Morphological and Anatomical Changes of the Keladi Cina (*Colocasia esculenta*) Plant in the Vegetative and Flowering Stages

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ABSTRACT

The crop cycle of the *C. esculenta* plant varies from 4 to 12 months depending on the cultivar. After planting, there is a period of rapid vegetative growth followed by a decline. During the period of decline there is an increase in the size of the undergrown corm.

Flowering in the Malaysian cultivars of *C. esculenta* is rare; it occurs only in a few cultivars. In the growth cycle of the plants without inflorescence, the apical meristem produces only foliar primordia which develop into leaves. In a flowering plant, the pattern is interrupted by the emergence of the floral primordia. Morphological and histological changes in the plant and meristem were observed.

Introduction

The importance of inducing flowering and seed production in taro (*Colocasia esculenta*) has only recently gained full interest and support (Volin, 1976; Alamu and McDavid, 1978; Wilson, 1979; Strauss and Arditti, 1979; Ghani, 1981). It is now possible to project seed production with improved and higher yielding cultivars of *C. esculenta*. Despite this, however, a gap exists in knowledge of processes and changes leading to flowering, during flowering and transition from the vegetative to floral stage.

The very source of such information at morphological level is the apical meristem of the plant. The apical meristem and its development contributes to plant expression which is observed as its vegetative leaf, time of initiation, number of leaves produced, rate of leaf production and likewise for the time, number and rate of inflorescences produced. The close and strong relationship between these two factors (the vegetative and flowering processes) is undoubtedly also linked to other factors such as leaf area index, net photosynthetic rate, senescence, tuber initiation and yield.

The positive relationship between leaf area and yield has been shown to be consistent (Purewal and Dargan, 1957; Enyi, 1967a; 1967b; 1977; Bourke and Perry, 1976; Ezumah and Plucknett, 1977; Abit and Alferez, 1980). This has stimulated the need for knowledge on the growth and development aspects in taro.

Materials and Methods

A uniform population of more than 600 plants was raised in field plots. The 7.2 m square plots each contained eight raised rows with 12 plants/rows. Spatial arrangement was 90x60 cm. The plants were under dryland cultivation and were watered twice daily.

Twenty randomly sampled plants were available for dissection each 14 days. Ten samples were fixed 70% FAA solutions (Formalin Acetic Alcohol = 90:5:5) and embedded for sectioning after the green foliar leaves and non-chlorophyllous leaves were removed.

The delicate tissues near the meristem in a number of specimens were damaged and lost, hence the final total were utilized of 10-15 per sample of successfully dissected growing points.

Hardening of tissues in preserved specimens prevented successful dissection of the primordia and apical meristem, resulting in loss of samples for weeks 6, 22, and 30.

Alongside this study, the plant population was used for a separate experiment on growth, the result contributing to the study of the apical meristem.

Results

Composition of the growing plant

Mature *C. esculenta* (cv. Keladi Cina) plants are composed of green foliar leaves, non-chlorophyllous leaves, the primordial leaves and the growing apex. Each structure is ensheathed within the preceding structure and is contained within the youngest of the exposed, green, foliar leaves. The leaves are spirally arranged on the corm.

In the first weeks after planting, a small leaf was produced and within it were leaf primordia and the apical meristem.

By the third week, the first foliar green leaf, a rolled expanding leaf and non-chlorophyllous leaves were distinguishable. After the third week, all plants consisted of the full complement of foliar structures. The apex was surrounded by recently initiated primordia. This constant pattern ensued until the 44th week in non-flowering plants.

In a flowering plant the pattern was interrupted. The terminal apex produced the inflorescence primordium and a lateral apex from the axil of the youngest leaf was the vegetative apex.

Production of foliar structures

Changes in the total number of foliar structures at different stages in the growth cycle were due to rate of leaf primordial production and leaf longevity. The number of expanded green leaves on a plant which must have been largely influenced by rates of senescence as well as expansion, contributed to the fluctuation in the total since the rest of the structures remained fairly constant as in 8 to 14 weeks, 24 to 28 weeks, 38 to 40 weeks and 42 to 44 weeks (Table 1).

At 16 weeks the maximum leaf number was achieved and this was followed by a decline until harvest at 44 weeks.

Corm initiation

Corm initiation was detected about week 16 and flowering occurred between weeks 18 to 21. These events appeared to have some correlation with leaf area. When corm initiation occurred there was an increase in living foliage area and leaf number up to 7 leaves but when flowering occurred there was a gradual decline to 6 and 5 leaves. This was correlated to the morphological and cellular changes observed at the apex.

Further work to establish a causal connection of the observed changes with leaf senescence rates is underway.

Table 1. Number of foliar structures of Keladi Cina plants at different stages.

Age of plant (weeks)	Expanded green leaves	Green rolled leaves	Non chlorophyllous leaves	Primordium	Total
2	1	-	2	1	4
3	2	1	2	1	6
4	2	1	3	3	9
6	3	-	-	-	-
8	3	2	2	3	10
10	4	2	2	3	11
12	5	2	2	3	12
14	5	2	3	3	13
16	7	4	3	3	17
18	6	4	2	3	15
20	5	3	3	3	14
22	-	-	-	-	-
24	5	2	3	3	13
28	4	2	3	3	12
30	-	-	-	-	-
32	3	2	4	3	12
34	3	1	3	3	10
36	-	-	-	-	-
38	3	1	2	3	9
40	2	1	2	3	8
42	2	1	1	3	7
44	2	0	2	3	7

Histological Studies of the Apical Meristem

Materials and Methods

Whole plants were dissected carefully to remove foliar structures one by one down to the apical dome on the meristem. Meristem tips were used for slide preparation as were leaves, petioles, corms. For histological preparations, paraffin embedding methods described by Johansen (1940), Sass (1958), and Gray (1962) were used. Sectioning of paraffin blocks was on a MSE sledge microtome at 10 μ thickness and Spencer Rotary Microtome (Model 820). Sections were stained with Safranin and Fast Green.

Results

The vegetative apex

The vegetative apex surface consisted of a layer of flattened cells, the tunica. The corpus region as such was not clearly distinguishable in longitudinal sections. It appeared as a transition between two rows of tunica cells and lower meristem region. Both tunica and corpus cells appear similar in size with large nuclei. At an older stage, meristematic activity in central corpus cells raised the apex to form a flattened dome. Periclinal divisions in the apical dome resulted in formation of leaf primordia. Subsequently, rapid division and elongation of cells resulted in further growth of leaf primordia. Each new leaf primordium was inserted within the previous one. A total of 32 to 34 leaves were produced in one crop cycle.

In plants producing inflorescences, there were changes at the apical meristem. Precise trigger for transition from vegetative to floral apex remains unknown for taro.

The floral apex

A distinct change in size and shape of the floral apex was noted. The vegetative apex was low and flattened, the floral apex consisted of a broad raised dome which became narrow and unusually elongated as it grew upwards. This was followed by differentiation which resulted in a double dome and a single primordium. The double dome structure consisted of differentiating terminal floral apex (spathe and spadix) and subtending foliar primordium.

The morphology of the floral apex

The flowering plant carries normal foliage green leaves (vegetative) and the cluster of inflorescences. The cluster of inflorescences arise in the axil of the youngest leaf. Spiral arrangement and ensheathing leaf bases result in a number of protective hood-like structures over inflorescence primordia. Average number of colorless inflorescence primordia was 3 to 4 and between each primordium was a "membranous sheath" structure. The terminal inflorescence apex and lateral floral primordia were displaced by the lateral vegetative apex.

Promotion of new leaves ceases when the growing point becomes reproductive and it would seem that the longevity of the last formed leaves is increased at this time. Subsequently, a lateral apex becomes activated and leaf production resumes from such a single growing point and this continues until full corm growth is attained at the end of the growth cycle.

Conclusion

The studies revealed the growth and developmental behavior of the growing meristem as a vegetative apex and its adjustment to accommodate the floral process over a "short" period before it reversed to become a vegetative apex.

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