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Comprehensive comparative morphology and developmental stages of coconut haustorium

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Abstract
A study was conducted to determine the morphological characters in coconut haustorium produced during the germination of nuts. During germination, the embryo enlarges to form white fleshy spongy apple possessing the serrated cotyledonary structure. The cultivar Chowghat Orange Dwarf shows earlier germination and haustorium development than the West Coast Tall cultivar. The results indicated that COD: WCT cultivar at 60 to 120 days after sowing *viz*., shoot length (14.66 to 76.66: 5.33 to 67.83 cm), haustorium fresh weight (20.56 to 118.40: 8.50 to 103.74 g), haustorium dry weight (2.77 to 14.94: 1.97 to 13.32 g), kernel weight (191.48 to 85.70: 207.27 to 132.73 g) and nut water volume (25.20 to 0.00: 47.10 to 0.00 ml) were evaluated. Coconut kernel exhausts successively, while the haustorium fills the cavity gradually. Haustorium development occurs statically along with seedling growth. The shoot length, haustorium fresh and dry weight were gradually increased but the kernel weight was slightly decreased. The nut water was continuously reduced during different developmental stages and completely disappeared at 100 days after sowing.

Keywords: Coconut, haustorium, chowghat orange dwarf, west coast tall, morphological parameters

Introduction
Coconut is botanically called as *Cocos nucifera* belonging to the family Arecaceae is considered to be the "Tree of heaven" due to its versatile nature. In terms of coconut production and productivity, India is one of the leading countries in the world (Karun, 2018). In India, coconut is mainly cultivated in the southern regions. Based on the morphology, the coconut palm has mainly classified into two group of cultivars namely Tall and Dwarf (Thomas *et al*., 2016) [10]. Coconut has three eyes with two blind eyes and one soft eye. Coconut germinates in the active eye called soft eye, where it grows in to shoot or plumule (Smit, 1970) [8]. During germination of the nuts, the basal part of embryo enlarges and develops to form white spongy serrated structure, embedded in the endosperm called "Haustorium" (Balachandran and Arumugam, 1995b) [2]. It mainly acts as store house of nutrients and helps in the mobilization of nutrients for growth and development of seedlings (Sugimuma and Murakami, 1990) [9]. Within 3 to 4 months, haustorium completely fills the cavity of nuts with the absorption of solid and liquid endosperm. According to available literature, very few studies are available on the possible interactions between growth and development of coconut haustorium. The aim of the study was mainly to observe the growth and developmental changes of haustorium during the germination of nuts.

Materials and Methods
Selection of plant materials
The cultivar Chowghat Orange Dwarf (COD) and West Coast Tall (WCT) were used for the study. The mature nuts were collected from coconut nursery, Tamil Nadu Agricultural University, Coimbatore. Morphological changes at different developmental stages *viz*., 60, 80, 100 and 120 Days after Sowing (DAS) were represented in Fig. 1. The parameters observed were the initial nut weight (g), shoot length (cm), haustorium fresh weight (g), haustorium dry weight (g), kernel weight (g) and nut water volume (ml).

Initial nut weight (g)
The matured nuts were harvested and pre- stored for one month period. The mature nuts were collected and initial nut weight (Fig. 2) was measured before sowing. The weight of the nuts was measured by using weighing balance.

Shoot length (cm)
After the emergence of shoot or plumule, the length of the shoots was taken by using measuring scale at different developmental stages of germination period.

Haustorium fresh weight (g)
During germination, the nuts were removed from soil at different developmental stages *viz*., 60, 80, 100 and 120 days after sowing. The nuts were dehusked and broken carefully to get the haustorium from the nuts. The fresh weight of the haustorium were taken by using weighing balance.

Haustorium dry weight (g)
The fresh haustorium were sliced into uniform pieces and dried in a hot air oven at 50 to 55° C. The constant dry weight of haustorium were measured.

Kernel weight (g)
After the removal of fresh haustorium, the remaining kernel or solid endosperm portion were peeled out and measured in weighing balance.

Nut water volume (ml)
The dehusked nuts were broken carefully to collect the nut water and it is measured by using measuring cylinder.

Statistical analysis
The data were evaluated by analysis of variance (ANOVA) by using SPSS version 16.0 for windows and $P< 0.05$ values were determined significant differences in the morphological parameters studied in coconut haustorium.

Results and discussion
The changes with respect to morphological parameters were quite similar in COD and WCT and represented in (Fig. 3 and Table. 1). The germination of Chowghat Orange Dwarf at 40 to 50 days after sowing and West Coast Tall cultivar occurs at 50 to 60 days after sowing. There is significant difference between the initial nut weight varies from 639.78 to 774.15 g in COD and that of WCT from 915.35 to 928.13 g. The shoot length was rapidly increased in the early stages from 14.66 to 76.66 cm in COD and in WCT it varies from 5.33 to 67.83 cm. In COD, the haustorium fresh weight was increased from 20.56 g and 118.40 g at 60 to 120 days after sowing of nuts and in WCT varies from 8.50 to 103.74 g. Similarly, the haustorium dry weight varies from 2.77 to 14.94 g in COD and 1.97 to 13.32 g in WCT. The kernel weight was remained at a constant state in the early stages of COD ranging from 191.48 to 85.70 g and that of WCT 207.27 to 132.73 g, but began to be gradually decreased from 60 to 120 DAS. Nut water volume was reduced from 25.20 to 8.96 ml in COD and 14.10 to 18.76 ml in WCT at 60 to 80 days after sowing respectively. The nut water volume was continuously reduced during different developmental stages and completely disappeared at 100 days after sowing. Li *et al*. (2019) [6] reported that physiological changes in seedling growth and haustorium development were studied in Hainan Tall and Red Dwarf of coconut. During the germination, seedling length and haustorium development were gradually increased and after 4.5 and 8.5 months of collection the haustorium weight, solid and liquid endosperm were slightly decreased. The coconut haustorium fresh weight was rapidly increased from 20.98g to 88.47g at 2nd and 4nd months of germination in Malaysian Yellow Dwarf (Konan *et al*., 2017) [4]. Manivannan *et al*. (2018) [7] revealed that the initial nut weight ranges from 818–1135 g, shoot length ranges from 27.6–60.5 cm and haustorium weight varied from 80.2 g to 131 g at 60 days after germination in West Coast Tall. At this stage, the liquid endosperm was replaced by the haustorium and it occupies the entire cavity of nut. The haustorium was filled with 22nd week of germination and meanwhile, the solid endosperm was degraded. After 16th week of germination, the mucilage content was appeared on the inner endosperm and it has oily in nature (Balachandran and Arumughan, 1995a) [1]. The coconut water during germination were studied in PB121 hybrid, Malaysian Yellow Dwarf and West African Tall cultivars. coconut water weight was similar in 0 to 2 months of gemination. After 4 months of germination drastically decreased of coconut water (Konan *et al*., 2011) [5].

Conclusion
The present study revealed that the Chowghat Orange Dwarf showed earlier germination and haustorium development than the West Coast Tall cultivar. The haustorium absorbs food materials from the solid and liquid endosperms and to supply nutrients for seedling growth. It acts as energy store which gets assimilated into the growth of the seedlings, thereby the haustorium gets exhausted leaving the white spongy apple. The haustorium was suitable for consumption purpose during 80 to 100th days after sowing. Thus, it was concluded that kernel weight and nut water volume was reduced along with the development of haustorium and coconut seedling.

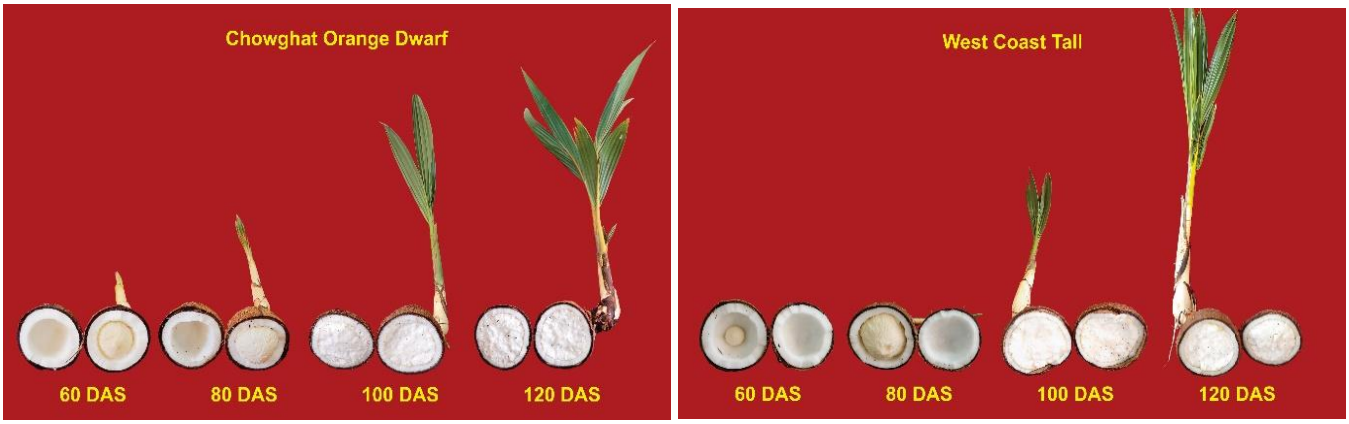

Fig 1: Development of coconut haustorium at different growth stages

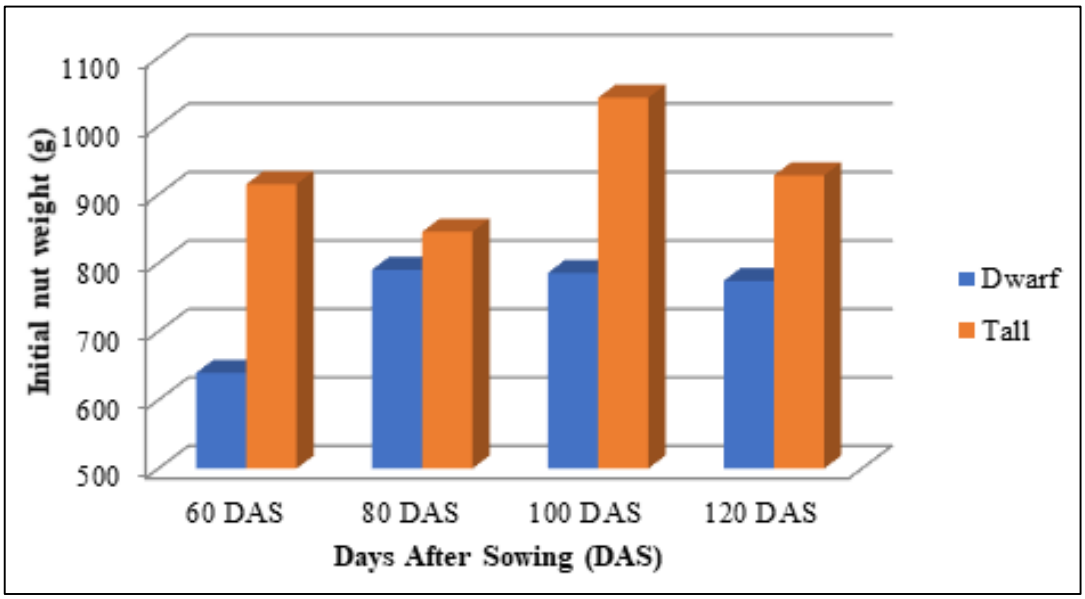

Fig 2: Selection of Plant Materials

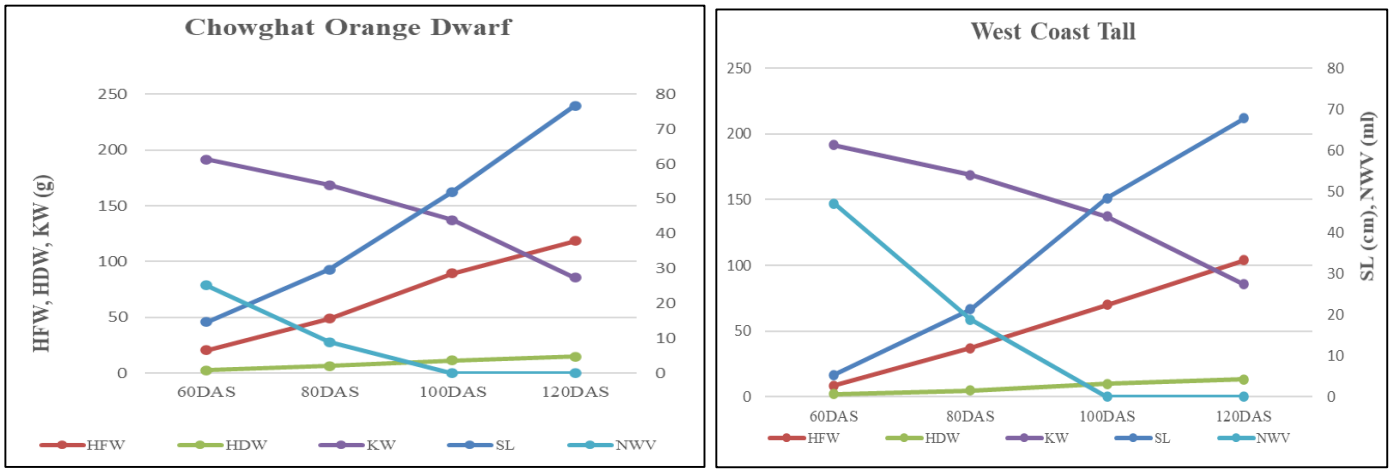

Fig 3: Changes of shoot length (SL), haustorium fresh weight (HFW), haustorium dry weight (HDW), kernel weight (KW) and nut water volume (NWV) at different developmental stages

Table 1: Morphological changes in Chowghat Orange Dwarf and West Coast Tall during different stages of development

Days After Sowing (DAS)		Shoot length (cm)		Haustorium fresh weight (g)		Haustorium dry weight (g)		Kernel weight (g)		Nut Water Volume (ml)	
		Dwarf	Tall	Dwarf	Tall	Dwarf	Tall	Dwarf	Tall	Dwarf	Tall
60 DAS		14.66	6.33	20.56	8.50	2.77	1.97	191.48	207.27	25.20	47.10
80 DAS		29.66	21.33	48.81	37.08	6.65	4.53	168.65	188.65	8.96	18.76
100 DAS		52.00	48.33	89.58	69.78	11.65	9.67	137.33	162.75	0.00	0.00
120 DAS		76.66	67.83	118.40	103.74	14.94	13.32	85.70	132.73	0.00	0.00
Mean		43.24	35.70	69.33	54.77	9.00	7.37	145.79	172.85	8.54	16.465
S.E(D)	C	0.55		1.00		0.16		2.24		1.21	
	D	0.77		1.42		0.23		3.16		1.72	
	C×D	1.09		2.00		0.32		4.47		2.43	
CD (0.05)	C	1.17**		2.15**		0.34**		4.80**		2.60**	
	D	1.66**		3.04**		0.49**		6.78**		3.68**	
	C×D	2.35**		4.30**		0.69**		9.59**		5.21**	

Results are represented as mean and $P<0.05$

References

1. Balachandran C, Arumughan C. Biochemical and cytochemical transformations in germinating coconut (*Cocos nucifera* Linn.). Journal of the American Oil Chemists' Society 1995a;72(11):1385-1391.
2. Balachandran C, Arumughan C. Triglyceride deposition in tissues of germinating coconut (Cocos nucifera Linn). Journal of the American Oil Chemists' Society 1995b;72(6):647-651.
3. Karun A. Coconut tissue culture: The Indian initiatives, experiences and achievements. CORD 2017;33(2):11-11.
4. Konan BR, Assa RR, Kouassi KN, Konan KJL, Amani NG. Variation of physicochemical parameters of coconut (*Cocos nucifera* L.) haustorium during germination. Int. J Agron Agric Res 2017;10(5):17-25.
5. Konan BR, Konan JL, Tetchi F, Assa RR, Amani G. The

biochemical characteristics of coconut (*Cocos nucifera* L.) water during germination. International Journal of Biological and Chemical Sciences 2011;5(6):2214-2223.
6. Li J, Htwe YM, Wang Y, Yang Y, Wu Y, Li D et al. Analysis of Sugars and Fatty Acids during Haustorium Development and Seedling Growth of Coconut. Agronomy Journal 2019;111(5):2341-2349.
7. Manivannan, Arivalagan, Rakesh Bhardwaj, Sugatha Padmanabhan, Poonam Suneja, Hebbar KB *et al*. Biochemical and nutritional characterization of coconut (*Cocos nucifera* L.) haustorium. Food Chemistry 2018;238:153-159.
8. Smit EHD. Morphological and anatomical studies of the coconut. Mededelingen Landbouwhoge school, Wageningen 1970, 70-8.
9. Sugimura Y, Murakami T. Structure and function of the haustorium in germinating coconut palm seed. Jap. Agric. Research Quart 1990;24:1-14.
10. Thomas B, Murphy DJ, Murray BG. Encyclopedia of applied plant sciences. Academic Press 2016.