
Thai traditional bent tree development by mother of Cocoa (*Gliricidia sepium*)

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Abstract There were four marking criteria and five major indicators of Thai bent trees. The indicators involved in the balance, rhythm, completeness and beauty and criteria consisted of number of bouquets, number of levels, the horizontal plane in each level, the rhythmic positioning of the bouquet in each level and the meaning or uniqueness. Moreover, the growth rate was measured from the development of the trunk's diameter, mother of cocoa after bent in nine different patterns. "Mai Khabuan" showed the highest growth rate compared to others; both growth rate of stem and main branch with 6.23% and 85.53% compared to week 0. However, the most beautiful and suitable forms of Thai traditional bent tree by mother of cocoa were "Mai Hok-Hiean", "Mai Khen" and "Mai Chark" respectively.

Keywords: Thai traditional bent tree, Mother of cocoa, Growth rate

Introduction

Bent trees growing in Asia originated in Thailand, China, and Japan. However, the bent tree is still popular in Japan (known in Japanese as "Bonsai"). In Thailand, bent trees are still limited in some communities because they require a complexity of traditional growing process, intensive care and long growing period. Therefore, the Thai traditional bent tree is a good way to express the rich heritage of Thai art in the same way as Japanese Bonsai show Japanese cultural creativity (Institution of Extension and Development on Knowledge Innovation, 2016).

Nowadays, the decline of Thai bent tree growing is obvious because many forms of Thai bent tree mentioned in "Khleng Mai Dud", which is the Thai poem about the Thai traditional bent tree narrated by Luang Mongkolrath (Chuang Kraier), cannot be found regularly except in The Grand Palace, The Temple of the Emerald Buddha, Wat Phra Chetuphol (Wat Pho), Wat Klong

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Teoi Nai, King Rama II Memorial Park and Wat Ampawan Chetikaram. However, the most perfect Thai bent trees with the original traditional Thai style according to “Klong Mai Dud” of Luang Mongkolrath can be found at Wat Klong Teoi Nai in Bangkok. These Thai miniaturized trees growing at Wat Klong Teoi Nai are in the patronage of the abbot (Phra Suntrakijjaphiwat).

The objectives were to study various forms of Thai traditional bent tree, to create an indicator guide of Thai traditional bent tree and to compare the growth rate of the Thai bent tree using mother of cocoa in various forms.

Materials and methods

The criteria and indicators were conducted to indicate Thai bent tree by conducting a research project from reliable sources such as secondary data from the books, journals, and other reliable sources, and primary data from a survey of historic places that related to Thai bented tree including; the Grand Palace, Temple of Emerald Buddha, Wat Phra Chetuphol (Wat Pho), Wat Klong Teoi Nai, King Rama II Memorial Park and Wat Ampawan Chetikaram and also from the interviews with the experts. Moreover, the growth rate of Thai bent tree was experimental designed using Completely Randomized Design (CRD) to record the growth of trunk and branches of bent mother of cocoa by using the medium size mother of cocoa which 4-5 meters height and 3.5-5 cm of trunk diameter. Treatments were consists of (T1) Mai Kabuan, (T2) Mai Chark, (T3) Mai Hok Hean, (T4) Mai Khen, (T5) Mai Yee Pun, (T6) Mai Talok, (T7) Mai Anne Chai, (T8) Mai Pah Khom and (T9) Mai Kammalor. Each treatment was repeated 10 times for 12 weeks.

Data were staistical computed analysis of variance and treatment means were comparted usind Duncan’s Multiple Ranfe Test (DMRT).

Results

Indicators of Thai bent tree

The quality of a Thai bent tree was measured. There were 4 marking criteria and 5 major indicators. These indicators and marking criteria are used as benchmarks to reflect the quality of each bent tree according to its designated pattern. The indicators consisted of 1) balance 2) rhythm 3) completeness 4) beauty and criteria include 1) number of bouquets 2) number of levels 3) the horizontal plane in each level 4) the rhythmic positioning of the bouquet in each level 5) the meaning or uniqueness. The marking criteria and indicators of each pattern are shown in Tables 1 to 9 and the major patterns which are stated.

Mai Kabuan

The shapes of Mai Kabuan were bent upward in a clockwise or anti-clockwise direction, the tip of the tree was placed at the same level of the top part of the trunk. Bouquets in each level were at the same level in every branch. There were 5 variations for Mai Kabuan which included Mai Kabuan Haa consisted of 2 bouquets in the first level, 2 bouquets in the second level and 1 bouquet in the third level (the top), Mai Kabuan Chet consisted of 3 bouquets in the first level, 3 bouquets in the second level, and 1 bouquet in the third level and Mai Kabuan Kao consisted of 4 bouquets in the first level, 4 bouquets in the second level, and 1 bouquet in the third level.

Mai Chak

The body trunk of pattern was flat and straight. The body was bent to make 90 degrees with the ground, and the base trunk and tip of the tree were in the same vertical line. Mai Chak pattern was normally formed into 3 levels with 2-3 bouquets in the first level, and the second level and only one bouquet at the top level.

Mai Hok Hean

The body of Mai Hok Hean was bent downward to the ground and then bent back upward. There was one branch and one bouquet or 11 branches and 3 levels which were 4 bouquets in the first level and second level, and 3 bouquets in the top level.

Mai Khen

The pattern was a major consideration the branches. There were three branches in this pattern, one branch was bent downward to the ground, one branch was bent to the side, and the last branch was bent upward. The bouquets were placed in the first level and second level or the first level and the top level with 2 bouquets in the first level and one bouquet in the second or top level.

Mai Yee Pun

Mai Yee Pun had a similar style to a Japanese bent tree (Bonsai). There was one main body and another hidden body with a slender tip.

Mai Talok

There were 2 styles of Mai Talok which were “Mai Talok Hua” and “Mai Talok Rak”. Mai Talok Hua is bloated at the top part of the body and Mai Talok Rak raised the root up with some soil. The concept of Mai Talok is

distortion of the natural form of bent tree and to make them look funny (Talok in Thai means funny).

Table 1. Indicators of “Mai Kabuan”



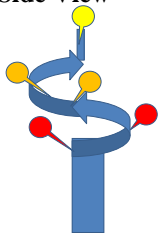
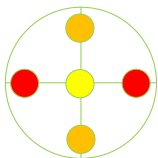



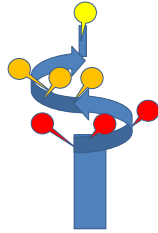
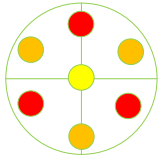



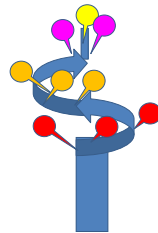
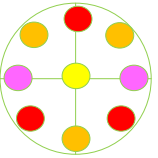



Mai Kabuan		Indicators
 <p>Mai Kabuan 5 (2-2-1)</p> <p>Side View</p>	 <p>Top View</p>	<ol style="list-style-type: none"> 1. 5, 7, or 9 bouquets 2. 3 spirally continuous levels either clockwise and anti-clockwise 3. Each bouquet is positioned at the same level 4. Positions of the bouquets beautifully set up with well balancing and in asymmetric form 5. The tip and the trunk are in the same vertical line 6. The bush in the top view forms a circle shape with the trunk as the center of the circle
 <p>Mai Kabuan 7 (3-3-1)</p> <p>Side View</p>	 <p>Level 3 </p> <p>Level 2 </p> <p>Level 1 </p>	
 <p>Mai Kabuan 9 (3-3-(2+1))</p> <p>Side View</p>	 <p>Level 3 </p> <p>Level 2 </p> <p>Level 1 </p>	
 <p>Side View</p>	 <p>Level 3 </p> <p>Level 2 </p> <p>Level 1 </p>	

Table 2. Indicators of “Mai Chak”



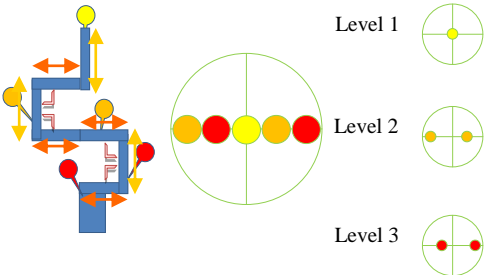



Mai Chak		Indicators
 <p>Mai Chak 5 (2-2-1) Side View</p>  <p>Top View</p>  <p>Level 1 </p> <p>Level 2 </p> <p>Level 3 </p>	<ol style="list-style-type: none"> The angle of branches and bouquets in each level must be at a right angle <ol style="list-style-type: none"> The right angle (90°) of the trunk and the right angle (90°) of the branches The trunk level in a right angle (90°) with the ground The level of the tree makes a total angle of 180° Number of bouquets is in an odd number For the caring purpose, the total level usually does not exceed 3 levels The perfectly balance asymmetric positioning with the 180° bend trunk to parallel with the ground Shape :Straight up, Flat 	

Table 3. Indicators of “Mai Hok Hean”



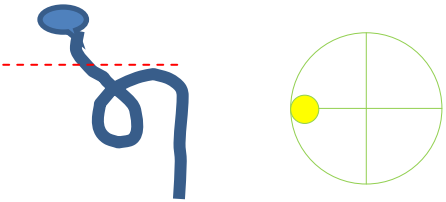
Mai Hok Hean		Indicators
 <p>Side View</p>  <p>Top View</p> 	<ol style="list-style-type: none"> The clearly twisting shape with the tip of twisted trunk must level over the twisted part Only one prominent bouquet which is the bouquet of the twisted trunk at the tip of the bend tree .This bouquet must shows the perfection of twisting trunk. Shape :Bend downward to the ground and then bend upward 	

Table 4. Indicators of “Mai Khen”

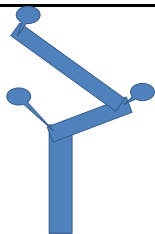
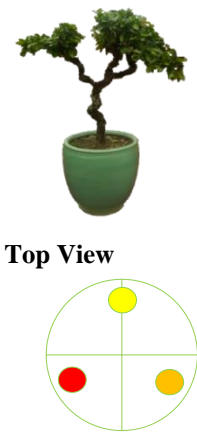

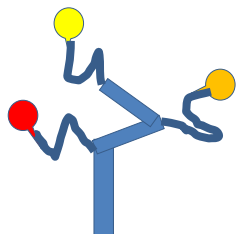
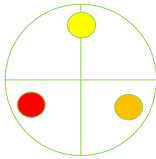
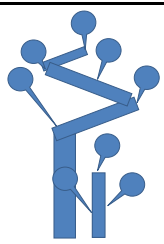


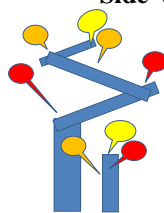



Mai Khen		Indicators
 <p>Side View</p>	 <p>Top View</p>	 <ol style="list-style-type: none"> 1. The position of each bouquet represents the structure of the human body (Khon actor) especially the positions of arms and head . Therefore, Mai Khen usually has 3 bouquets to represent 2 arms and 1 head . 2. The bouquet that represents the arms must be 120°-180°. Level against each other according to the act that the grower is trying to imitate, but the main bouquet which represents the head could be free style . 3. The imbalanced leveling is usually used to underline the dynamic movements of “Khon” imitation. 4. The precision of arm branches direction setting
		

Table 5. Indicators of “Mai Yee Pun”

Mai Yee Pun		Indicators
 <p>Side View</p>	 <p>Top View</p>	 <ol style="list-style-type: none"> 1. Similar to Japanese Bonsai called “Shokan” or “Twin Trunk Style” with more than one trunk .Both can be from one main trunk or two individuals, the secondary trunk called “hidden trunk”. 2. 1-2 trunks in the same container with one trunk as a main body and another as secondary body with the significantly different height and the secondary trunk will be bent out from the main thick trunk. 3. The base trunk of main body is thick and slimmer down at the tip
	<p>Level 3</p>  <p>Level 2</p>  <p>Level 1</p> 	

Mai Anne Chai

The body of Mai Anne Chi is short and leans in one direction to imitate the style of waterside trees.

Mai Paa Khom

The body of Mai Paa Khom is bent to imitate the natural tree form but in the bent size .The branches were bent spirally around the body in the shape of an upside down alms bowl .There were 3 levels for this pattern and each level had three bouquets, in total 9 bouquets.

Mai Kammalor

The body of Mai Kammalor is bent straight and bent down toward the ground without bending backward .The tip of Mai Kammalor would not be higher than the bent point and the hidden body if any, would be bent spirally upward against the main body.

Table 6. Indicators of “Mai Talok”


Mai Talok	Indicators
	<p>1. Creativity and imaginative bend pattern such as using the root to imitate the trunk or increase the size of the trunk</p>

Table 7. Indicators of “Mai Anne Chai”

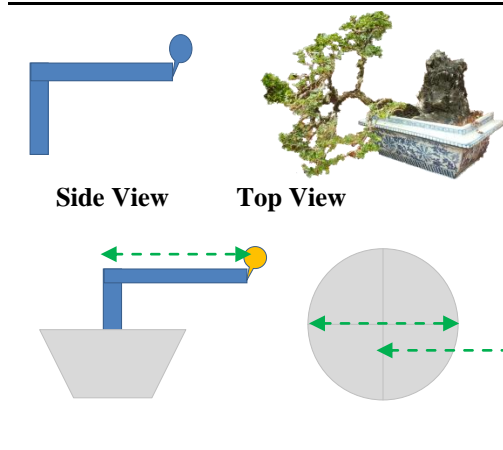
Mai Anne Chai	Indicators
	<ol style="list-style-type: none"> 1. The feeling like watching a tree along the riverside . 2. The length of the tree is balanced with the size of containers and also united with other ornaments and decorations in the container. 3. Body and bouquets lean in the same direction.

Table 8. Indicators of “Mai Paa Khom”

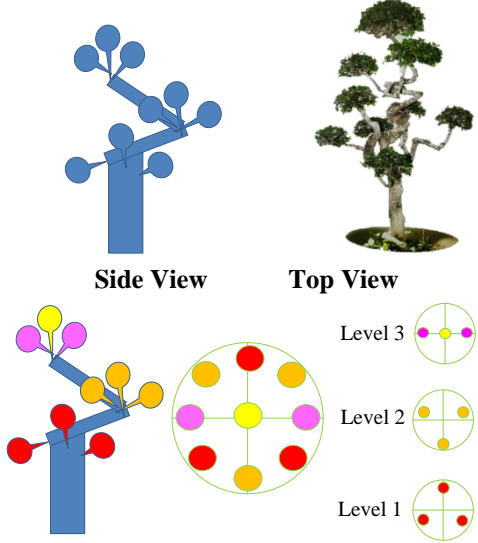
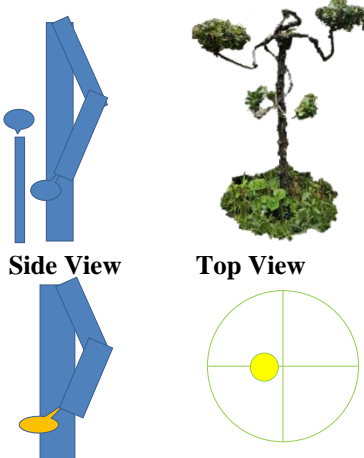
Mai Paa Khom	Indicators
 <p>The diagrams for Mai Paa Khom include a blue side view of a tree with a main trunk and three levels of branches, each with three bouquets. The top view shows a circular arrangement of bouquets in three levels: Level 1 (3 bouquets), Level 2 (6 bouquets), and Level 3 (9 bouquets). The bouquets are arranged in an upside-down bowl pattern.</p>	<ol style="list-style-type: none"> 1-2 body trunks are the normal number for one container, with the significantly different in height to distinguish between main trunk and secondary trunk . 2. The main trunk has 3 levels and each level has 3 bouquets, in total 9 bouquets for main trunk . 3. Bouquets in each level are in the same horizontal line. 4. The balanced distribution of bouquets in each level . 5. The distribution of the bouquets is in upside down alms bowl pattern and evenly distributed.

Table 9. Indicators of “Mai Kammalor”

Mai Kammalor	Indicators
 <p>The diagrams for Mai Kammalor include a blue side view of a tree with a main trunk that bends down to the ground and a tip that is positioned below the bend point. The top view shows a circular arrangement of bouquets in a single level.</p>	<ol style="list-style-type: none"> 1 .The main trunk has been bend down to the ground which similar to Mai Hok Hean but the tip is not bend upward . 2 .The tip is positioned below the bend point, in some case, the tip is roundly bend to bind the base point of the trunk. 3. Body :Straight, and bend down to the ground without bending back upward, the tip must not higher than bend point

The Comparison of growth rate

The growth rate was measured from the development of the trunk’s diameter, mother of cocoa after bent in the 9 different patterns, as described in the book of “Loung Mongkolrath”, which is the master book of Thai bent tree.

The results indicated that the controlled mother of cocoas had the most growth rate which was 8.93% compared to the recorded diameter in the first week beginning of experiment). The average increment of circumference was 0.1020 cm per week and the second best development was Mai Kabuan (6.23%, 0.0940 cm), followed by Mai Talok (6.07% ,0.0867 cm), and Mai Hok Hean (4.79% , 0.0664 cm). Moreover, the comparison of the growth from the development of main branch diameter of bent mother of cocoa indicated that Mai Kabuan had the highest growth rate which was 83.53% compared to the beginning in week 0 and the average circumference increment was 0.2685 mm, followed by Mai Hok Hean (49.39%, 0.1799 mm), Mai Chak (42.17%, 0.1513 mm), and Mai Khen (31.57%, 0.1545 mm). However, after the statistical differential comparison test, the mother of cocoa in the control group (without bending and miniaturization) had a significantly higher development of circumference than all bent trees at the 95% of confidence interval .On the other hand, all 9 bent trees had not significant statistical difference and Mai Kabuan had significantly best development of diameter among 9 patterns of Thai bent tree at 95% confidence interval .This information is summarized in Table 10.

Table 10. Growth rate comparison between 9 patterns of Bent Trees

Pattern	% Growth Comparing with Week 0 (Circumference)	% Growth Comparing with Week 0 (Diameter of Main Branch)
Control	8.9286 ^b	24.7191 ^b
Mai Kabuan	6.2111 ^a	85.5309 ^a
Mai Chak	4.6102 ^a	42.1650 ^b
Mai Hok Hean	4.8205 ^a	49.3914 ^b
Mai Khen	4.7017 ^a	31.5734 ^b
Mai Paa Khom	4.0395 ^a	13.6590 ^b
Mai Kammalor	4.5463 ^a	13.1773 ^b
Mai Talok	4.6844 ^a	22.0347 ^b
Mai Yee Pun	3.9725 ^a	23.0347 ^b
Mai Anne Chi	4.4935 ^a	21.4894 ^b
F-test	F =2.956** P=0.005	F =1.682** P=0.005

Remarks : ^{a-b} in the same row indicated the difference between them (P<0.05)

Discussion

According to the historical records, the Thai bent tree originated in the Ayuttaya period. Bent tree concepts had been obtained from Japanese Bonsai through Japanese immigrants during the reign of King Ekathosarot to the reign of King Prasat Thong (H.R.H. Prince Damtong Rajanupab, 1929). However, development of the Thai bent tree had been halted during the Siam-Burmese

war at the end of Ayuttaya kingdom and then the Thai bent tree had been resurrected again under the patronage of King Rama I of Rattankosin Era. King Rama I rebuilt the capital of the Kingdom of Siam in Bangkok and he also built The Grand Palace as a royal residence and it had been decorated by Thai traditional bent tree. He also created a royal garden where Thai bent trees played an important role as the major decorations (Anothai, 2006). According to the record derived from the royal gazette, there is clear evidence that Thai bent trees could still be found in the courtyard around Amarintaravinijchai Mahaisoonrarabhimhan Throne Hall (H.R.H. Prince Damtong Rajanupab, 1929). Then, in the reign of King Rama II, Phrachao Lukther Krommuen Jessadabodinh (King Rama III in the future) had been ordered to create a garden which contained Thai bent trees in The Grand Palace area. After he ascended the throne, he ordered recording the picture manuscript of Thai bent trees on the wall of Wat Phrachetupol Vimolmangkalaram and there are also the manuscripts of other multidisciplines (Anothai, 2006). However, since the beginning of the Thai bent tree history, there were no official books about Thai bent tree techniques until the reign of King Rama V. Luang Mongkolrath (Chuang Krilerk) narrated a poem which described the Thai bent tree and then Phrachao Peenangther Phraongchao Arthronthipnibha printed this poem in the memorial books of the funeral of Phraya Sampharakor (Chom Krilerk) (H.R.H. Prince Damtong Rajanupab, 1929)

There were 2 interesting issues related to Mai Ka Buan. The pattern of Mai Kabuan: trees usually had an odd number of nine because the odd number would portray the continuity and the perfect angle of views. There were 3 levels of “Kabuan”. The different levels of “Kabuan” are designated according to the social level of the owner according to the “Monarchy System” of ancient Thai culture; Kabuan 5 was for normal noblemen and merchants, Kabuan 7 was for elite and lower royal family members, and Kabuan 9 was for the higher royal family members; therefore, Mai Kabuan with Kabuan 9 could be found in The Grand Palace and the royal temple. The levels of Mai Kabuan were limited the imitation of the levels of “Bai Sri Ton” which had 9 levels for the King and the Queen, 7 levels for the Crown Prince and Crown Princess, 5 levels for other royal family members, and 3 levels for the noblemen and commoners according to report of Oranop Somboonna (2009). This different number of Bai Sri Ton levels were applied to the number of level in Mai Kabuan.

The clockwise and anti-clockwise spiral direction in Mai Kabuan might be shown the imitation of Indian idealistic belief of Hinduism and Buddhism which the clockwise direction would conduct sacred vibrations and good things would come to the owner. This belief could be found widely in the Buddhist ceremonies that usually have the clockwise swirl walking around the Buddhist

temple or Buddhist statues). In Thai called “Thaksinivatara” which stated by Office of Royal Society (2009).

The halt of development was found from this experiment .The mother of cocoa in this experiment ceased growing during the summer season because of the overheated condition and the drought, due to this situation, Chandrakasem Rajabhat University announced a water saving policy which affected the mother of cocoas in this experiment and caused them to succumb to the overheated condition. Rosenzweig and Parry (1993) stated that the situation led to the abnormal reaction of the plants. This abnormality could be found in any growing stages and affected many significant mechanisms of the plants, such as growing mechanism, photosynthesis, protein synthesis, biomolecular metabolism, and effects to gen (Farooq *et al.*, 2009). These abnormalities could lead to decrease in production (Cushman and Bohnart, 2000) and the death of the plant at the end (Munns, 2002). The symptoms that occurred with mother of cocoas after they were affected by overheated conditions that ceased the growing rate and some of them died.

During week 12 of the experiment, the mother of cocoa were attacked by aphids .This led the plants going to die in bent branches in week 13 .Aphids are an important pest of plants in the legume family .They suck the nutrients from the plant and they also have high reproduction (Powell and Hardie, 2000). The most attacked parts were the tip of the plants and the younger leaves were attacked more than the older leaves (Ibbotson and Kennedy, 1950). The scale insects and white flies were also the pests that disturbed the experiment. There were differences in the growth of leaves and branches, the height, and the width of bouquets among 9 patterns of Thai bent trees.

The results indicated that the most important technique for bending the bend tree was positioned the bend tree and let them escape from gravity, a technique called “Negative gravitropism”. According to this technique, the tree would grow in the different direction of the gravity force; when the body of the tree is placed along with the ground, the tip of the tree would grow upward to the sky .The reason behind this phenomenon comes from the density of oxygen in the base of the trunk is higher than the tip of the tree; therefore, the base of the trunk will grow better than the tip and cause the body of the tree to bend up to escape from gravity (Yamamoto *et al.*, 2002). This technique helps to bend the body of the tree easily and the decreasing water can soften the tree body make the bending process easier and prevent the bend body from breaking.

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