The comparative studies of the changes in apices of some kinds of tropical fruit and temperate fruit

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Abstract

The transition from vegetative growth to flowering is one of the most important periods of ontogenesis. Changes in apices of mangosteen (*Garcinia mangostana* L.) and rambutan (*Nephelium lappaceum* L.) were studied at Chanthaburi Horticultural Research Centre in Chanthaburi. Also, strawberry (*Fragaria ananassa* Duch.) were studied at Doi Tung in Chiangrai. The samples were taken every fortnight and were dissected under a stereomicroscope magnified 10 to 64 times. Vegetative apices of all crops studied were seen as flattening apices. These were rounded and flattened in mangosteen, lobed and flattened in rambutan and non-swelling with last trifoliate leaf in strawberry. The first evidence of flower initiation appeared as an enlargement and raising of the apices. Then the sepal development was noted. As sepals grew, petal initiation was seen. When the sepals began to enclose the bud, it was about the same time that the pistils and/or stamens began to develop. The minimum temperature was the most important factor and was highly correlated with changes in apices of all crops studied.

Introduction

The transition from vegetative growth to flowering is a result of the coordinated interaction of all parts of the plant after the receipt of some type of environmental signal for flower induction to occur (Aksenova et al. 1980). The literature is not well established on tropical fruit, how environment, such as maximum and minimum temperature (°C), sun shine hours (hr/day), amount of rainfall (mm/day), maximum and minimum relative humidity (%) and soil temperature (°C) affects the transition from vegetative stage to reproductive stage of this crop. Contrasting with the literature on the effect of the environment, such as temperature and daylength on the flowering of temperate fruit, the literature on tropical fruit is not well established (Gur 1985; Tran Thanh Van 1985; Guttridge 1985). However, the correlation between the environmental factors and the transition from vegetative growth to flowering, or in other words, induced apices to flower, has not been studied in detail. Thus, comparative studies of the changes in apices of some kinds of tropical fruit and temperate fruit were done. This was to asssess the morphological changes from vegetative apices to flower apices of mangosteen, rumbutan and strawberry (*Garcinia mangostuna* L., *Nephelium Lappaceum* L. and *Fragaria ananassa* Duch.) respectively, and to correlate these changes with environmental factor studies.

Materials and Methods

The experiments were conducted from 1991 to 1992 at Chanthaburi Horticultural Research Centre, Chanthaburi, for mangosteen and rambutan, whereas strawberry were studied at Doi Tung, Chiangrai in 1993. Ten plants of 16 to 17 year -old mangosteen and 10 plants of 12 to15 year -old rambutan that were equal in size and maturity were sampled. Ten strawberry plants cultivar Tioga No.16 that were transplanted from tissue culture in March 1993, and were grown in nursery, were used as materials from September to the end of November 1993.

Ten shoots of each sample plant of mangosteen and rambutan with at least a couple of old leaves below them, were sampled at fortnightly intervals from 15 September 1991 to 30 July 1992. The samples were then dissected under a stereomicroscope magnified 10 to 64 times and were stereomicrographed. Ten uniform plants of strawberry were also sampled at fortnightly intervals from 15 September to the end of November 1993. The samples were dissected and stereomicrographed as in mangosteen and rambutan. The percent of apices induced to flower of all crops studied were recorded and correlated with maximum and minimum temperature (°C), sun shine hours (hr/day) amount of rainfall (mm/day), maximum and minimum relative humidity (%) and soil temperature at the depth of 100 cm (°C). All the environmental factors were recorded at the sites of the study. The results were analyzed using multiple linear regression analysis. For strawberry, since it was known previously that the minimum temperature (°C) was highly correlated with percentage induced to flower of many cultivars (Manakasem 1991), only minimum temperature (°C) was studied.

Results and discussion

Figure 1 (a) - (I), Figure 2 (a) - (g) and Figure 3 (a) - (e) shows the morphological changes in apices from the vegetative induce to flower stage of mangosteen, rambutan and strawberry, respectively. The vegetative apices of all crops studied were seen as flattening apices. They were rounded and flattened in mangosteen [Figure 1 (e)], lobed and flattened in rambutan [Figure 2 (a)] and non-swelling with last trifoliate leaf in strawberry [Figure 3 (a)]. The dissection of apices under the stereomicroscope of tropical fruit trees to see the morphological changes has not been studied. However, in comparision with the longitudinal section in rambutan from the work of Tongumpai (1980), the results were comparatively the same. The work in mangosteen has not been recorded. Probably, it was quite difficult to dissect and find apices of mangosteen from vegetative to early stages of flower. The tissues were very soft and there was lot of liquid around them. This difficulty was also found on strawberry. However, the stereomicrograph of vegetative apices was comparatively the same as photographed using SEM technique (Manakasem 1991).

The first evidence of flower initiation appeared as an enlargement and raising of apices. Figure 1 (a), (b), (c), (d), and (e) show the vegetative development of mangosteen apex to leaf bud. Figure 1(f) shows the flower bud initiation. The apex was round and raised non-segmented forming a flower bud Then the ovary, the stigma and stami-nodes were developed only in the middle of the flower bud. Then the sepal and petal were developed and seen [Figure 1 (g)]. We could notice the red purple flower bud of the mangosteen without using a microscope. The flower bud is completely developed. However, we could not see the earlier stages without using dissecting technique under stereomicroscope. Figure 1 (h) and (I) show the complete flower development and the core of blossom flower under the stereomicroscope.

Flower initiation in rambutan appeared as 2 raising lobes of apex and the buds below the apex [Figure 2 (b)]. Then sepals, petals, stamens and pistils developed [Figure 2 (c)]. The short racemes were then seen on the trees [Figure 2 (d)] in early December. After that the racemes elongated [Figure 2 (e)] and developed as seen in Figure 3 (f). Figure 3 (g) shows the flowering of rambutan. When shoots of rambutan are turning black and swollen, the flower has already initiated with its apices on stage as seen in Figure 2 (c). The changes of apices before this stage could not be seen without using dissecting technique under stereomicroscope.

The first evidence of flower intiation in strawberry appeared as an enlargement and raising of the apex [Figure 3 (b)]. Signs of the start of sepal development on primary flower primordium were then seen [Figure 3 (c)]. As sepals grew, petal initiation was noted [Figure 3 (d)]. The sepals began to enclose the bud at about the time the stamens began to develop. Then the epidermal hairs developed and began to cover the flowers. At about this time pistil differentiation began [Figure 3 (e)]. The changes in apices of strawberry have been well documented both using dissecting technique under stereomicroscope (Durner and Poling 1985; Manakasem 1991) and using SEM technique (Manakasem 1991). This result agreed with their result.

The results of multiple linear regression analysis, using percentage induced to flower of mangosteen and rambutan and microclimatic factors studied are shown in equations 1 and 2, respectively.

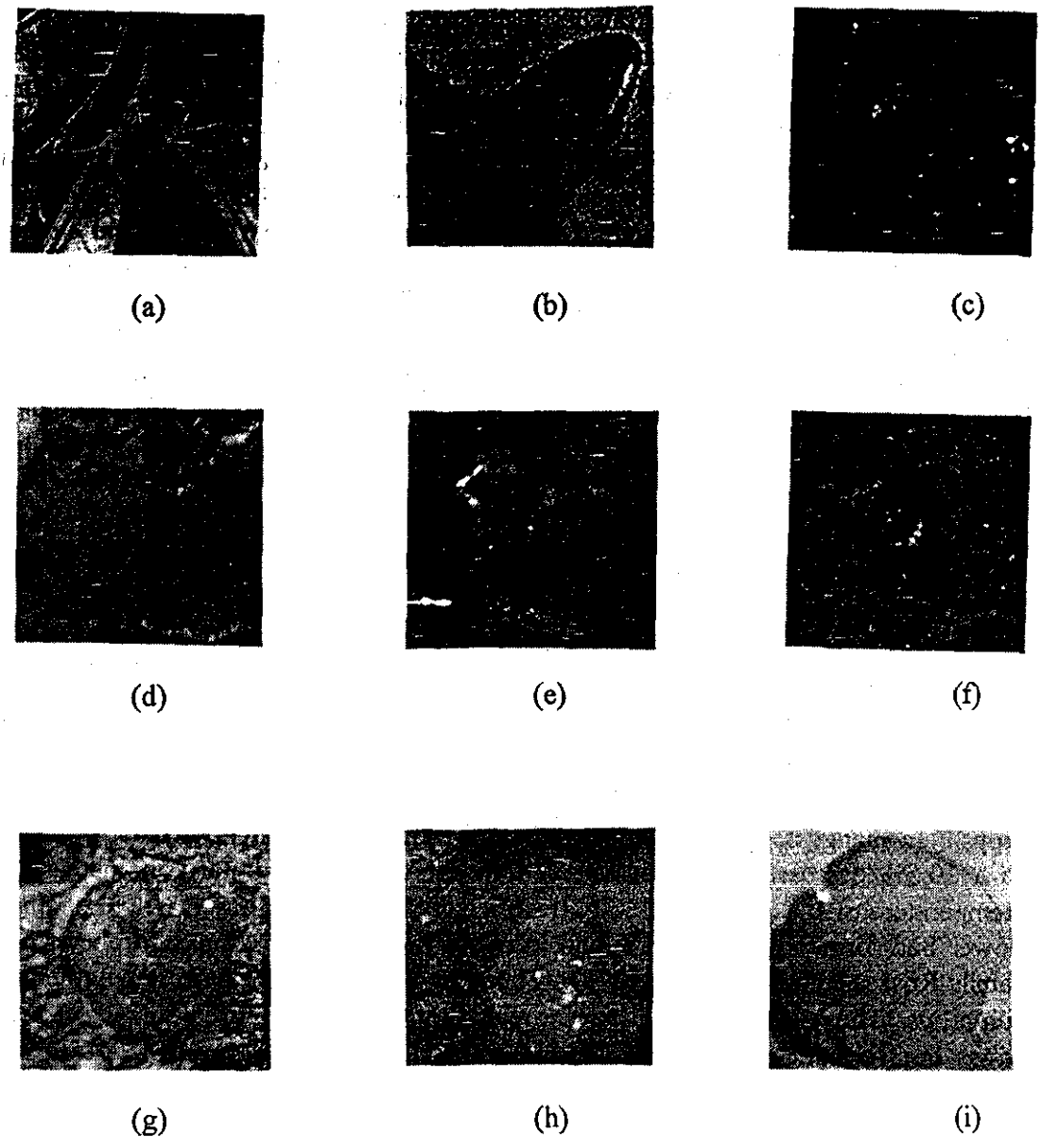
$$Y = 280.961 - 10.547^{*} \text{ min temp.} + 0.893^{NS} \text{ sun shine hr.} - 0.876^{NS} \text{ rainfall} \quad (1)$$
$$R^2 = 0.61^{**}$$

$$Y = 176.571 - 6.719^{*} \text{ min. tem} + 5.96^{NS} \text{ sun shine hr} - 1.019^{NS} \text{ rainfall} \quad (2)$$
$$R^2 = 0.68^{**}$$

The equations indicated that the minimum temperature had an effect on the changes in apices of both crops. In mangosteen, when the minimum temperature was increased 1°C, this resulted in a 10.5% decrease of flower induction. Whereas in rambutan, an increase in minimum temperature of 1°C resulted in 6.7% decrease in flower induction. Low temperature induced flower bud formation has been found in many plants. For example, in cherry and plants in family Rosaceae (Abbott et al, 1975). Thus low temperature has the same effect on tropical fruit crops. The results in strawberry show that the low temperature beginning at 18°C induced flower bud formation. Heide (1977) found that temperature from 12 to 18°C was required to ensure independence from photoperiodic effect on flower initiation of some Junebearing cultivars. Since Tioga No.16 was bred in California for mild climate, the result is believable.

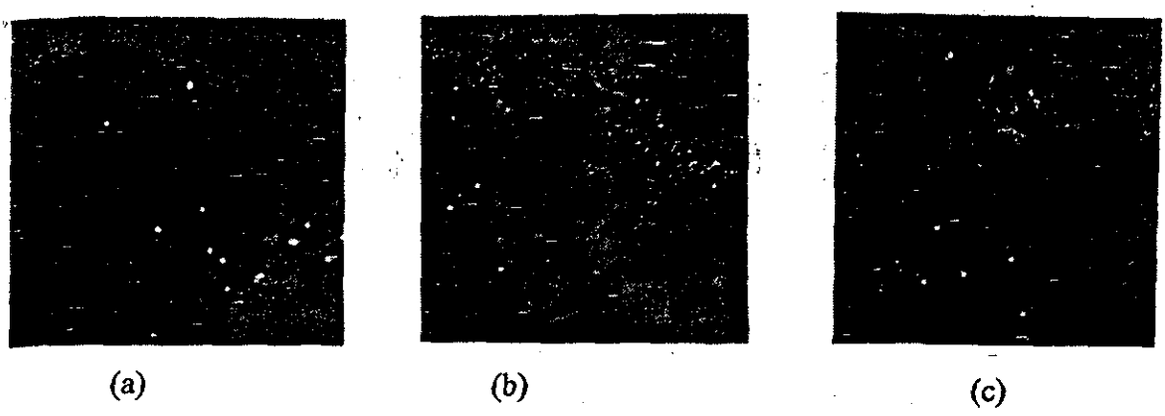
Conclusions

The morphology of vegetative apices of all crops studied were soft and flat. The first evidence of flower initiation was an enlargement and raising of the apices. Then the flower developed. In mangosteen, the ovary developed first. Then the sepal and petal developed. In rambutan, after the two raised lobes of apices developed, the sepal, petal, stamen and pistil developed. The short raceme was then seen and flowering appeared. After an enlargement and raising of the apex on flower initiation in strawberry; sepal, petal, stamens and pistil developed. Of all crops studied minimum temperature was the most important factor affecting the changes in apices from the vegetative stage to flower.

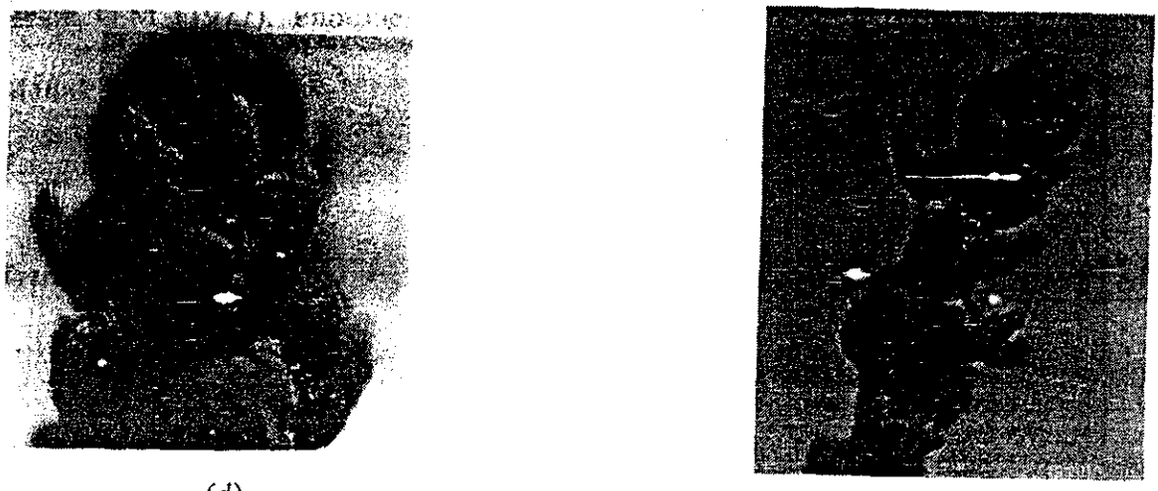


(a) Bud sample (b) Shoot tip (c) Flattening apex
(d) Four round parts of apex (e) Leaf bud initiation (f) Flower bud intiation
(g) Flower development (h) Complete flower development (i) Core of blossom flow

Fig. 1. Changes in apices of mangosteen *(Garcinia mangostana)* under stereomicrospic magnification 10 to 64 times.



(a) (b) (c)

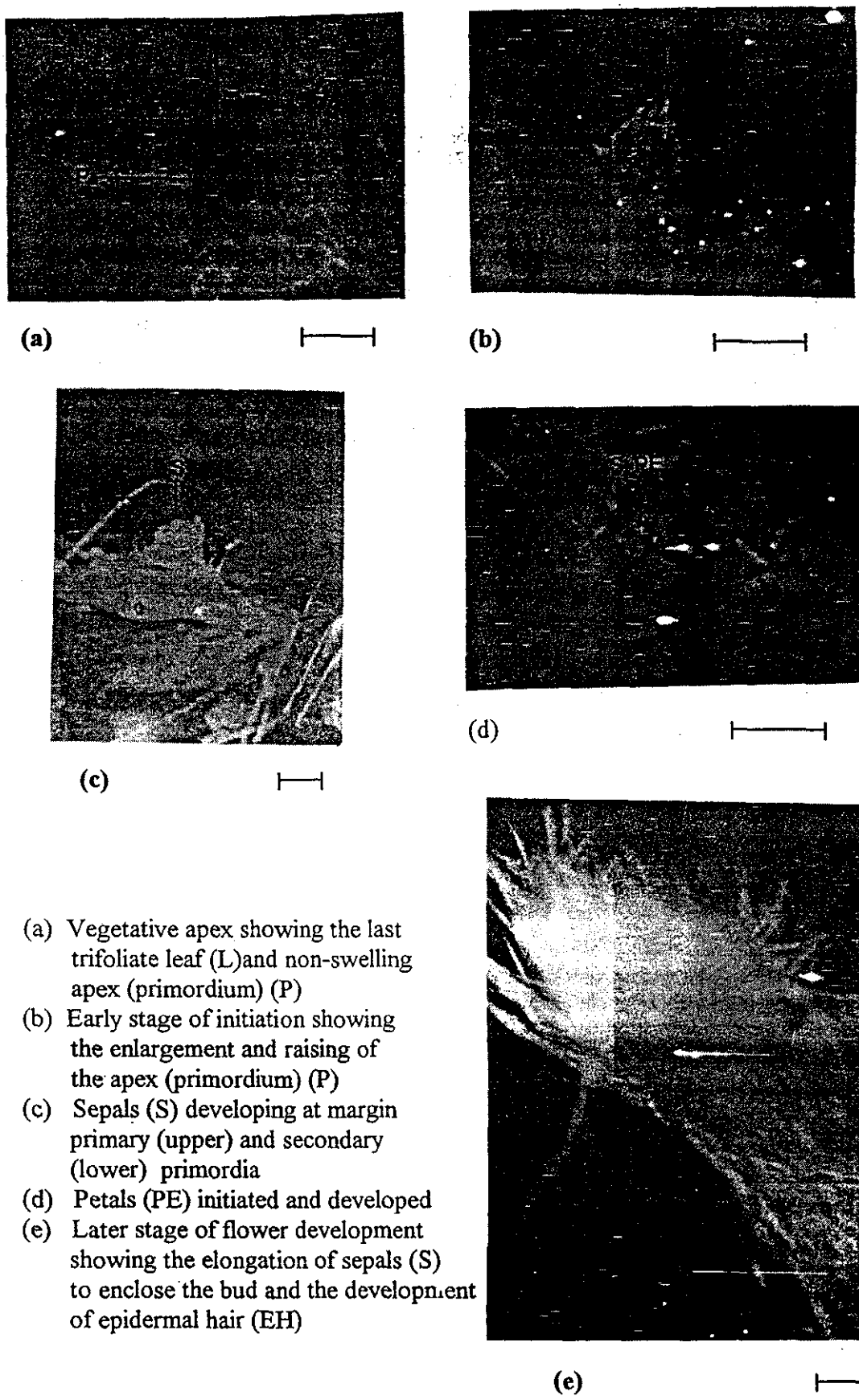


(d) (e)

(f) (g)

(a) Leaf apex
(b) Flower apex show 2 lope morphology
(c) Complete flower
(d) Short raceme
e) Extended raceme with bracts
(f) Racemose type
(g) Flowering stage

fig.2 Changes in spices of rambutan (*Nephelium lappaceum* L.) under stereomicropic magnification 10 to 64 times.



(a) Vegetative apex showing the last trifoliate leaf (L)and non-swelling apex (primordium) (P)
(b) Early stage of initiation showing the enlargement and raising of the apex (primordium) (P)
(c) Sepals (S) developing at margin primary (upper) and secondary (lower) primordia
(d) Petals (PE) initiated and developed
(e) Later stage of flower development showing the elongation of sepals (S) to enclose the bud and the development of epidermal hair (EH)

Fig.3 Changs in apices of strawberry (*Fragaria ananassa* Duch.) under stereomicroscopic magnification 10 to 64 times. Scale bar = 500 μm

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