

# GERMINATION, GROWTH AND DRY MATTER PARTITIONING IN COCONUT

C. Manjula, B. Chempakan and V. Rajagopal

*The differences during the early stages of germination in the water absorption by the seednuts among three cultivars and one hybrid of coconut (Cocos nucifera L.) namely, WCT (Tall), MYD and COD (dwarfs) and WCT x COD is highlighted. The amount of water absorbed is higher in WC tall and the hybrid as compared to dwarfs. Growth parameters like the length of root and shoot as well as the volume of the haustorium are analysed. In addition, the partitioning of dry matter into husk, shell, kernel, haustorium, root and shoot were also determined. The essential role of haustorium during the developmental changes as envisaged by the greater partitioning of dry matter is brought out.*

*Key words:* Cocos nucifera L., coconut, dry matter partitioning, germination, growth parameters, haustorium

## INTRODUCTION

Coconut (*Cocos nucifera* Linn.) is known to be one of the important commercial crops in the world. It is propagated by seednuts. The germination of the seeds depends on various external and internal factors. The most important external factors commonly affecting the germination of the seeds are water, soil, aeration, temperature, and light. According to Kolher et al. (1962), the germination of the seed may start during the imbibition. The rate of germination and early seedling growth differ among the different plant species and between genotypes of the same species. In coconut, during the process of germination, the embryo commences to grow in two directions - the plumule and the root grows towards the "soft eye", and the other end of the germ develops into the absorbent spongy growth known as *haustorium* (Menon and Pandalai 1958).

The present investigation highlights the differences among the cultivars in water absorption by the seednuts, growth parameters and also partitioning of dry matter into husk, shell, kernel and *haustorium*.

## MATERIALS AND METHODS

For the present study, two dwarf cultivars namely COD (Chowghat Orange Dwarf), MYD (Malayan Yellow Dwarf), a tall cultivar WCT (West Coast Tall) and a hybrid WCT x COD were selected. From each of these, 50 nuts of uniform maturity were collected and stored under laboratory conditions. Seednuts of WCT x COD were kept for 1 mo, whereas those of COD and MYD, for 2 wk.

### Sowing

A 5 m x 3 m bed was prepared for each cultivar and the nuts were sown vertically with the stalk end up at a distance of 50 cm x 60 cm. As the experiment was conducted between June and September, the field was fully saturated due to the monsoon rains. The nuts were numbered and the total weight of each nut was taken before sowing.

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1. Senior Research Fellow at National Research Centre for Spices, Calicut, Kerala, India.
2. Senior Scientist in Biochemistry at Central Plantation Crops Research Institute, Kasaragod, Kerala, India.
3. Principal Scientist in Plant Physiology at Central Plantation Crops Research Institute, Kasaragod, Kerala, India and for correspondence.

### Sampling

Preliminary studies in the laboratory had shown that the dwarfs COD and MYD germinated faster than WCT and WCT x COD. Accordingly, the dwarf varieties were sampled at weekly intervals, whereas WCT and WCT x COD at fortnightly intervals. For each sampling, five nuts were collected at random. There was a total of ten stages, including 'O' stage (1st stage) i.e. prior to sowing. The sampling was noted in terms of days after sowing (DAS). The dwarfs (COD and MYD) is considered as one set, while WCT and WCT x COD represented another set.

Immediately after sampling the total fresh weight of nuts were taken, dehusked and then split open into two halves. The kernel or endosperm was separated from the shell and the total fresh weights of husk, shell and kernel were taken. In the initial stages, sub-samples were taken from the shell, husk and kernel, kept in an oven at 85°C till constant reached and dry weight taken of all components. At later stages, when the *haustorium*, shoot and root developed, they were also included for dry weight determination. The volume of *haustorium* and lengths of shoot and root were also taken. Based on these observations, the rate of water absorption and dry matter partitioning of the nut components were calculated.

## RESULTS AND DISCUSSION

### Germination

The appearance of shoot just above the husk is taken as the indication for germination (Menon and Pandalai 1958). In the present study, two groups of cultivars were selected viz. the early germinating dwarfs (COD and MYD) and late germinating ones, the tall (WCT) and WCT x COD (hybrid). The number of days taken for germination were recorded in each case. Accordingly, the dwarfs COD and MYD germinated in 28 days, whereas it took 42 days for WCT and WCT x COD to germinate. The experiment was terminated by 77 days in dwarfs and by 115 days in both tall and hybrid coconuts.

### Fresh and Dry Weights

Figure 1 shows the fresh weights of nuts during germination; wherein WCT had the maximum fresh weight followed by WCT x COD, COD and MYD. Husk also showed a gradual increase in all the four genotypes, WCT x COD showing the maximum and MYD the minimum (Fig.2). Dry weight also showed a similar pattern except for the kernel and shell, where both fresh and dry weights of these remained constant during the period.

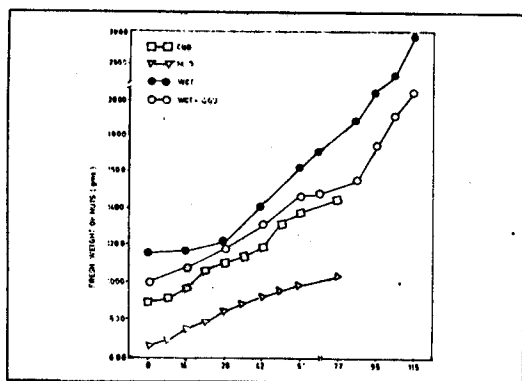


FIGURE 1  
Changes in the fresh weight of nuts (gms) at different stages of germination (□ -COD; ▽ -MYD; ● -WCT; ○ -WCT x COD)

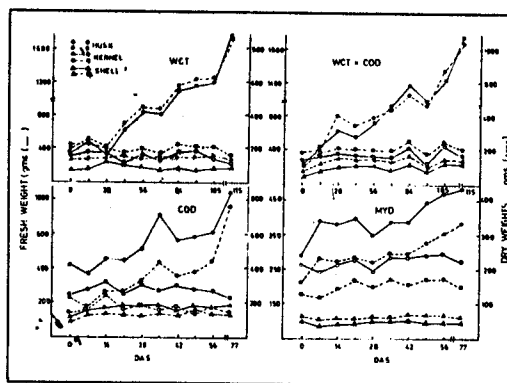
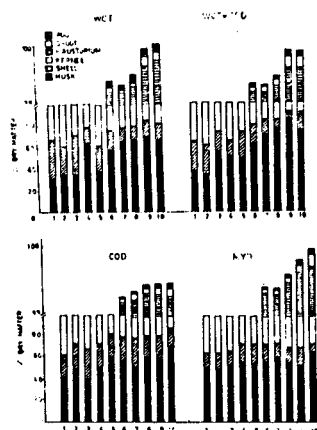
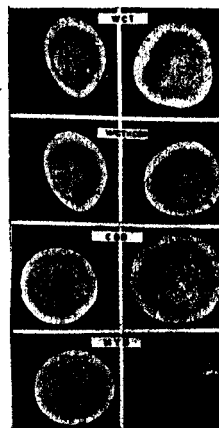


FIGURE 2  
Changes in the fresh weight (-) and dry weight (---) of husk, kernel and shell (gm) at different stages of germination. (● - husk; ▲ - shell; ○ - kernel) DAS: Days After Sowing



**FIGURE 3**  
Distribution of dry matter among the husk (■), shell (▨), kernel (□), haustorium (◻), shoot (◻) and root (◻) in coconut genotypes. DAS: Days After Sowing.



**PLATE 1**  
Split seednuts showing the appearance of haustorium on 14 DAS and 28 DAS. Note the difference in the size of the haustorium between the cultivar and hybrid.

### Water Absorption

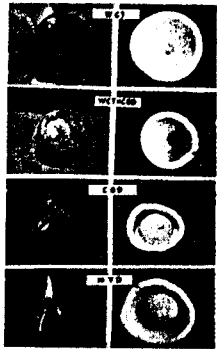
The higher amount of water absorbed in WCT and WCT x COD as compared to the dwarfs might be attributed to the thickness of the husk as explained earlier by Thampan (1975). As dwarfs germinated earlier than the tall and hybrid, further supports the differential nature of the husk as an important determinant of germination in coconut. This was supported by an earlier study (Larson 1966) which showed that the removal of the seed coat in peas allowed rapid imbibition, which in turn speeded up the germination process.

### Growth Index

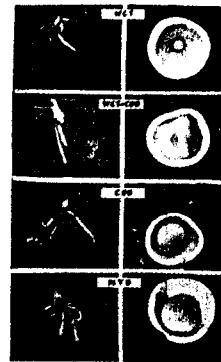
The growth indices of *haustorium*, shoot and root are shown in Tables 1a and 1b. The fresh and dry weights and volume of the *haustorium* and lengths of shoot and root showed a gradual increase in all cases. By 77 days from sowing or DAS, the *haustorium* attained a maximum weight of 34 g to 36 g in COD and MYD, while the haustorium of WCT and WCT x COD attained a weight of 80 g to 90 g by 115 DAS, clearly more than two times of the dwarfs. *Haustorium* appeared as button sized structure by 14 DAS in COD and MYD and by 28 DAS in WCT and WCT x COD (Plate 1) and continued to grow and fill the cavity (Plates 2 and 3). At the termination of the experiment (77 DAS, dwarfs 115 DAS, tall and hybrid), four well developed roots with prominent shoot growth was observed in both dwarfs and the tall and hybrid. However, the *haustorium* from WCT had higher volume (314.6 cm<sup>3</sup>) than the hybrid (205.3 cm<sup>3</sup>), while the dwarfs had almost similar volume (152.9 cm<sup>3</sup>). Irrespective of the cultivar, the shoot length increased with time, the growth being higher in WCT x COD than the dwarfs. Similarly, the root length also showed a gradual increase in the four genotypes. Thus, eventhough there was delay in the development of *haustorium* as well as on the emergence of shoot and root in WCT and WCT x COD as compared to dwarfs, the latter had lower volume of *haustorium*. This was reflected in the production of dry matter and its partitioning.

### Dry Matter Partitioning

The distribution of dry matter among the components of seednuts viz. husk, shell, kernel and also *haustorium*, shoot and root at later stages of development is represented in Figure 3. At the time of sowing, the dry matter was almost equally distributed (31%-36%) among the husk, shell and kernel in the case of WCT, whereas in the hybrid, the shell had lower dry matter compared to the other two



**PLATE 2**  
Full seednuts (left) and split seed nuts (right) on 42 DAS, showing the development of root, shoot and haustorium respectively. Note the rapid development in the dwarfs. DAS: Days After Sowing



**PLATE 3**  
Full seednuts (left) and split seednuts (right) on 56 DAS showing the development of root/shoot and haustorium. Note the distinctly slower development in tall (WCT) and hybrid. DAS: Days After Sowing

components. In both dwarfs, the dry matter of husk was higher than that of the kernel and shell. There was a gradual increase in the dry matter of the *haustorium*, shoot and root with time in all genotypes, the rate of increase being higher in tall and hybrid than in dwarfs. The greater partitioning of dry matter in the *haustorium* than in the shoot and the root implies the essential role of *haustorium* during the developmental stages as reported by Menon and Pandalai (1958).

## CONCLUSION

Seednuts of all the four cultivars/hybrids were exposed to the same level of soil moisture, as plots were saturated to the same degree of water availability during germination. Thus, the difference in the cultivars in the imbibition of water and resultant changes in fresh weights may be attributed to the thickness of the husk. The extent of influence due to the initial uptake of water, differing in germinability among the varieties/hybrids, on the biochemical composition of the kernel could be explained in terms of the utilization of reserve food materials like lipids, starch, and proteins and their solubilization by the respective hydrolytic enzymes viz. lipase, amylase, invertase and protease (Manjula, Chempakan and Rajagopal 1993). The total sugars, reducing sugars and amino acids of nut water also showed variation during the early phase, wherein the contents increased in the early stages, but declined after the development of the *haustorium* (Manjula, Pers. Commun.)

Results thus indicate the differential nature of the *haustorium* in bringing out greater partitioning of dry matter, during the early phase of germination.

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Table 1(a)  
Indices of shoot, root and haustorium (WCT and WCT x COD)<sup>1</sup>

Genotypes	DAS <sup>2</sup>	Haustorium			Shoot			Root		
		Volume (cm <sup>3</sup> )	Fresh Weight (gm)	Dry Weight (gm)	Length (cm)	Fresh Weight (gm)	Dry Weight (gm)	Length (cm)	Fresh Weight (gm)	Dry Weight (gm)
	70	41.6	11.9	2.08	5.3	5.0	0.73	19.7	2.5	0.30
	84	69.4	13.3	2.20	4.0	5.8	0.82	35.8	3.4	0.47
WCT	95	1279.5	29.2	3.01	10.3	7.0	0.98	37.8	8.5	0.92
	105	284.4	70.0	9.40	14.3	24.1	3.40	55.0	11.6	1.58
	115	314.6	80.4	12.03	16.3	24.5	4.09	72.9	11.9	2.43
	70	37.1	11.1	1.79	8.9	4.6	0.64	15.7	2.7	0.37
	84	84.3	20.1	2.84	5.7	4.9	0.59	27.1	2.5	0.21
WCT x COD	95	173.4	41.1	5.30	8.5	11.6	1.56	28.0	2.7	0.38
	105	187.3	84.0	10.21	7.7	15.4	2.27	62.1	8.5	1.19
	115	205.3	99.0	12.03	12.5	19.9	3.29	63.5	12.9	1.70

WCT - West Coast Tall

WCT x COD - West Coast Tall x Chowghat Orange Dwarf

<sup>2</sup> Days After Sowing

Table 1(b)  
Indices of shoot, root and Haustorium (COD and MYD)<sup>1</sup>

Genotypes	DAS <sup>2</sup>	Haustorium			Shoot			Root		
		Volume (cm <sup>3</sup> )	Fresh Weight (gm)	Dry Weight (gm)	Length (cm)	Fresh Weight (gm)	Dry Weight (gm)	Length (cm)	Fresh Weight (gm)	Dry Weight (gm)
	35	46.4	10.5	1.59	5.9	2.5	0.43	27.5	2.3	0.17
	42	76.2	13.0	1.99	6.3	4.4	0.66	27.2	3.5	0.35
COD	49	107.5	14.0	2.64	5.3	4.8	0.73	28.3	4.3	0.53
	56	116.5	19.0	2.76	7.0	5.0	0.74	41.1	4.4	0.45
	77	156.0	34.0	3.41	5.9	8.3	1.23	43.5	7.5	0.88
	35	77.0	14.0	1.90	8.0	3.7	0.37	13.0	2.4	0.29
	42	107.5	17.0	2.21	6.0	5.4	0.69	27.5	2.7	0.29
MYD	49	134.6	18.4	3.49	8.5	5.7	0.86	25.8	4.4	0.43
	56	143.7	23.3	3.50	7.0	5.8	0.75	29.0	7.3	0.79
	77	151.8	36.0	6.13	9.5	11.9	1.81	32.4	8.0	1.11

<sup>1</sup> COD - Chowghat Orange Dwarf

MYD - Malayan Yellow Dwarf

<sup>2</sup> Days After Sowing