70
Mean	3.10	3.30	1.80	0.55	0.45	0.35
S.D.±	0.71	0.57	0.28	0.07	0.07	0.07
C.V%.	22.81	17.14	15.71	12.86	15.71	20.20
S.I%	64.67	73.90	41.00	12.95	10.25	7.55
A.V.	2.39	2.73	1.52	0.48	0.38	0.28

Table 5: Mean number of branches at a given branch order in oval middle strata of canopy

Tree No.	Branch order				
	6	**7**	**8**	**9**	**10**
1	1.3	1.2	1.3	1.7	0.8
2	1	1.4	1.8	1.3	0.7
Total	2.30	2.60	3.10	3.00	1.50
Mean	1.15	1.30	1.55	1.50	0.75
S.D.±	0.21	0.14	0.35	0.28	0.07
C.V%.	18.45	10.88	22.81	18.86	9.43
S.I%	52.10	64.37	66.47	67.62	37.74
A.V.	0.94	1.16	1.20	1.22	0.68

Table 6: Mean number of branches at a given branch order in oval upper strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.1	2.5	2.8	2.6	2.2	0.6
2	2	2.2	3.7	4.9	3	0.7
Total	4.10	4.70	6.50	7.50	5.20	1.30
Mean	2.05	2.35	3.25	3.75	2.60	0.65
S.D.±	0.07	0.21	0.64	1.63	0.57	0.07
C.V.%	3.45	9.03	19.58	43.37	21.76	10.88
S.I%	40.39	43.63	53.34	43.34	41.52	11.82
A.V.	1.98	2.14	2.61	2.12	2.03	0.58

Table 7: Mean number of branches at a given branch order in Singapore lower strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.8	2.8	3.9	4.3	4	2.6
2	2.4	3.1	3.8	4.5	4	1.3
Total	5.20	5.90	7.70	8.80	8.00	3.90
Mean	2.60	2.95	3.85	4.40	4.00	1.95
S.D.±	0.28	0.21	0.07	0.14	0.00	0.92
C.V.%	10.88	7.19	1.84	3.21	0.00	47.14
S.I%	51.49	60.84	83.98	94.64	88.89	22.91
A.V.	2.32	2.74	3.78	4.26	4.00	1.03

Table 8: Mean number of branches at a given branch order in Singapore middle strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	1.7	2.1	1.6	0.8	0.6	0.2
2	1.3	1.6	0.9	1.1	0.2	
Total	3.00	3.70	2.50	1.90	0.80	0.20
Mean	1.50	1.85	1.25	0.95	0.40	0.20
S.D.±	0.28	0.35	0.49	0.21	0.28	
C.V%.	18.86	19.11	39.60	22.33	70.71	
S.I%	57.96	71.26	35.95	35.14	5.58	9.52
A.V.	1.22	1.50	0.76	0.74	0.12	0.20

Table 9: Mean number of branches at a given branch order in Singapore upper strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.2	3.1	4.2	5.4	5.3	3.2
2	2.3	3	3.1	3.7	3.8	2.8
Total	4.50	6.10	7.30	9.10	9.10	6.00
Mean	2.25	3.05	3.65	4.55	4.55	3.00
S.D.±	0.07	0.07	0.78	1.20	1.06	0.28
C.V.%	3.14	2.32	21.31	26.42	23.31	9.43
S.I%	40.36	55.17	53.19	62.00	64.62	50.32
A.V.	2.18	2.98	2.87	3.35	3.49	2.72

Table 10: Mean number of branches at a given branch order in Bombay lower strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2	2.6	3.2	2.9	2.3	1.2
2	2.7	3.4	4.2	4.5	1.2	0.4
Total	4.70	6.00	7.40	7.40	3.50	1.60
Mean	2.35	3.00	3.70	3.70	1.75	0.80
S.D.±	0.49	0.57	0.71	1.13	0.78	0.57
C.V.%	21.06	18.86	19.11	30.58	44.45	70.71
S.I%	41.22	54.10	66.51	57.08	21.60	5.21
A.V.	1.86	2.43	2.99	2.57	0.97	0.23

Table 11: Mean number of branches at a given Branch order in Bombay middle strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	1	1.3	1.8	1.3	1	0.9
2	1.6	2.2	1.4	0.7		
Total	2.60	3.50	3.20	2.00	1.00	0.90
Mean	1.30	1.75	1.60	1.00	1.00	0.90
S.D.±	0.42	0.64	0.28	0.42		
C.V%.	32.64	36.37	17.68	42.43		
S.I%	39.81	50.62	59.87	26.17	45.45	40.91
A.V.	0.88	1.11	1.32	0.58	1.00	0.90

Table 12: Mean number of branches at a given Branch order in Bombay upper strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.4	3.4	3.8	2.7	2.2	0.7
2	2.2	2.4	4.2	4	3	1.6
Total	4.60	5.80	8.00	6.70	5.20	2.30
Mean	2.30	2.90	4.00	3.35	2.60	1.15
S.D.±	0.14	0.71	0.28	0.92	0.57	0.64
C.V%.	6.15	24.38	7.07	27.44	21.76	55.34
S.I%	51.39	52.21	88.50	57.88	48.44	12.23
A.V.	2.16	2.19	3.72	2.43	2.03	0.51

Table 13: Mean number of branches at a given Branch order in Cricket Ball lower strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.7	3.4	4.2	4.5	1.9	1
2	2.8	4	4.7	3	3	1.7
Total	5.50	7.40	8.90	7.50	4.90	2.70
Mean	2.75	3.70	4.45	3.75	2.45	1.35
S.D.±	0.07	0.42	0.35	1.06	0.78	0.49
C.V%.	2.57	11.47	7.95	28.28	31.75	36.66
S.I%	57.01	69.70	87.16	57.22	35.58	18.19
A.V.	2.68	3.28	4.10	2.69	1.67	0.86

Table 14: Mean number of branches at a given Branch order in Cricket Ball middle strata of canopy

Tree No.	Branch order				
	6	**7**	**8**	**9**	**10**
1	1.4	1.8	2.2	1.1	0.4
2	1.5	1.9	2.4	0.9	
Total	2.90	3.70	4.60	2.00	0.40
Mean	1.45	1.85	2.30	1.00	0.40
S.D.±	0.07	0.07	0.14	0.14	
C.V%.	4.88	3.82	6.15	14.14	
S.I%	57.47	74.14	89.94	35.77	
A.V.	1.38	1.78	2.16	0.86	

Table 15: Mean number of branches at a given Branch order in Cricket Ball upper strata of canopy

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2	2.8	4.7	4.4	2.3	1.8
2	2	3.1	3.4	4.2	4.2	2.2
Total	4.00	5.90	8.10	8.60	6.50	4.00
Mean	2.00	2.95	4.05	4.30	3.25	2.00
S.D.±	0.00	0.21	0.92	0.14	1.34	0.28
C.V.%	0.00	7.19	22.70	3.29	41.34	14.14
S.I%	42.55	58.25	66.61	88.48	40.56	36.54
A.V.	2.00	2.74	3.13	4.16	1.91	1.72

Table 32: Overall branch order contribution in Oval

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.80	2.56	2.28	1.76	1.36	0.40
2	2.24	2.60	3.00	2.36	1.68	0.40
Total	5.04	5.16	5.28	4.12	3.04	0.80
Mean	2.52	2.58	2.64	2.06	1.52	0.40
S. D.	0.40	0.03	0.51	0.42	0.23	0.00
C. V%.	15.71	1.10	19.28	20.60	14.89	0.00
S. I%.	70.80	85.06	71.03	54.52	43.12	13.33
A. V.	2.12	2.55	2.13	1.64	1.29	0.40

Table 33: Overall branch order contribution Singapore

Tree No.	Branch order					
	6	**7**	**8**	**9**	**10**	**11**
1	2.68	3.20	3.88	4.20	3.96	2.40
2	2.40	3.08	3.12	3.32	3.20	1.64
Total	5.08	6.28	7.00	7.52	7.16	4.04
Mean	2.54	3.14	3.50	3.76	3.58	2.02
S. D.	0.20	0.08	0.54	0.62	0.54	0.54
C. V%.	7.79	2.70	15.35	16.55	15.01	26.60
S. I. %	55.76	72.74	70.54	74.71	72.44	35.30
A. V.	2.34	3.06	2.96	3.14	3.04	1.48

Table 34: Overall branch order contribution Bombay

Tree No.	Branch order					
	6	7	8	9	10	11
1	2.16	2.92	3.52	3.40	1.64	1.04
2	2.60	3.20	3.92	3.08	2.40	1.32
Total	4.76	6.12	7.44	6.48	4.04	2.36
Mean	2.38	3.06	3.72	3.24	2.02	1.18
S. D.	0.31	0.20	0.28	0.23	0.54	0.20
C. V%.	13.07	6.47	7.60	6.98	26.60	16.78
S. I. %	52.78	73.01	87.68	76.88	37.82	25.05
A. V.	2.07	2.86	3.44	3.01	1.48	0.98

Table 35: Overall branch order contribution in Cricket ball

Tree No.	Branch order					
	6	7	8	9	10	11
1	2.44	3.20	4.44	4.00	1.84	1.12
2	2.52	3.60	4.20	3.24	2.88	1.56
Total	4.96	6.80	8.64	7.24	4.72	2.68
Mean	2.48	3.40	4.32	3.62	2.36	1.34
S. D.	0.06	0.28	0.17	0.54	0.74	0.31
C. V%.	2.28	8.32	3.93	14.85	31.16	23.22
S. I. %	54.58	70.21	93.48	69.43	36.59	23.17
A. V.	2.42	3.12	4.15	3.08	1.62	1.03

Table 31: Overall branch order contribution in Kalapatti

Tree No.	Branch order						
	6	7	8	9	10	11	12
1	3.28	3.88	5.24	5.12	4.12	1.56	0.76
2	3.64	4.36	4.24	2.52	1.48	0.84	0.68
3	3.44	4.20	4.20	3.60	1.12	0.20	
4	4.28	4.48	4.60	2.12			
5	4.52	5.32	2.92	1.28	0.64	3.60	0.80
6	4.12	4.48	3.80	2.08	0.88		
7	3.48	3.84	5.76	5.76	1.44	0.72	0.20
8	5.00	5.32	5.20	3.48	1.04	0.72	
9	3.76	5.08	6.44	5.72	3.12	1.00	0.40
10	4.72	5.84	5.76	4.64	2.80	0.96	0.24
11	3.80	4.40	3.64	3.04	1.40	0.32	0.16
12	4.16	4.00	4.28	3.32	2.72	0.84	0.04
13	2.80	3.32	4.12	4.24	2.84	0.20	
14	2.48	3.00	3.84	2.88	1.72	1.24	1.04
15	3.20	3.44	3.44	3.04	2.56	0.48	0.32
16	3.88	4.56	4.20	2.52	0.76	0.20	0.08
Total	60.56	69.52	71.68	55.36	28.64	12.88	4.72
Mean	3.79	4.35	4.48	3.46	1.91	0.92	0.43
S.D	0.68	0.78	0.96	1.32	1.04	0.87	0.34
C.V%.	17.92	17.88	21.34	38.13	54.51	94.87	78.34
S.I%	48.24	55.41	54.72	33.24	13.49	0.73	1.44
A.V.	3.11	3.57	3.52	2.14	0.87	0.05	0.09

Table 16: Number of main branches producing the given lower order branches in lower strata of canopy in Kalipatti

Tr/br	6	7	8	9	10	11	12	13
1	10	10	10	10	8	6	4	2
2	10	10	10	9	9	3	3	
3	10	10	10	8	5	2		
4	10	10	9	6				
5	10	10	9	6	5	2	1	
6	10	10	9	7	2			
7	10	10	10	10	2	1	1	
8	10	10	10	8	3	3	S	
9	10	10	10	10	10	6	3	
10	10	10	10	10	8	7	3	1
11	10	10	9	8	8	3	2	
12	10	10	10	9	7	3	2	
13	10	10	10	10	9	6	1	
14	10	10	10	8	7	5	5	1
15	10	10	10	9	7	3	2	
16	10	10	10	9	4	1	1	
Total	160	160	156	137	94	51	28	4
Mean	10	10	9.75	8.56	6.26	3.64	2.33	1.33
S.D.±	0	0	0.44	1.36	2.60	1.98	1.30	0.57
C.V%.	0	0	4.58	15.93	41.55	54.48	55.82	43.30
S.I%	100	100	93.02	71.97	36.62	27.63	20.61	37.79
A.V.	10	10	9.3	7.19	3.66	2.77	2.06	3.77

Table 17: Number of main branches producing the given middle order branches in Middle strata of canopy in Kalipatti

Tr/br	6	7	8	9	10	11	12	13
1	5	5	5	5	4	2	1	1
2	5	5	5	3	1			
3	5	5	5	4	3			
4	5	5	4	4	1			
5	5	5	5	3	2			
6	5	5	3	1				
7	5	5	5	5	4	3	1	1
8	5	5	5	4	3	1	1	
9	5	5	5	5	3	2	2	1
10	5	5	5	5	4	1		
11	5	5	4	3	1			
12	5	5	4	2	2	2		
13	5	5	5	5	3	2	1	
14	5	5	4	3	1			
15	5	5	5	4	3	3	1	
16	5	5	5	4	2	1		
Total	80	80	74	60	37	17	7	3
Mean	5	5	4.62	3.75	2.46	1.88	1.16	1
S.D.±	0	0	0.61	1.18	1.12	0.78	0.40	0
C.V%.	0	0	13.38	31.55	45.62	41.38	34.99	0
S.I%	100	100	80.11	51.33	33.53	36.90	37.92	100
A.V.	5	5	4.0	2.56	1.67	1.84	1.89	5

Table 18: Number of main branches producing the given upper order branches in upper strata of canopy in Kalipatti

Tr/br	6	7	8	9	10	11	12	13
1	10	10	10	10	10	9	9	9
2	10	10	10	10	7	1		
3	10	10	9	8	5	1	1	
4	10	10	10	9	6			
5	10	10	9	4	2			
6	10	10	10	10	4			
7	10	10	10	9	9	4	3	2
8	10	10	10	7	3			
9	10	10	10	10	8	5	5	2
10	10	10	10	10	7	6	3	2
11	10	10	10	9	9	1		
12	10	10	9	9	8	7	5	1
13	10	10	10	10	9	4		
14	10	10	10	10	10	3		
15	10	10	10	10	6	5	1	
16	10	10	10	10	9	5	1	
Total	160	160	157	145	112	51	28	13
Mean	10	10	9.81	9.06	7	4.25	3.5	2.6
S.D.±	0	0	0.40	1.61	2.47	2.49	2.77	1.94
C.V%.	0	0	4.10	17.77	35.37	58.60	79.35	74.97
S.I%	100	100	94.09	74.51	45.23	19.54	8.02	32.53
A.V.	10	10	9.4	7.45	4.52	1.95	0.80	3.25

Table 19: Number of main branches producing the given lower order branches in Lower strata of canopy in Oval

Tr/br	6	7	8	9	10	11	12
1	10	8	4	2	2	1	
2	10	10	10	9	6	5	1
Total	20	18	14	11	8	6	1
Mean	10	9	7	5.5	4	3	1
S.D.±	0	1.41	7.24	4.9	2.82	2.82	0
C.V%.	0	15.71	60.60	89.99	70.71	94.28	0
S.I%	100	75.85	27.57	6.11	19.52	3.43	100
A.V.	10	7.58	2.75	0.61	1.95	0.34	10

Table 20: Number of main branches producing the given middle order branches in middle strata of canopy in Oval

Tr/br	6	7	8	9	10
1	5	5	5	5	2
2	5	5	5	4	2
Total	10	10	10	9	4
Mean	5	5	5	4.5	2
S.D.±	0	0	0	0.70	0
C.V%.	0	0	0	15.71	0
S.I%	100	100	100	42.14	100
A.V.	5	5	5	2.1	5

Table 21: Number of main branches producing the given upper order branches in upper strata of canopy in Oval

Tr/br	6	7	8	9	10	11
1	10	10	10	9	8	3
2	10	10	10	10	10	3
Total	20	20	20	19	18	6
Mean	10	10	10	9.5	9	3
S.D.±	0	0	0	0.70	1.41	0
C.V%.	0	0	0	7.44	15.71	0
S.I%	100	100	100	87.92	90	
A.V.	10	10	10	8.79	9	

Table 22: Number of main branches producing the given lower order branches in Lower strata of canopy in Singapore

Tr/br	6	7	8	9	10	11	12	13
1	10	10	10	10	9	8	4	4
2	10	10	10	9	9	8	4	2
Total	20	20	20	19	18	16	8	6
Mean	10	10	10	9.5	9	8	4	3
S.D.±	0	0	0	0.70	0	0	0	1.41
C.V%.	0	0	0	7.44	0	0	0	47.14
S.I%	100	100	100	87.92	100	100	100	75
A.V.	10	10	10	8.79	10	10	10	7.5

Table 23: Number of main branches producing the given middle order branches in middle strata of canopy in Singapore

Tr/br	6	7	8	9	10
1	5	5	4	2	1
2	5	5	3	3	2
Total	10	10	7	5	3
Mean	5	5	3.5	2.5	1.5
S.D.±	0	0	0.70	0.70	0.70
C.V%.	0	0	20.20	28.28	47.14
S.I%	100	100	69.82	59.76	39.64
A.V.	5	5	3.45	2.98	1.98

Table 24: Number of main branches producing the given upper order branches in upper strata of canopy in Singapore

Tr/br	6	7	8	9	10	11	12	13
1	10	10	10	10	10	9	6	2
2	10	10	9	8	6	5	3	1
Total	20	20	19	18	16	14	9	3
Mean	10	10	9.5	9	8	7	4.5	1.5
S.D.±	0	0	0.70	1.41	2.82	2.82	2.12	0.70
C.V%.	0	0	7.44	15.71	35.35	40.40	47.14	47.14
S.I%	100	100	87.92	75.85	51.71	46.35	39.64	39.64
A.V.	10	10	8.79	7.58	5.17	4.63	3.96	3.96

Table 25: Number of main branches producing the given lower order branches in Lower strata of canopy in Bombay

Tr/br	6	7	8	9	10	11	12
1	10	10	10	9	7	6	2
2	10	10	10	7	3	1	1
Total	20	20	20	16	10	7	3
Mean	10	10	10	8	5	3.5	1.5
S.D.±	0	0	0	1.41	2.82	3.53	0.70
C.V%.	0	0	0	17.67	56.56	101.01	47.14
S.I%	100	100	100	73.17	31.02	-0.59	39.64
A.V.	10	10	10	7.31	3.10	0.59	3.96

Table 26: Number of main branches producing the given middle order branches in middle strata of canopy in Bombay

Tr/br	6	7	8	9	10	11
1	5	5	5	5	4	3
2	5	5	3	2		
Total	10	10	8	7	4	3
Mean	5	5	4	3.5	4	3
S.D.±	0	0	1.41	2.12		
C.V%.	0	0	35.35	60.60		
S.I%	100	100	51.71	27.57	8	100
A.V.	5	5	2.58	1.37	4	5

Table 27: Number of main branches producing the given upper order branches in upper strata of canopy in Bombay

Tr/br	6	7	8	9	10	11
1	10	10	10	9	8	3
2	10	10	10	10	6	4
Total	20	20	20	19	14	3.5
Mean	10	10	10	9.5	7	3
S.D.±	0	0	0	0.70	1.41	0.70
C.V%.	0	0	0	7.44	20.20	20.20
S.I%	100	100	100	87.92	69.82	69.82
A.V.	10	10	10	8.79	6.98	6.98

Table 28: Number of main branches producing the given lower order branches in Lower strata of canopy in Cricket ball

Tr/br	6	7	8	9	10	11	12
1	10	10	10	7	7	5	3
2	10	10	10	9	6	5	1
Total	20	20	20	16	13	10	4
Mean	10	10	10	8	6.5	5	2
S.D.±	0	0	0	1.41	0.70	0	1.41
C.V%.	0	0	0	17.67	10.87	0	70.71
S.I%	100	100	100	73.17	82.75	100	19.52
A.V.	10	10	10	7.31	8.27	10	1.95

Table 29: Number of main branches producing the given middle order branches in middle strata of canopy in Cricket ball

Tr/br	6	7	8	9	10
1	5	5	3	3	2
2	5	5	5	3	
Total	10	10	8	6	2
Mean	5	5	4	3	2
S.D.±	0	0	1.41	0	
C.V%.	0	0	35.35	0	
S.I%	100	100	51.71	100	100
A.V.	5	5	2.58	5	5

Table 30: Number of main branches producing the given upper order branches in upper strata of canopy in Cricket ball

Tr/br	6	7	8	9	10	11	12	13
1	10	10	10	9	6	5	1	
2	10	10	10	10	9	7	1	
Total	20	20	20	19	15	12	2	
Mean	10	10	10	9.5	7.5	6	1	
S.D.±	0	0	0	0.70	2.12	1.41	0	
C.V%.	0	0	0	7.44	28.28	23.57	0	
S.I%	100	100	100	87.92	59.76	65.51	100	
A.V.	10	10	10	8.79	5.97	6.55	10	

Table 36: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 160 branches) at lower strata of tree canopy in kalipatti

Tr/br order		7	8	9	10	11	12	13	14
No. of branches produced at the	2	6	8	30	13	12			
	3	8	28	16	9	13			
	4	1	7	5	2	2			
	5								

Table 37: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 80 branches) at Middle strata of tree canopy in kalipatti

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2	4	10	12	8		
	3	2	15	12	3		
	4	4	7	3			
	5						

Table 38: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 160 branches) at upper strata of tree canopy in kalipatti

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2	4	20	36	32	12	
	3		3	20	17		
	4	6	7				
	5		3				

Table 39: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at lower strata in Oval variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2		1	5	3	6	1
	3			2	2		
	4						
	5						

Table 40: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 10 branches) at Middle strata in Oval variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2		1	4	5		
	3						
	4						
	5						

Table 41: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at upper strata in Oval variety

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Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2			4	8	5	
	3						
	4		3				
	5						

Table 42: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at Lower strata in Singapore variety

Tr/br order		7	8	9	10	11	12	13
No. of branches produced at the	2				5	8	3	
	3			2	2			
	4							
	5							

Table 43: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 10 branches) at Middle strata in Singapore variety

.

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2	3			2		
	3	4					
	4		1				
	5						

Table 44: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at upper strata in Singapore variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2			2	4	5	4
	3			3		2	
	4						
	5						

Table 45: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at Lower strata in Bombay variety

Tr/br order		7	8	9	10	11	12	13
No. of branches produced at the	2		2	2	4	5	3	
	3		2	2				
	4							
	5							

Table 46: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 10 branches) at Middle strata in Bombay variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2				4	1	
	3		3	2			
	4						
	5						

Table 47: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at upper strata in Bombay variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2			4	8	3	
	3			4	1		
	4						
	5						

Table 48: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at Lower strata in Cricket ball variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2			2	2	9	2
	3		2	3			
	4						
	5						

Table 49: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 10 branches) at Middle strata in Cricket ball variety

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2			5			
	3			4	1		
	4						
	5						

Table 50: Effect of Extent of branching at 6th order on production of branches at subsequent orders (out of 20 branches) at Upper strata in Cricket ball variety

.

Tr/br order		7	8	9	10	11	12
No. of branches produced at the	2		1	3	3	8	2
	3			3			
	4						
	5						

Table 51: Branch bifurcation ratios Kalipatti

Branch order range → / End order ↓	13-15		10-12		7-9	
	Br. No.	**Ratio**	**Br. No.**	**Ratio**	**Br. No.**	**Ratio**
N	70	0.81	830	0.94	476	1.27
N-1	86	1.25	880	1.24	375	1.72
N-2	69	0.76	707	1.43	218	2.87
N-3	91	0.99	493	1.71	76	5.85
N-4	92	1.70	288	2.64	13	13.00
N-5	54	1.93	109	2.87	1	
N-6	28	1.27	38	9.50		
N-7	22	1.38	4			
N-8	16	2.29				
N-9	7					
Total	535		3349		1156	
Average Index		0.88		0.75		0.58

Table 52: Branch bifurcation ratios Oval

Branch order range ▶	10-12		7-9		5-6	
End order ▼	Br. No.	Ratio	Br. No.	Ratio	Br. No.	Ratio
N	90	1.10	57	1.73	15	15.00
N-1	82	1.67	33	1.43	1	0.06
N-2	49	1.36	23	1.92		
N-3	36	1.38	12			
N-4	26	2.36				
N-5	11	5.50				
N-6	2					
Total	296		125		16	
Average Index		0.70		0.60		

Table 53: Branch bifurcation ratios Singapore

Branch order range →	13-15		10-12		7-9	
End order ↓	**Br. No.**	**Ratio**	**Br. No.**	**Ratio**	**Br. No.**	**Ratio**
N	26	0.74	96	0.99	33	1.94
N-1	35	1.59	97	1.17	17	1.06
N-2	22	1.29	83	1.57	16	2.29
N-3	17	1.13	53	1.33	7	
N-4	15	1.36	40	1.54		
N-5	11	1.10	26	3.25		
N-6	10	1.43	8			
N-7	7	7.00				
N-8	1					
Total	144		403		73	
Average Index	Index	0.82		0.81		0.60

Table 54: Branch bifurcation ratios Bombay

Branch order Range →	13-11		10-8	
End order ↓	Br. No.	Ratio	Br. No.	Ratio
N	42	1.62	129	1.63
N-1	26	1.04	79	1.25
N-2	25	0.96	63	1.85
N-3	26	1.18	34	2.43
N-4	22	1.83	14	7.00
N-5	12	4.0	2	
N-6	3	3.00		
N-7	1			
Total	157		321	
Average Index	Index	0.73		0.60

Table 55: Branch bifurcation ratios Cricket Ball

Branch order range →	12-14		9-11		7-8	
End order ↓	Br. No.	Ratio	Br. No.	Ratio	Br. No.	Ratio
N	21	0.91	119	1.03	30	1.43
N-1	23	2.09	115	1.29	21	3.00
N-2	11	1.22	89	1.62	7	7.00
N-3	9	1.13	55	1.45	1	
N-4	8	1.14	38	2.92		
N-5	7	1.17	13	13.00		
N-6	6	6.00	1			
N-7	1	1.00				
N-8	1					
Total	87		430		59	
Average Index	Index	0.76		0.72		0.5

Table 58: Correlation between Branch number and Bearing units in the variety Kalipatti branches up to 13-15 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	70	46	65.7	231	60	26.0
N-1	86	51	59.3	192	41	21.4
N-2	69	40	58.0	161	48	29.8
N-3	91	5	54.9	177	36	20.3
N-4	92	42	45.7	167	40	24.0
N-5	54	35	64.8	91	17	18.7
N-6	28	17	60.7	67	10	14.9
N-7	22	12	54.5	51	12	23.5
N-8	16	8	50.0	44	8	18.2
N-9	7	5	71.4	10	4	40.0
N-10	0	0				
N-11	1	0	0.0			

Correlation between branches and bearing units in Kalipatti

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.93	0.97	1	
Column 4	0.90	0.95	0.99	1

Table 57: Correlation between Branch number and Bearing units in the variety Kalipatti branches up to 10-12 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	830	688	82.9	3723	981	26.3
N-1	880	630	71.6	2579	579	22.5
N-2	7.7	484	68.5	1907	451	23.6
N-3	493	322	65.3	1079	251	23.3
N-4	288	168	58.3	680	111	16.3
N-5	109	71	65.1	146	28	19.2
N-6	38	17	44.7	29	9	31.0
N-7	4	2	50.0	5	1	20.0

Correlation between branches and bearing units in Kalipatti

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.93	0.97	1	
Column 4	0.90	0.95	0.99	1

Table 56: Correlation between Branch number and Bearing units in the variety Kalipatti branches up to 7-9 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	476	374	78.6	2561	572	22.3
N-1	375	215	57.3	1540	263	17.1
N-2	218	102	46.8	864	185	21.4
N-3	76	44	57.9	410	79	19.3
N-4	13	5	38.5	106	24	22.6
N-5	1	0	0.0	4	1	25.0

Correlation between branches and bearing units in Kalipatti

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.97	1		
Column 3	0.98	0.99	1	
Column 4	0.94	0.98	0.98	1

Table 61: Correlation between Branch number and Bearing units in the variety Oval branches up to 10-12 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	90	86	95.6	470	76	16.2
N-1	82	75	91.5	330	51	15.5
N-2	49	43	87.8	167	25	15.0
N-3	36	30	83.3	109	16	14.7
N-4	26	14	53.8	50	5	10.0
N-5	11	4	36.4	9	2	22.2
N-6	2	0	0.0	3	1	33.3

Correlation between branches and bearing units in Oval

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.97	0.98	1	
Column 4	0.96	0.97	0.99	1

Table 60: Correlation between Branch number and Bearing units in the variety Oval branches up to 7-9 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	57	55	96.5	310	51	16.5
N-1	33	30	90.9	146	25	17.1
N-2	23	19	82.6	60	12	20.0
N-3	12	7	58.3	16	5	31.3

Correlation between branches and bearing units in Oval

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	1	1		
Column 3	0.99	0.99	1	
Column 4	0.99	0.99	0.99	1

Table 59: Correlation between Branch number and Bearing units in the variety Oval branches up to 5-6 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	15	14	93.33	40	8	15
N-1	1	1	100	3	1	1

Correlation between branches and bearing units in Oval

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	1	1		
Column 3	1	1	1	
Column 4	1	1	1	1

Table 64: Correlation between Branch number and Bearing units in the variety Singapore branches up to 13-15 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	29	26	89.7	97	22	22.7
N-1	40	35	87.5	131	24	18.3
N-2	22	19	86.4	62	11	17.7
N-3	17	15	88.2	48	7	14.6
N-4	15	11	73.3	36	9	25.0
N-5	11	6	54.5	9	3	33.3
N-6	10	8	80.0	19	5	26.3
N-7	7	6	85.7	14	4	28.6
N-8	1	0	0.0			
N-9	152	126	82.9	416	85	20.4

Correlation between branches and bearing units in Singapore

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.98	0.99	1	
Column 4	0.95	0.96	0.97	1

Table 63: Correlation between Branch number and Bearing units in the variety Singapore branches up to 10-12 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	96	92	95.8	444	94	
N-1	97	92	94.8	429	79	18.4
N-2	83	79	95.2	282	46	16.3
N-3	53	50	94.3	181	32	17.7
N-4	40	34	85.0	91	15	16.5
N-5	26	12	46.2	42	10	23.8
N-6	8	5	62.5	3	1	33.3
N-7	403	364	90.3	1272	277	18.8

Correlation between branches and bearing units in Singapore

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.97	0.97	1	
Column 4	0.94	0.94	0.98	1

Table 62: Correlation between Branch number and Bearing units in the variety Singapore branches up to 7-9 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	33	31	93.9	310	51	16.5
N-1	17	14	82.4	146	25	17.1
N-2	16	12	75.0	60	12	20.0
N-3	7	6	85.7	16	5	31.3
N-4	73	63	86.3	532	93	17.5

Correlation between branches and bearing units in Singapore

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.96	0.98	1	
Column 4	0.96	0.98	0.99	1

Table 66: Correlation between Branch number and Bearing units in the variety Bombai branches up to 11-13 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	42	34	81.0	280	65	23.2
N-1	26	21	80.8	213	39	18.3
N-2	25	22	88.0	188	30	16.0
N-3	26	21	80.8	123	22	17.9
N-4	22	13	59.1	71	13	18.3
N-5	12	4	33.3	8	1	12.5
N-6	3	0	0.0			
N-7	1	0	0.0			
N-8	157	115	73.2	883	170	19.3

Correlation between branches and bearing units in Bombai

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.98	1		
Column 3	0.90	0.95	1	
Column 4	0.95	0.95	0.97	1

Table 65: Correlation between Branch number and Bearing units in the variety Bombai branches up to 8-10 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	129	104	80.6	673	165	24.5
N-1	79	61	77.2	441	97	22.0
N-2	63	47	74.6	234	38	16.2
N-3	34	15	44.1	89	17	19.1
N-4	14	6	42.85	39	6	15.4
N-5	2	1	50	5	1	20.0
N-6	321	234	72.89	1481	324	21.9

Correlation between branches and bearing units in Bombai

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.98	0.99	1	
Column 4	0.96	0.97	0.99	1

Table 69: Correlation between Branch number and Bearing units in the variety Cricket Ball branches up to 12-14 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	21	19	90.5	69	22	31.9
N-1	23	20	87.0	64	28	43.8
N-2	11	8	72.7	29	7	24.1
N-3	9	7	77.8	25	7	28.0
N-4	8	7	87.5	42	9	21.4
N-5	7	6	85.7	2		25.0
N-6	6	3	50.0	0		0.0
N-7	1	1	100.0	1		20.0
N-8	1	1	100.0			
N-9	87	72	82.8	76		31.0

Correlation between branches and bearing units in Cricket Ball

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.91	0.93	1	
Column 4	0.95	0.97	0.95	1

Table 68: Correlation between Branch number and Bearing units in the variety Cricket Ball branches up to 9-11 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	119	101	84.9	466	156	33.5
N-1	115	103	89.6	495	141	28.5
N-2	89	80	89.9	294	92	31.3
N-3	55	48	87.3	194	62	32.0
N-4	38	21	55.3	69	18	26.1
N-5	13	5	38.5	19	8	42.1
N-6	1	0	0			
N-7	430	358	83.25	1537	477	31.0

Correlation between branches and bearing units in Cricket Ball

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.98	0.98	1	
Column 4				

Table 67: Correlation between Branch number and Bearing units in the variety Cricket Ball branches up to 7-8 orders

Branch order from terminal	Total branches	Number of branches flowering	Per cent branches flowering	Total number of flowers produced	Total number of fruit set	Per cent fruits set
N	30	25	83.3	93	34	36.6
N-1	21	17	81.0	75	19	25.3
N-2	7	6	85.7	23	5	21.7
N-3	1	0	0.0			
N-4	59	48	81.4	191	58	30.4

Correlation between branches and bearing units in Cricket Ball

	Column 1	Columns 2	Column 3	Column 4
Column 1	1			
Column 2	0.99	1		
Column 3	0.98	0.98	1	
Column 4	0.98	0.99	0.95	1

CHAPTER V

DISCUSSION

The results obtained from the studies on vegetative growth, branching pattern, flowering and fruiting pattern in sapota are discussed in this Chapter.

Organisation in plants reflects the precisely controlled genetic program, which determines their development. The architecture is not to be confused with shape (or) physiognomy nor is it to be confused with growth habit. Since, this refers essentially to the ultimately expressed form of the organism and implicates size and it refers to a continuum (Tomlinson, 1978).

5.1 BRANCHING PATTERN

Aubreville (1964) on the lines of Tomlinson has described the architecture of Sapotaceae family as the architecture determined by monopodial trunk with rhythmic growth and spiral or decussate phyllotaxis bearing whorled branch tiers with similar phyllotaxis. Branches grow rhythmatically but are modular. Each branch is plagiotropic by apposition since, inflorescence is lateral the branches grow indefinitely.

Fagerlind (1943), on the other hand described architecture as a monopodial, orthotropic and episodically growing trunk, which produces tiers of modular branches. Each branch sympodial and plagiotropic by apposition,

with spiral or decussate (distichous) phyllitaxis. Branch modules are usually hapaxanthic.

But, the fundametal difference in the above models is sympodial growth. In the latter it is by apposition while, in the former by substitution. In Fagerlind's model old branches are progressively defoliated since their apical meristems are determinate by development of a terminal inflorescence. But, in Aubreville's model all the branch modules are leafy potentially even the oldest by virtue of their indeterminate growth and lateral inflorescence.

Though, there have been some studies in sapotaceae in respect of yield attributes there have not been any attempt to study the architecture of Sapota. We have taken five varieties and studied in detail the branching pattern at three canopy levels.

In the study on branching pattern in Kalipatti variety it is clear that at 6^{th} order of tree canopy after displacement of 5^{th} order branch a mean number of 2.19-4.02 number of 6^{th} order branches were produced. After displacement of 6^{th} order a mean number of 2.28 to 4.76 number of branches were produced in different strata of tree canopy of 7^{th} order. After a mean range of 1.74 to 5.10 number of followed displacement of 7^{th} order terminal further growth 8^{th} order branches were produced. Displacing the 8th order terminal a mean number of 1.09 to 4.70 number of 9^{th} order branches were produced. After 9^{th} order terminal was displaced a mean number of 0.81 to 2.90 number of branches

were produced, after displacement of 10th order terminal a mean number of 0.35 to 1.60 number of branches were produced.

This kind of branching conforms to Aubreville (1964) model which states clearly that the growth in Sapotaceae is monopodial with rhythmic growth and by syllepsis one or two lateral branches (usually third or fifth) at the lower side of the shoot at the level where the axis is bent upward.

While, studies on branching pattern in other four cultivars indicated the same pattern in that in the Oval variety after displacement of 6th order further growth was followed by a mean number of 1.15 to 3.10 number of branches. After displacement of 6th order terminal 1.30 to 3.30 number of 7th order branches were produced. After 7th order terminal was displaced 1.55 to 3.25 number of 8th order branches were produced, after displacement of 8th order terminal 0.55 to 3.75 number of 9th order branches were produced. After displacement of 9th order branches 0.45 to 2.60 number of 10th order branches were produced in all the strata of tree canopy.

In the variety Singapore the trend of branching indicated the same model of architecture in that, 6th order branches after displacement of 5th order branches have produced a mean number of 1.50 to 2.60 number of branches. After displacement of 6th order branches further growth was followed by a mean number of 1.85 to 3.05 number of branches. After 7th order branches were displaced a mean number of 1.25 to 3.85 number of 8th order branches were produced. After displacement of 8th order branches 0.95 to 4.55 number

of 9^{th} order branches were produced and the trend continued up to 11^{th} order with production of 0.20 to 3.0 number of branches after displacement of 10^{th} order terminal in all the strata of tree canopy.

Whilst, the studies in other two cultivars viz. Bombay, Cricket Ball revealed the same trend and that in Sapota irrespective of the strata and variety growth is monopodial with rhythmic growth and by syllepsis one or two lateral branches develop from the axils of the leaves at the lower side of the shoot at the level where the axis is bent upward. These branches in turn produce an initial long hypopodium and the process is repeated. Since, the reoriented terminal meristem continues its rhythmic growth with short inter nodes and lateral inflorescences. The result is a long-lived erect short shoot. New rosettes are added as the tier expands laterally and the result is the flat branch complex, which characterizes this model.

Since, the uppermost tier will branch repeatedly while the trunk axis remains dormant. Trees are characteristically flat topped here and there with individuals throwing up the next segment of the trunk as the leader undergoes extension.

5.2 COMPARISON OF BRANCHES AT DIFFERENT STRATA IN SAPOTA

In the Kalipatti variety all the branches in the lower strata canopy extended their branches up to 9^{th} order and the per cent of trees extending to the higher order beyond 9^{th} order to 12^{th} order decreased gradually, the

sustainability index values indicate that the probability per cent of any branch extending up to a given order was higher up to 9th order. This indicated by sustainability index values, which are 45.70 at 8th order, followed by 42.8 per cent at 7th order and 2.65 per cent at 12th order.

In the middle strata of tree canopy, the observed sixteen trees have extended their branches up to 8th order and per centage of trees extending to the higher order levels have declined with only seven trees extending to the 11th order. The sustainability index values also indicate the same with 48.4 per cent at 7th order followed 49.1 per cent at 6th order and 5.24 per cent at 11th order.

While, in the upper strata of the canopy, also same trend is indicated with sustainability index values, which are 66.2 per cent at 7th order followed by 56.32 per cent at 8th order and 3.87 per cent at 12th order.

This shows that in sapota variety Kalipatti the branching was maximum with highest sustainability value over 40 per cent up to 8th order though the branch orders continued to grow up to 12th order. All the strata observed in Kalipatti tree canopy behaved in the same manner with more number of branches concentrated in the lower order levels and less number of branches at higher order levels.

The same conclusion can be drawn from the studies on number of main branches producing the given lower order branches in the sapota. Here, in the lower strata of tree canopy the mean and sustainability index values indicate

that towards the higher branch orders the branch order presence is decreased. The mean values for the number of branches at 6^{th} and 7^{th} order is 10 each whereas mean value at 13^{th} order was 1.33. Similarly the Sustainability index values are 100 per cent each in 6^{th} and 7^{th} order while at 13^{th} order the value is 37.79 per cent.

In the middle strata of tree canopy the mean and sustainability index values indicate the same in that mean values at 6^{th} and 7^{th} order were five each while, at 13^{th} order it was one, similarly the sustainability values are 100 per-cent each in 6^{th} and 7^{th} order levels, while at 12^{th} order it is 37.92.

Mean values at the upper strata of tree canopy are 10 each at 6^{th} and 7^{th} order while, at 13^{th} order it is 2.60 only. Similarly sustainability index values 100 per cent each in 6^{th} and 7^{th} order levels, while at 13^{th} order is 32.53 per cent.

In studies on overall branching pattern of Kalipatti variety the same trend is observed here, the sustainability index maximum at 7^{th} order (55.4%) followed by 8^{th} order (54.72%) while it is lowest at 12^{th} order (1.441%). The mean values indicate that the mean number of branches at 8^{th} order is highest (4.48) followed by 7^{th} order (4.35) while it is lowest at 12^{th} order (0.43).

The studies on the other four cultivars indicated the same trend in that in the variety Oval the sustainability index values are more in the lower strata up to 7^{th} order. While, the value is more in the middle strata up to 9^{th} order and in

the upper strata the sustainability index values are more up to 8^{th} order indicating that vigor and growth of the variety is more in the lower levels of tree canopy.

In the variety Singapore, the sustainability index values are more in the lower strata up to 10^{th} order. While, the value is more in the middle strata up to 7^{th} order and in the upper strata the sustainability index values are more up to 10^{th} order indicating the variety Singapore is a prolific bearer

In the variety Bombay the sustainability index values show that in the lower strata the value was more up to 8^{th} order. While, in middle and upper strata it is up to 8^{th} order. This indicates that the vigor of the variety is high in the lower levels.

In the variety Cricket Ball and Singapore, the sustainability index values are more up to 8^{th} order in lower and middle strata while, it is up to 9^{th} order in the upper strata of tree canopy indicates the growth and vigor of the variety decreases with increase in the order level.

This indicates the growth and branching pattern in that all the branch modules are leafy potentially even in the oldest by virtue of their indeterminate growth and lateral inflorescences. The photosynthesic area is much more extensive. When the tree is young the plagiotropic apparatus can be closely fitted to light intensity of the forest under growth and the disposition of the leaf rosettes in tiers is seen as a mechanism to avoid mutual shading. When the tree

is old there is a large number of modules with a flowering potential so that the biotope is well inundated with diaspores. This mechanism is largely independent of whether the tree reiterates or not. This successful architecture is undoubtedly the result of precise organisational control of apical meristems (Attims, 1969).

5.3 BRANCH EXTENSION STUDIES

The results obtained from studies on effect of branching at 6^{th} order on production of branches at subsequent orders are discussed here.

These studies only reinforced the fact that in Kalipatti the concentration of branches are more at lower orders and the intensity decreases at higher levels and more clearly points out to the fact that if more number of branches are produced at 6^{th} order the branch extension is less and vice versa.

Branch Extension studies in Kalipatti lower strata of tree canopy revealed the same that if there were two branches produced in a maximum of 30 branches, out of 160 branches at 6^{th} order extended their growth up to 9^{th} order. If there were three branches produced, a maximum of 28 branches out of 160 branches extended up to 8^{th} order. If there were four branches produced a maximum of seven branches out of 160 branches extended up to 8^{th} order. In the middle strata of canopy the studies indicated that if there were two branches produced a maximum of twelve branches out of 80 branches extended up to 9^{th} order, if there were three branches produced at 6^{th} order a maximum of fifteen

branches out of 80 branches extended up to 8th order and if there were four branches produced a maximum of seven branches out of 80 branches extended up to 8th order. In the upper strata also if there were two branches produced a maximum of 36 branches out of 160 branches observed have extended up to 9th order. If there were three branches produced, a maximum of 20 branches out of 160 branches observed have extended up to 9th order. If there were four branches produced a maximum of seven branches out of 160 branches extended up to 8th order. If there were five branches produced three branches have extended up to 8th order.

The studies on other four varieties implied the same trend of branching in that in Oval variety in lower strata of tree canopy if there were two branches produced at 6th order a maximum of six branches out of 20 branches extended their growth up to 11th order. If there were three branches produced at 6th order a maximum of two branches out of 20 branches extended up to 9th order. In the middle strata of tree canopy if there were two branches produced at 6th order a maximum of five branches out of ten branches have extended up to 10th order .In the upper strata of tree canopy if there were two branches produced a maximum of eight branches out of 20 branches extended up to 10th order. If there were four branches produced a maximum of three branches out of 20 branches extended up to 8th order.

In Singapore variety branch extension studies in the lower strata of tree canopy indicated the same that if there were two branches produced a

maximum of eight branches extended growth up to 11th order. If there were three branches produced at the 6th order a maximum of two branches extended up to 9th order. In the middle strata of tree canopy the study indicated that if there were two branches produced at 6th order a maximum of two branches extended up to 10th order. If there were three branches produced at 6th order a maximum of four branches extended up to 7th order. In the upper strata of tree canopy the study indicated that if there were two branches produced at 6th order a maximum of five branches extended up to 11th order. If there were three branches produced a maximum of three branches extended up to 9th order

In Bombay variety branch extension studies in the lower strata of tree canopy indicated that if there were two branches produced a maximum of five branches extended growth up to 11th order. If there were three branches produced at the 6th order a maximum of two branches extended up to 9th order. In the middle strata of tree canopy the study indicated that if there were 2 branches produced at 6th order a maximum of 4 branches extended up to 10th order. If there were three branches produced at 6th order a maximum of three branches extended up to 9th order. In the upper strata of tree canopy the study indicated that if there were two branches produced at 6th order a maximum of eight branches extended up to 10th order. If there were three branches produced a maximum of four branches extended up to 9th order.

Branch extension studies in the lower strata of tree canopy in Cricket Ball variety indicated that if there were two branches produced a maximum of

nine branches extended growth up to 11th order. If there were three branches produced at the 6th order a maximum of two branches extended up to 9th order. In the middle strata of tree canopy the study indicated that if there were two branches produced at 6th order a maximum of five branches extended up to 9th order. If there were three branches produced at 6th order a maximum of four branches extended up to 9th order. In the upper strata of tree canopy the study indicated that if there were two branches produced at 6th order a maximum of eight branches extended up to 11th order. If there were three branches produced a maximum of three branches extended up to 9th order.

This is indicated in the Aubreville's model of architecture (1964) in that plagiotrophy of the branch is endured in its first module by the activity of the apical meristem of the orthotropic trunk. If this apex is removed it is replaced by the apex of one of the youngest branch tiers below which immediately became orthotropic. If this orthotropic trunk is cut off at a much lower level there is no proleptic substitution by a dormant meristem on the trunk rather there is dedifferentiation of the apical meristem of the plagiotropic branch module nearest the cut.

This could be due to proliferation of more branches at lower order resulting in more competition for resources and thereby restriction in extension growth. These results also overly indicate the possibility of canopy management by pruning and induction of more branches at lower orders sothat those branches may not extend beyond 9th order. This gives an understanding

that to contain the growth of the shoots/branches and to restrict the canopy. The pruning has to be employed in the initial phases of training so that more number of branches can be produced at lower orders, which in turn reduce the extension growth of the branch. This can pave way for High Density planting of sapota

5.4 BRANCH BIFURCATION RATIOS

The results obtained from the studies on branch bifurcation ratios are discussed in this chapter.

It is clear from the (Table 51) that in Kalipatti variety if the branch extension was up to 13-15 orders the number of branches produced at each lower order was lesser where as, when the growth was medium *i.e.* 10-12 orders the number of branches produced progressively increased from lower to higher order and there was an inverse relation with branch bifurcation ratios. Similar results was found when the total branch growth was up to 7-9 orders *i.e.* the lesser was the branch growth extension higher was the branch bifurcation ratios *i.e.* more number of branches were produced at the lower order.

Similar results were observed for other four cultivars viz. Oval, Singapore, Bombay and Cricket Ball in that in the Oval variety if the branch extension was up to 10-12 orders the number of branches produced at lower orders was lesser whereas, when the growth was medium i.e. up to 7-9 orders

the number of branches produced increased progressively with decreasing branch bifurcation ratios.

In the variety Singapore branch extension was inversely related to the number of branches produced at lower orders and branch bifurcation ratios. Here the number of branches produced at lower order increased progressively from higher (13-15 orders) to moderate (10-12orders) branch extension with decreasing branch bifurcation ratios.

In the variety Bombay if the branch extension was up to 11-13 orders the number of branches produced at each lower order was lesser whereas, when the extension was medium (8-10) the number of branches produced increased progressively with decreasing branch bifurcation ratios.

In the Cricket Ball variety also the relationship between the number of branches produced at lower order levels and branch bifurcation ratio was inversely related with branch extension in that in the longer branch of branch extension upto 12-14 orders. The number of branches was lesser at lower order levels and the number of branches increased to moderate branch growth extension with lesser branch bifurcation ratios.

5.5 FLOWERING PATTERN

The results obtained from the studies on flowering pattern are discussed here under.

If branch growth extension up to 13-15 orders the flowering was observed up to N-9 level orders from the terminal and in all the branches at all the orders per cent of displaced terminals flowering was more than 50 per cent but, the total number of flowers produced was maximum on the branches up to N-4. Similarly the total number of fruits set & per cent of fruit set was also higher up to N-4.

Similarly when the branch extension growth was moderate up to 10-12 orders the flowering was found up to N-7 from the terminal on the branch but, the total number of flowers and the number of fruits set was higher up to N-4 order.

When the branch extension growth was up to 7-9 orders, the flowering was found up to N-5 level and maximum flowering was concentrated up to N-3 level.

In the Oval variety maximum attributes of flowering and fruit set was observed up to N-4 level for longer branches (10-12 orders), N-2 for moderate branches (7-9 orders).

In Singapore variety which is a vigorous variety the attributes of flowering and fruit set was maximum up to N-4 level for longer branches (13-15 orders), N-3 level for moderate branches (10-12 orders) and N-4 level for shorter branches (7-9 orders).

In Bombay variety it was up to N-4 level that the attributes of flowering and fruit set were maximum in the longer branches (11-13 orders) and in the shorter branches (8-10 orders) it is up to N-3 level.

While, in the Cricket Ball variety the flowering and fruit set attributes were maximum up to N-4 level in longer branches (12-14 orders) and moderate branches (9-11orders). While, it is up to N-1 level in shorter branches (7-8 orders).

These studies give an understanding that in Sapota irrespective of the variety and strata of branches maximum flowering and fruit set attributes were found up to N-4 level though the flowering was seen in the entire order levels.

In the Aubreville (1964) model of architecture this is indicated in that the branch complex is from start a complex of short modules. Each consists of a basal hypopodium or first internode, which is more or less horizontal in orientation. Distally the spiral of leaves is produced with progressively short inter nodes at the same time the orientation of the apical meristem becomes erect by syllepsis one or more lateral branches develop from the axils of shoot at the level where the axis is bent upward. These branches in turn produce an initial long hypopodium and the process is repeated. Since, the reoriented terminal meristem continues its rhythmic growth with short internodes and lateral inflorescence. New rosettes are added as the tier expands laterally.

5.6 FRUITING PATTERN IN KALIPATTI

The results obtained from the studies on fruiting pattern are discussed here under.

In the Kalipatti variety in the higher range of branch extension *i.e.* 13-15 order levels, the fruit set in confined to top N-4 level with 40-60 fruits. In the medium range of branch extension *i.e.*10-12 order levels, the fruit set in confined to top N-3 level with 251-981 fruits. In the lower range of branch extension *i.e.*7-9 order levels the fruit set in confined to top N-2 level with 185-572 fruits.

Same trend of terminally concentrated fruit set was also observed in all the four other varieties in that in Oval variety in the higher range of branch extension *i.e.* 10-12 order levels, the fruit set in confined to top N-4 level with 16-76 fruits. In the medium range of branch extension *i.e.* 7-9 order levels, the fruit set in confined to top N-2 level with 12-51 fruits. In the Singapore variety in the higher range of branch extension *i.e.* 13-15 order levels, the fruit set in confined to top N-2 level with 11-22 fruits. In the medium range of branch extension *i.e.*10-12 order levels, the fruit set in confined to top N-4 level with 15-94 fruits. In the lower range of branch extension *i.e.*7-9 order levels, the fruit set in confined to top N-2 level with 12-51 fruits. In the Bombay variety in the higher range of branch extension *i.e.* 11-13 order levels the fruit set in confined to top N-4 level with 13-65 fruits. In the medium range of branch extension *i.e.*8-10 order levels, the fruit set in confined to top N-3 level with

17-165 fruits. In the Cricket ball variety in the higher range of branch extension *i.e.* 12-14 order levels, the fruit set in confined to top N-2 level with 7-22 fruits. In the medium range of branch extension *i.e.* 9-11 order levels, the fruit set in confined to top N-4 level with 18-156 fruits. In the lower range of branch extension *i.e.*7-8 order levels, the fruit set in confined to top N-1 level with 19-34 fruits. This study indicates that the fruiting intensity is more at higher order levels and gradually decreased lower at the lower order levels indicating that canopy management can be possible in Sapota and training in the initial stages to contain canopy and to produce more number of new/ultimate shoots in subtending branches.

5.7 POSSIBILITY OF PRUNING & HIGH DENSITY PLANTING IN SAPOTA

The principal involved in the improvement of yield per unit area of land utilized, by increasing planting density are based on the need to fill the allotted space in the orchard row as soon as possible (Dass, 1978). There after correct pruning and the tree training must maintain the canopy size once the allotted space has been filled. High density planting as a system can fulfill the above criterion and thus maintains the canopy size and increases the yield.

In Sapota however, there have not been any studies related to High density planting and canopy management the reason can be the lack of dwarfing root stocks in addition to the non awareness regarding its branching pattern, shoot extension and flowering habit.

Further, it is said that Sapota is a evergreen plant and that it is not advisable to prune (Chudawat, 1998).

Our studies on the branching pattern, flowering, fruit set in Sapota indicated clearly that in Sapota the displaced terminal continues to flower like spur in temperate trees particularly apple.

It has also been observed that more the number of branches produced at lower orders, the extension growth are less. Though flowering has extended down the terminal depending up on the branch much of the flowering was confined to N-4 level. In this context it is pertinent to imply that the pruning of branches in the initial stages will result in less extension growth with more number of branches produced at lower orders. Since, the bearing is confined to the periphery that is up to N-4 orders increasing in the number of branches in the higher orders can also increase the productivity. This is possible by pruning of the terminal orders after crop harvest. So that more new growth is initiated and subtended lower order shoots can be expected to flower and fruit. This view is strengthened by our observations on five varieties where, the flowering was observed down a branch up to N-9 level. This possibility of training to contain the tree size by initial training by way of pruning & pruning of fruited shoots to induce more laterals for further fruiting have to be experimentally verified before it goes as a recommendation

CHAPTER VI

SUMMARY

The present investigation on branching pattern, flowering and fruiting pattern in five varieties of Sapota was carried out in Agricultural Research Institute (ARI) Rajendranagar, Hyderabad during August 2003 to November 2004. The result of these investigations is briefly summarized below.

The study on mean number of branches at a given branch order in Kalipatti lower strata of tree canopy revealed that irrespective of the variety and strata of tree canopy in all the five varieties of Sapota observed same kind of branching pattern was observed. In Kalipatti variety the mean number of branches produced have increased up to 8^{th} order and thereafter declined at higher orders. In the variety Oval and Singapore varieties the increase in mean number of branches was up to 9^{th} order. While, the progressive increase of branches found up to 8^{th} order in both Bombay and Cricket Ball varieties.

Based on these studies it is suggested that the branching pattern in Sapota follows a growth curve which is characterized by production of more number of branches at lower order level and decline in the intensity of branches at higher order levels. It is further suggested that the canopy if restricted to the lower order levels more of branches would be produced at subtended order levels to enable easy horticultural operations.

Studies on branch bifurcation ratios revealed that the Rb ratios are inversely related to the number of branches produced at lower order levels and that lesser the branch growth the number of branches produced were more and more will be the branch bifurcation ratios in different lengths of branch extension. These studies suggest that by containing the growth of the branch we can have higher branch bifurcation ratios and more number of branches.

While, Studies on effect on extent of branching at 6^{th} order on production of branches at subsequent orders reinforced the fact that if more number of branches were produced at 6^{th} order the corresponding branch extension growth would be less and vice versa. Which can be employed in canopy management in that by restricting the branch extension growth more number of branches will be produced at lower order levels.

Lastly, the Studies on flowering pattern suggest that the economically important flowers and fruits are produced in large numbers in terminal branch orders *i.e.* up to N-4 level irrespective of the length of branch extension *i.e.* longer, medium and shorter branch extension. Though the flowering was found uniformly in entire order levels.

These studies suggest that the productivity, which is a much-touted word in today's commercial Horticulture can be augmented in Sapota by pruning of the

terminal orders after crop harvest so that more new growth is initiated and subtended lower order shoots can be expected to flower and fruit at lower levels.

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APPENDIX

DAILY METEOROLOGICAL DATA RECORDED AT A.R.I., RAJENDRANAGAR DURING THE PERIOD NOVEMBER 2003 TO AUGUST 2004

MONTH	TEMPERATURE (°C) MAX	TEMPERATURE (°C) MIN	R.H. (%) I	R.H. (%) II	RAIN FALL (mm)	RAINY DAYS	SUN SHINE (hrs.)	WIND SPEED (km/hr)	EVAPO-RATION (mm)	MEAN TEMP.
Nov	36.5	16.0	87	23	7.0	8	10.2	2.7	6.2	26.3
Dec	36.6	16.2	70	19	2.0	2	9.5	2.1	5.5	26.4
Jan	37.5	16.4	64	28	2.5	2	9.7	2.1	6.0	27.0
Feb	36.2	15.0	63	20	3.0	5	9.9	3.3	5.6	25.6
Mar	36.4	15.6	77	25	0.0	0	9.9	3.4	5.5	26.0
Apr	37.8	15.6	79	25	0.0	0	10.2	3.2	7.2	26.7
May	38.6	17.4	58	25	0.0	0	10.2	2.1	6.2	28.0
Jun	36.4	15.4	79	39	25.0	12	9.6	2.4	5.5	25.9
Jul	33.4	16.6	89	45	11.0	10	9.9	6.4	5.7	25.0
Aug	32.5	19.4	88	41	0.0	0	9.8	4.8	6.2	26.0
TOTAL	361.9	163.6	754.0	290.0	50.5	39.0	98.9	32.5	59.6	262.8
MEAN	36.2	16.4	75.4	29.0	5.1	3.9	9.9	3.2	6.0	26.3