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[1]Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu, India
[2]Department of Biotechnology, K.S. Rangasamy College of Technology, Tiruchengode, Namakkal District, Tamil Nadu, India
[3]Department of Biotechnology, VIT University, Vellore, Tamil Nadu, India

Architectural effect of different tea clones on the development of blister blight disease

Ponnusamy Ponmurugan[1], Balasubramanian Mythili Gnanamangai[2*], Kolandaisamy Manjukarunambika[3]

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Summary

An attempt has been made to analyze the architectural traits of six elite tea (*Camellia sinensis*) clones representing the three principal *taxa* Assam, China and Cambod with respect to the correlation of blister blight disease (*Exobasidium vexans*) development. In order to analyze the architecture, branching habit and flushing behavior were observed and subsequently compared with disease incidence. All the clones followed similar architectural pattern irrespective of the cultivar but varied with levels of disease severity. The number of branches was higher in China when compared to Assam and Cambod, branch length was bigger in Assam followed by Cambod and China. Branch angle of all the clones lay well within the described range of theoretical value of 45 to 90°. In general, internodal length was bigger in Assam followed by Cambod and China. These architectural characteristics determined the number of harvestable tea shoots in the bush canopy. China cultivars exhibited an erectophile type of leaf angle, which influenced effective net photosynthesis, transpiration rates and light penetration in leaves. These factors are playing important roles in a disease development strategy. This study should be useful for clonal selection for new clearings and re-planting areas. Moreover, plants breeding programmes for studying the yield and tea quality losses due to blister blight disease benefit from the findings herein.

Keywords: Blister blight, *Exobasidium vexans* incidence, plant architecture, tea bush pattern.

Introduction

Tea plant architecture is the spatial distribution of different leaf composition covering scale leaf, scar of scale leaf, fish leaf, maintenance foliage, mother leaf, 1st, 2nd and 3rd leaves and a bud, stems and flowers on that plant at a given time (Fig. 1). Tea (*Camellia sinensis*) is an evergreen plant that undergoes many cultural operations like plucking, pruning, tipping and centering. Plucking of young harvestable shoots containing 2-3 leaves and a bud is being done and subjected to manufacture for tea powder. Young shoots are continuously harvested at 10-14 day intervals which affects the bush health significantly. Tea bushes are pruned to attack many pests and diseases (Barthakur, 2011). After 4-5 years, depending upon the nature of tea cultivars and climate, tea bushes undergo pruning which gives rise to new shoots. Those shoots are physiologically effective. Some other factors determining the bush health are altitude of the tea garden, climate, pruning and tipping heights, length of the pruning cycle and the system of plucking.

Tea plant architecture depends on geometric, environmental factors and tea estate elevations influencing growth, including plucking patterns like manual plucking and shear harvesting and monsoon seasons. It is determined by an interaction between the intrinsic architecture defined by its genome and the characteristics of the population in which it grows (plant density). Tea plants are planted by single, double and triple hedge methods to get the maximum crop yield per hectare. These planting styles regulate the architecture of tea plant. Tea plant canopies are complex depending upon the style of planting (planting layout), tipping height and pruning types like light (80-90 cm from the ground level), medium (60-70 cm) and heavy pruning (15-25 cm). Several parameters can be used to characterize the tea canopy architecture which includes leaf area index, leaf distribution and number of harvestable shoots on plucking surface (Girardin et al., 1999).

Tea being a monoculture crop is susceptible to a number of destructive diseases and provides a stable microclimate for various diverse phytopathogens (Premkumar et al., 2008). Among the leaf diseases, blister blight disease caused by a fungus *Exobasidium vexans* Massee is one of the most damaging diseases of tea plants worldwide (Sinniah et al., 2016). It is an important foliar disease incapable of causing enormous crop loss throughout the tea growing regions of Asia, especially in India, Sri Lanka, Indonesia and Japan. *E. vexans* completes its life cycle in a short span of 11-28 days (Premkumar and Baby, 2005). Thus, many generations of the fungus are completed during the favorable condition of the monsoon. The pathogen infects young succulent harvestable shoots leading to severe crop loss. The crop loss varies with the geographical locations and nature of tea clones and seedlings. It was estimated to be 33% in Sri Lanka (De Silva et al., 1992), 20-25% in Indonesia and as high as 35% in India (Radhakrishnan and Baby, 2004). In addition to crop loss the disease adversely affects the quality of made tea (Ponmurugan et al., 2016). Variation in several architectural traits combines to give species a distinctive visual appearance. But these different architectures were well correlated with different light-interception properties (Falster and Westoby, 2003) rather its other metabolism and conduciveness to disease.

Commercial tea population lies under three principal *taxa*, 'China' (*Camellia sinensis* (L.) O. Kuntze), 'Assam' (*C. assamica* ssp. *assamica* (Masters) Wight) and 'Cambod' (*C. assamica* ssp. *lasiocalyx* (Planch ex Watt) Wight) (Barua, 1965). Plant architecture is the visible, morphological expression of the genetic blue print of a tree (Halle, 1978). Architectural analysis of tea clones will facilitate selection of the better traits against high yield, pests and disease resistance. The objective of the present study is to analyze the architectural features of different tea clones with respect to the development of blister blight disease over the course of the growing seasons.

Materials and methods

Six elite tea clones *viz.*, UPASI-1 and UPASI-3 (Assam), UPASI-9 and UPASI-15 (China) and UPASI-17 and TRI-2025 (Cambod) maintained in UPASI Tea Research Institute Experimental Garden under similar cultural conditions were examined for various architectural parameters. The choice of the six tea cultivars was

* Corresponding author

selected on the basis of differences in architectural features, green leaf yield potential and tea quality parameters. Moreover, studies were undertaken to assess the specific effect of the architectural traits on epidemic blister blight development, tea cultivars with similar levels of susceptibility and resistance to blister blight were chosen. All the clones were planted in 1969 at 120 × 120cm spacing, in contour single hedge planting system. Observations on canopy architecture, floral characteristics and leaf morphology were made with unplucked tea plants maintained in the breeding plots and plants under regular cultural operations.

Data on position of trunk, branch angle, branch length and number of branches were recorded. Branches were designated as the first order (n+1), the second order (n+2) and so on till seventh order (n+7). Internodal length was measured in the well-developed shoots which are about to be plucked. Shoot components were designated as a bud, first (7^{th} order), second (6^{th} order), third (5^{th} order), mother (4^{th} order), fish (3^{rd} order), and scale (2^{nd} order) leaves and maintenance foliage (1^{st} order). Branch and internodal lengths were measured with a metric scale. Branch and leaf angles were measured with a circular ocular meter (HONDA and FISHER, 1978). Leaf area was also calculated conventionally. All the observations were replicated 10 times in separate bushes and the data were subjected to statistical analysis.

Blister blight disease incidence was assessed every plucking round in all the three experimental blocks covering Assam, China and Cambod tea cultivars. Young tender shoots containing three leaves and a bud were collected randomly from the harvest baskets and each shoot was examined individually for the incidence of blister blight. Disease incidence was quantified on a percentage basis. The sequence of lesion development was divided into five stages such as 1) occurrence of translucent lesions, 2) well-defined lesions, 3) incipient stage of spore forming lesions, 4) vigorously sporulating lesions and 5) necrotized lesions and were carefully documented while examining the incidence of blister blight disease.

Healthy and infected harvestable shoots were collected from all the bushes of six tea cultivars falling under Assam, China and Cambod traits periodically. The freshly harvested leaves were used for chlorophyll estimations. A 100 mg of harvested tea plant material was taken in preparing the leaf disc using the conventional paper puncher. The prepared leaf disc was submerged in 5 ml of DMSO (dimethyl sulfoxide) and the chlorophyll was estimated by following WELLBURN (1994). For all other biochemical parameters the 1 gm of harvested shoots was extracted and concentrated with 80% ethanol, and the final extract was filtered and used for estimation of total sugars (AOAC, 1990), nitrogen (DUBOIS, 1956), amino acids (MOORE and STEIN, 1948), polyphenols (DEV CHOUDHURY and GOSWAMI, 1983) and catechins (SWAIN and HILLIS, 1959).

The data obtained were subjected to analysis of variance (ANOVA) and the significant means were segregated by critical difference (CD) at various levels of significance (GOMEZ and GOMEZ, 1984).

Results

Wide variations were observed in the canopy architecture among tea cultivars (Tab. 1). Assam tea cultivars were orthotrophic with 'de-current' or 'deliquescent' branches *i.e.,* terminal leader eventually disappears and lateral branches tend to grow upwards. China tea cultivars were plagiotrophic with excurrent branches *i.e.*, a prominent terminal leader with horizontal drooping lateral branches while Cambod tea cultivars were neither orthotrophic nor plagiotropic.

All the clones bear identical branching dynamics with non-rhythmic or continuous growth without endogenous periodicity of extension. In China cultivars, the number of branches (second to fourth order) was significantly higher than in Assam and Cambod cultivars (Tab. 2). Significant variation in the branch length was observed between Assam and China tea cultivars while it was not significant either between Cambod and Assam or Cambod and China cultivars (Tab. 2). Branch angle lies well within the range of 45 to 90° (Tab. 2). Tea leaves follow a special pattern of arrangement, 'anisophylly'. Each shoot comprises one or two scale leaves, one fish leaf, mother leaf and three to four normal leaves with a terminal bud (Fig. 1). No significant variation was observed between the shape and size of maintenance foliage, mother leaf and third leaf. Internodal length increased gradually from maintenance foliage to third leaf and de-clined in second and first leaves. Among the clones, no significant variation was observed in the intermodal lengths of maintenance

Tab. 1: Comparison of architectural parameters of different tea cultivars

Parameters	Tea cultivars		
	Assam	China	Cambod
Habit Growth habit	Tree 10-15m tall Under trees with virgate branches	Big shrub 1-3m tall Vigorous shrub with compound branches	Erect shrub 5-6m tall Erect, openly branched shrubs
Branching pattern	Semi-orthotrophic arise above the ground, excellent spread	Semi-plagiotropic compact, arise from the ground	Semi-orthotropic and semi-plagiotropic with profuse branching, arise from the base.
No. of branches in each order Branch length (cm) Branch angle(°) Internode length (cm) Stem circumference (cm) Length of main stem (cm)	2.8 to 6.0 11 to 36 50 to 70 2 to 6 37.5 37.5	3.5 to 8.7 7 to 25 40 to 47 1 to 4 30.5 28.8	2.8 to 6.6 8 to 30 50 to 70 1 to 5 33.3 32.5
Leaves	Large, horizontal, broad, light green	Small, narrow, erect, dark green	medium size, broad, light green, semi-erect
Leaf angle type Flowering Plucking surface (cm^2) Plucking points/sq.ft Yield Potential Tea quality	Planophile (>70°) Sparse 9788 155.5 High Medium	Erectophile (<50°) Profuse 9044 125.5 Low Superior	Oligophile (50-70°) Medium dense 9358 141.0 Moderate Superior

Tab. 2: Branching pattern parameters of various tea clones

Branch parameters	Assam		China		Cambod		C.D. at P = 0.05
	UPASI-1	UPASI-3	UPASI-9	UPASI-15	UPASI-17	TRI-2025	
No. of Branches							
First order	5.7	5.5	6.7	6.5	6.6	4.5	1.3
Second order	6.3	6.7	8.7	8.3	6.4	5.7	2.1
Third order	4.1	3.7	6.8	6.5	4.6	3.5	1.3
Fourth order	4.2	4.6	7.2	5.4	4.6	3.4	1.5
Fifth order	2.7	3.0	3.9	3.4	3.5	2.8	1.1
Average	**4.6**	**4.7**	**6.7**	**6.0**	**5.1**	**4.0**	**1.5**
Branch length (cm)							
First order	23.8	22.7	19.9	24.0	28.4	20.2	6.3
Second order	20.8	23.7	29.4	32.5	34.4	24.5	7.5
Third order	31.0	28.7	22.4	28.5	25.2	24.2	6.5
Fourth order	10.7	12.5	19.3	20.5	16.4	14.6	6.2
Fifth order	08.5	07.5	10.5	15.3	08.4	08.8	3.3
Average	**19.0**	**19.0**	**20.3**	**24.2**	**22.6**	**18.5**	**6.0**
Branch angle(°)							
First order	67.3	53.5	44.5	43.5	52.3	65.7	18.3
Second order	70.5	57.8	44.3	43.5	62.7	70.7	25.2
Third order	72.8	63.6	43.6	45.0	53.0	55.5	17.2
Fourth order	51.5	53.5	42.5	40.0	52.5	60.7	13.5
Fifth order	63.5	58.5	42.5	45.6	50.7	55.5	16.5
Average	**65.1**	**57.4**	**43.5**	**43.5**	**54.2**	**61.6**	**18.1**

Average	**34.4**	**72.9**	**15.1**	**51.2**	**24.8**	**61.1**	**16.1**

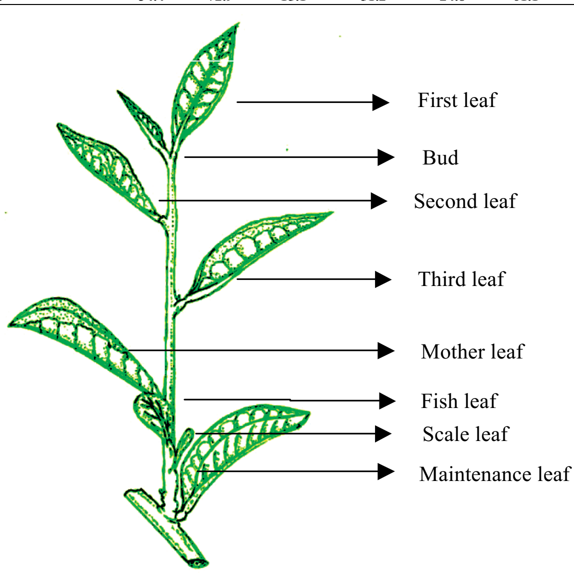

Fig. 1: Shoot structure of a periodic tea shoot containing different types of leaves

leaf to scale leaf, scale leaf to fish leaf and fish leaf to mother leaf (Tab. 3).

Tea canopies in terms of number of plucking points and plucking surface among tea cultivars vary at different levels. Both numbers of plucking points and plucking surface were found to be higher in Assam (9788 cm^2, 155.5/sq.ft; respectively) followed by Cambod (9358 cm^2 and 141/sq.ft) and China (9044 cm^2 and 125.5/sq.ft). They may be attributed to leaf size and leaf distribution in the canopy. Assam cultivars had a higher leaf angle followed by Cambod and China (Tab. 3).

Flowers are solitary, pleonanthic type where they are produced on lateral branches and thus the shoot are not limited by flowering. Flowering is always on old branches (rhamiflory) and so does not affect the shoot construction during its life cycle as observed in many species. Sympodial branching, sylleptic growth habit, semi-orthotropic and semi-plagiotropic branching, anisophylly, peonanthic flowers and rhamiflory are characteristic to *Camellia* spp. (Fig. 3B).

Blister blight infection was more in Assam cultivar tea leaves than in Cambod and China, which is coinciding with the result of leaf angle and leaf area. Leaf angle of Assam cultivars was planophile (>70°) type which were horizontal, whereas, the same in China and Cambod cultivars was erectophile (<50°) and oligophile (50-70°) types; respectively. An average of leaf angle in China cultivars recorded was 28.1° in UPASI-9 and 27.7° in UPASI-15. Whereas, it was 54.2° and 56°; respectively, with Assam UPASI-1 and UPASI-3.

The observations made in different tea cultivars with respect to blister blight disease incidence were presented in the Tab. 3. Different stages of blister blight lesions were recorded in tea shoots. The lesions were fully matured and ready for spore dispersal in the third leaf (Fig. 3C) subsequently the lesion got necrotized (Fig. 3D). On the second leaf, however, the lesions were immature and slightly lesser in number. The first leaf showed fewer lesions, which were in their early stages of development. The pattern remained the same in all the three tea cultivars. Blister blight infection was registered the maximum with Assam UPASI-3 followed by Cambod TRI-2025

Tab. 3: Leaf architectural parameters of various tea clones and blister blight disease incidence

Leaf parameters	Assam		China		Cambod		C.D. at P = 0.05
	UPASI-1	UPASI-3	UPASI-9	UPASI-15	UPASI-17	TRI-2025	
Leaf angle(^{0})							
First order	55.3^{b}	52.3^{b}	27.8^{a}	27.5^{a}	45.7^{b}	43.3^{b}	10.7
Second order	58.5^{bc}	60.5^{bc}	30.5^{a}	30.5^{a}	50.6^{bc}	43.5^{b}	11.6
Third order	55.7^{bd}	63.2^{bd}	31.5^{a}	28.8^{a}	42.5^{bc}	45.6^{bc}	10.6
Fourth order	72.5^{bd}	62.2^{bd}	27.0^{a}	25.7^{a}	45.2^{bc}	43.8^{bc}	13.3
Fifth order	56.5^{bcd}	65.5^{bd}	40.5^{a}	42.7^{abc}	55.6^{bcd}	60.5^{bd}	15.3
Sixth order	50.7^{bc}	52.6^{bc}	20.5^{a}	22.5^{a}	48.5^{bc}	47.3^{bc}	14.7
Seventh order	30.5^{bcd}	35.7^{bd}	18.7^{a}	16.0^{a}	23.5^{abc}	25.6^{abcd}	11.3
Average	**54.2**	**56.0**	**28.1**	**27.7**	**44.5**	**44.2**	**12.5**
Leaf area (cm^2)							
Maintenance foliage(MF)	23.5^{ab}	30.5^{c}	22.2^{a}	20.9^{a}	20.5^{a}	27.5^{bc}	3.0
Scale leaf (SL)	00.8^{a}	01.3^{a}	00.7^{a}	00.7^{a}	01.3^{a}	01.3^{a}	1.1
Fish Leaf (FL)	00.7^{a}	02.2^{b}	01.3^{ab}	01.1^{ab}	01.5^{ab}	01.5^{ab}	1.1
Mother Leaf (ML)	19.6^{a}	29.9^{d}	19.9^{a}	19.0^{a}	19.5^{ac}	23.0^{bc}	2.5
IIIrd leaf (3L)	20.0^{b}	29.0^{d}	18.0^{a}	19.0^{ab}	18.0^{a}	23.0^{c}	1.6
IInd leaf (2L)	15.0^{bc}	19.0^{d}	13.5^{ab}	11.1^{a}	16.0^{b}	17.5^{cd}	2.5
Ist leaf (1L)	07.3^{bc}	11.5^{be}	06.8^{bc}	04.9^{a}	07.5^{bcd}	08.3^{bd}	1.3
Average	**12.4**	**17.6**	**11.8**	**11.0**	**12.0**	**14.6**	**1.9**
Internodal length (cm)							
MF><SL	2.7^{bc}	3.0^{bc}	2.0^{ac}	1.5^{a}	2.7^{bc}	2.5^{ac}	1.0
SL><FL	3.0^{bcd}	3.5^{bde}	2.5^{ac}	2.0^{a}	3.0^{bcd}	4.0^{be}	0.5
FL><ML	4.5^{b}	4.0^{b}	3.3^{a}	3.0^{a}	4.0^{b}	4.0^{b}	0.3
ML><3L	4.9^{be}	4.3^{bcde}	3.7^{ac}	3.0^{a}	4.7^{bde}	4.0^{bcd}	0.7
3L><2L	7.5^{b}	6.0^{bc}	4.7^{ac}	3.7^{a}	6.0^{bc}	5.5^{ac}	2.2
2L><1L	4.5^{cd}	4.7^{d}	2.3^{ab}	2.0^{a}	3.3^{abc}	3.5^{bcd}	1.3
1L><Bud	3.3^{c}	2.5^{bc}	1.3^{a}	1.0^{a}	1.2^{a}	1.5^{ab}	1.0
Average	**4.3**	**4.0**	**2.8**	**2.3**	**3.6**	**3.6**	**1.0**
Blister blight Infection(%)							
Translucent lesion	37.7^{bc}	75.5^{e}	17.7^{a}	52.5^{cd}	27.0^{ab}	65.5^{de}	18.8
Well-defined lesion	36.5^{b}	78.5^{d}	15.5^{a}	55.5^{c}	28.5^{ab}	64.5^{c}d	17.5
Spore-forming lesion	38.0^{bc}	75.5^{be}	16.6^{a}	57.7^{bd}	27.5^{ac}	66.0^{bde}	15.5
Speculating lesion	34.8^{b}	77.5^{d}	15.0^{a}	57.0^{c}	25.0^{ab}	64.5^{cd}	16.5
Necrotized lesion	25.0^{bc}	57.5^{f}	10.5^{a}	33.5^{cd}	15.9^{ab}	45.0^{de}	12.0
Average	**34.4**	**72.9**	**15.1**	**51.2**	**24.8**	**61.1**	**16.1**

and minimum with China UPASI-15. These tea clones were highly susceptible to blister blight infection. In contrast, tea clones such as Assam UPASI-1, Cambod UPASI-17 and China UPASI-9 were tolerant to blister blight. Observations on the various stages of blister blight infections in tea leaves such as translucent, well- defined, spore forming, sporulating and necrotized lesions, there is no significant difference recorded (Tab. 3).

Various degrees of biochemical constituents were observed in all the six tea cultivars (Fig. 4). Healthy and infected clone of the same cultivar showed significant reduction in all biochemical constituents, especially the chlorophyll, polyphenols and catechins. The difference was high between the healthy and infected clones of UPASI-15 followed by TRI-2025 and UPASI-3. In contrast the difference was comparatively low in all the biochemical parameters including sugar and nitrogen in UPASI-1, UPASI-9 and UPASI-17 clones. All the biochemical constituents in healthy conditions registered no significant difference among the six tea cultivars except for polyphenols which is high in UPASI -15.

Discussion

China cultivars having more branches indicate the vulnerability of the disease incidence. Pruning induced more number of proleptic and sylleptic branches with high shrubby appearance (Zhou and Hara, 1990) which lead to die back of weaker branches (Ponmurugan et al., 2000). Branch length was more in the case of second and third

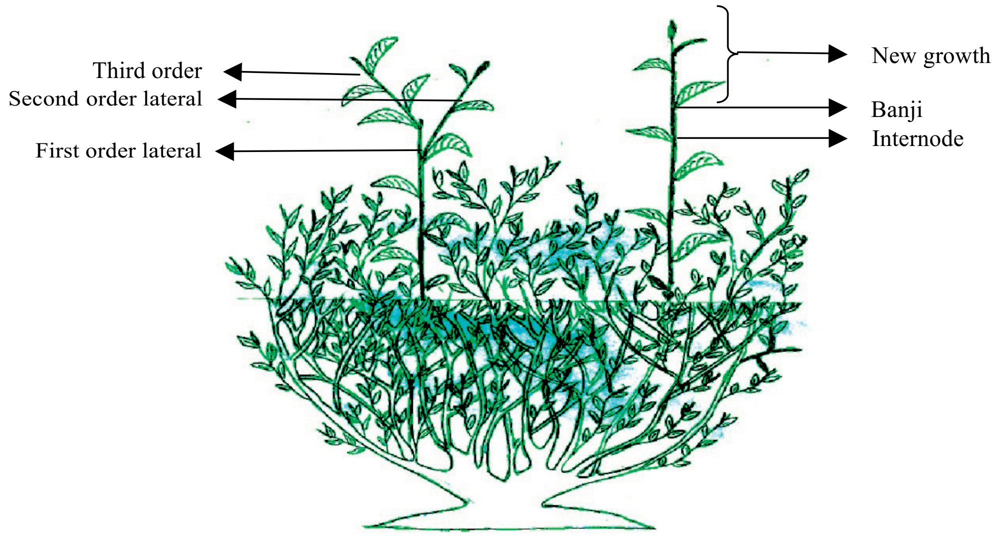

Fig. 2: Branching pattern of a tea bush

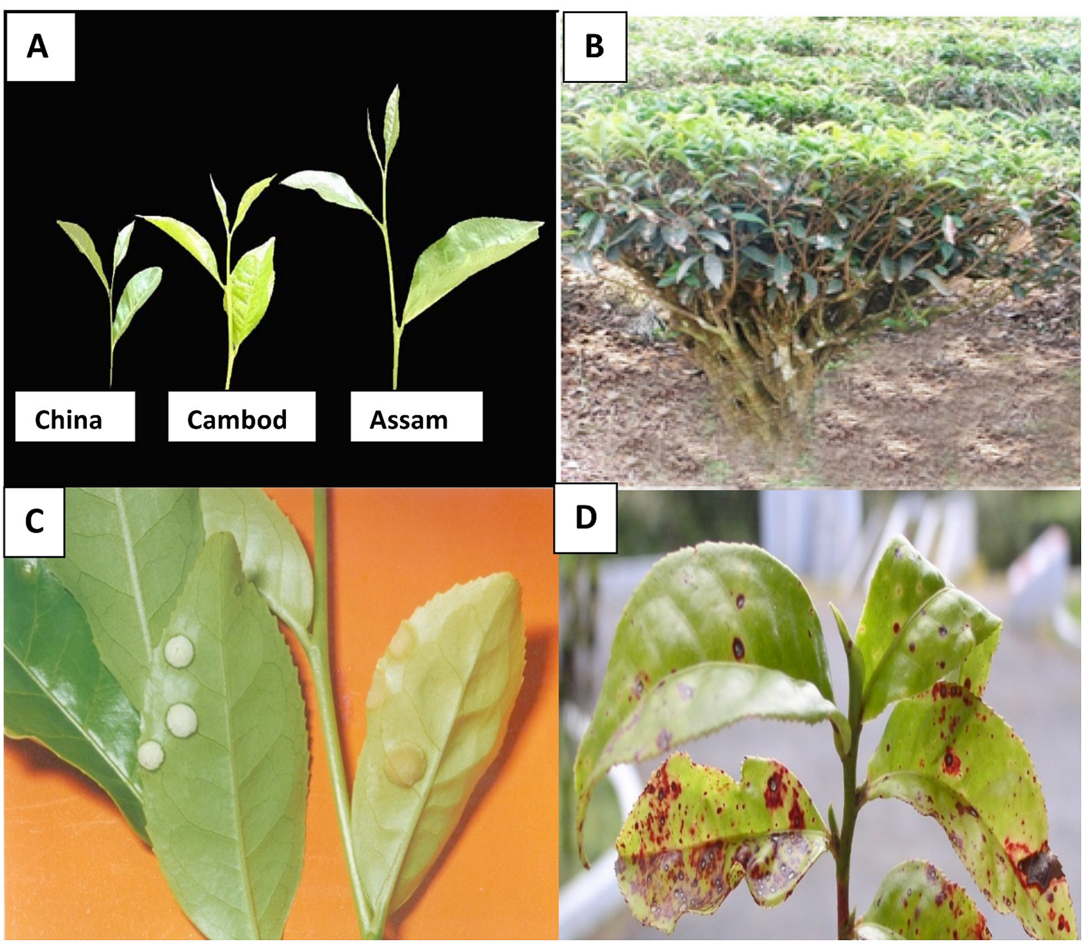

Fig. 3: Architectural characters of tea plants and blister blight infection. A, Different tea cultivar harvestable shoots; B, A typical tea bush; C, Sporulating lesions of blister blight infected tea shoots and; D, Necrotized lesions of blister blight infected tea shoot).

order branches of all the clones. This may be due to the lack of air space and less competition between the branches for absorption of light, photosynthesis and exchange of gases (SARLIKIOTI et al., 2011). Branch angle determined the spread of the bush and it was most often influenced by planting style. High density planting leads to formation of weak branches and less supporting wood (BALASUBRAMANIAN, 2010). In the case of Assam type, overall branch angle was comparatively higher which might have enabled the better spread of the bush and increased plucking points (BARTHELEMY and CARAGLIO, 2007).

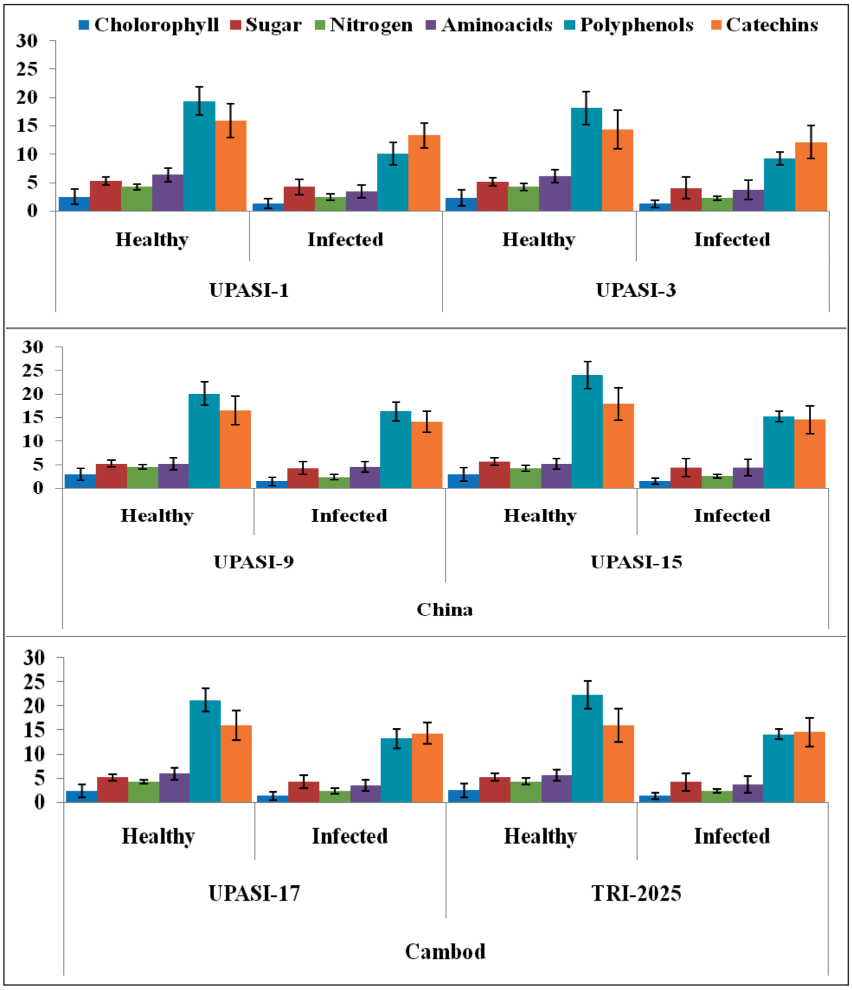

Fig. 4: Biochemical parameters of the harvestable tea shoot with respect to clones and blister blight infection.

With no significant variation among the tea clones between the shape and size of maintenance foliage, mother leaf and third leaf, smaller leaf area of China cultivars may be attributed to branch angles and its length and number of branches besides its genetic potential (Owuor et al., 2008). In general, variation in the proportion of leaf and internode in tea shoot will influence the recovery percentage and quality of made tea. Plant canopies are complex with dynamic structures which depend on growth stage, plant density, planting layout, growth pattern and branching habit (Girardin et al., 1999). According to Tivoli et al. (1996) the density of stems per unit area affected disease development and severity by changing the movement of the pathogen within the canopy and/or the microclimate.

As per Banerjee (1992), Assam, China and Cambod cultivars of the present investigation can be grouped into planophile, erectophile and oligophile, respectively (Fig. 3A). The angle of inclination facilitates trapping of light energy, thereby promoting photosynthesis and productivity (Ando et al., 2007). Electrophiles are more efficient in photosynthesis as the lamina is fully exposed to the sun light. Leaves act as natural spore traps where the planophiles enhance the deposition of the inoculum and thereby promoting disease incidence (Le May et al., 2009). Higher susceptibility of Assam clones to foliar diseases and pests can be attributed to its leaf angle. Based on the result of flowering patterns, cultivated *Camellia* fall under Attim's model (Fig. 3B) irrespective of the cultivar (Halle, 1978). Recently paraheliotropism of leaves were reported to have photoinhibition resulting in deleterious effects on plant (Puglielli et al., 2017).

Leaf angle of China cultivars were erect, which determined effective physiological parameters, especially in net photosynthesis, transpiration rates and light penetration in leaf tissues (Balasubramanian, 2010). Erect position of leaves played a key role in determining disease development (Onfroy et al., 2007). Due to these characteristic features, the incidence of blister blight is very less in China cultivars which registered at 15.1% in resistant UPASI-9 clone and 44.4% in susceptible UPASI-15 clone (Tab. 3). The results clearly showed that there was a direct correlation between leaf angle and blister blight infection in tea plants.

The results on the blister blight incidence coincide with a similar observation made by Nakamura (1991) and opined that tea cultivars have been found to react differently to blister blight and they significantly vary in their degree of resistance and susceptibility to the disease severity. Moreover, the nature resistance in tea cultivars to blister blight is due to defense response mechanism. In accordance with the report of Le May et al. (2009), the behavior of various pea cultivars with respect to ascochyta blight disease has been studied and disease dynamics exhibited to depend on plant morphology. Ideal plant architecture can optimize canopy architecture, improve photosynthetic efficiency, and prevent lodging, thus resulting in overall high yield (Pan et al., 2017).

Similar results for biochemical constituents were reported earlier in grafted and ungrafted tea clones by Balasubramanian et al., 2010. The results suggest that there is no influence of architecture for biochemical constituents among the tea cultivars except for polyphenols which is mainly attributed to the quality of brewed tea. And it also infers that since the bush canopy of some tea cultivars favors disease development, the infected clones showed significant difference in all biochemical constituents as compared to healthy bush. These results were in agreement with works of PONMURUGAN et al., 2016, where all the biochemical constituents were significantly reduced in foliar diseased shoots of tea plants.

Conclusion

To conclude, this study will be of more useful in clonal selection in new clearings and re-planting programmes in the tea estates. Plant architecture study is a method in which cultivar characteristics and disease development with respect to architectural traits are correlated. Canopy structure is thus an important factor as it is directly involved in controlling disease development during the crop season consequently on yield attributes. Moreover, this investigation will also be useful for Tea Plant Breeders to manipulate plant architecture such as a way to facilitate disease avoidance, which may be a valuable alternate approach to mitigate blister blight disease severity.

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Address of the authors:
Ponnusamy Ponmurugan, Department of Botany, Bharathiar University, Coimbatore, Tamil Nadu, India
Balasubramanian Mythili Gnanamangai, Department of Biotechnology, K.S.Rangasamy College of Technology, Tiruchengode – 637 215, Namakkal District, Tamil Nadu, India, ORCID 0000-0001-9681-2318
E-mail corresponding author: mythumithras@gmail.com
Kolandaisamy Manjukarunambika, Department of Biotechnology, VIT University, Vellore, Tamil Nadu, India