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Studies on vivipary in dwarf coconut cultivars

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ABSTRACT

Vivipary is a problem in some dwarf varieties of coconut as their seed nuts show low germination compared to Talls. An experiment was carried out to study the extent of vivipary in dwarf coconut varieties (MGD, MYD, MOD and CGD) with WCT as control. Observations on nut traits like shape, colour, length, weight and water content of the seed nut, thickness, weight and polyphenol content of the husk, length and weight of embryo, TSS of nut water were recorded from 10-, 11- and 12-month-old nuts of each variety. Observations were also recorded at bimonthly intervals during November 2011-September 2012. None of the ten-month-old seed nut exhibited vivipary. However, few 11th old MOD nuts (3%) harvested during November showed vivipary. The results showed that the extent of vivipary was highest during September and least during January. Among the varieties, MYD exhibited maximum vivipary (24%) followed by MOD and MGD (16%) and the least was in WCT (0.6%). Vivipary was negatively correlated with various nut characters, husk thickness and weight. However, prevailing climatic conditions like amount of rainfall, number of rainy days and relative humidity during the preceding 30-day of harvest had significant positive correlation with vivipary. It is suggested that vivipary in dwarf varieties can be avoided by harvesting the seed nuts at the proper stage.

Key words: Vivipary, coconut, dwarf varieties, nut traits, climatic conditions.

INTRODUCTION

Coconut (*Cocos nucifera* L.) has been a part of the Indian culture and plays a significant role in the agrarian economy of India. Tall varieties occupy 90% of the area under coconut. Of late, dwarf varieties are gaining popularity due its short stature, resistance to biotic stresses and the ease with which its nuts can be harvested. In dwarf coconut varieties the seed nuts show lesser germination percentage and seedling recovery compared to Talls. Vivipary is suspected to one of the reasons for the poor germination and seedling recovery observed in dwarf varieties. Vivipary is the phenomenon wherein the seeds germinate before dropping down and the seedlings grow, while it still attached to the mother plant. In viviparous seed nuts, the plumule which germinated and protrudes from the seed nut dries up either during storage or due to damage during transit. Mature seed nuts are harvested when atleast one nut in the oldest bunch starts becoming dry. In tall varieties it takes 11-12 months, whereas as in dwarfs, nuts will mature in 10-11 months. It is reported that dwarf coconut varieties posses rare traits such as polyembryony, vivipary (de lamothe *et al*., 6; Ratnambal *et al*., 11). According to Corner (5) the peg-like embryo of coconut, embedded in the kernel beneath the germ pore in the shell (soft eye), never really stops growing. This effectively makes the coconut viviparous (live-bearing) and, as it is no longer viable if it is dried for storage (as copra), it is also classified as recalcitrant (Chin and Roberts, 4).

The present study reports the incidence of viviparous germination in different dwarf genotypes of coconut. An attempt was made to analyze the vivipary of coconut with an intention to highlight the importance of harvesting the nuts at proper stage.

MATERIALS AND METHODS

Four dwarf cultivars, *viz*. Malayan Green Dwarf (MGD), Malayan Yellow Dwarf (MYD), Malayan Orange Dwarf (MOD) and Chowghat Green Dwarf (CGD) were used for the study along with West Coast Tall (WCT) as control. The nuts were collected from Coconut Development Board Farm, Neriamangalam, Kerala. Thirty nuts of each variety were harvested at 10th, 11th and 12th month to see the effect of age of the nut on vivipary. The palm number, shape of the nut, colour of the nut, weight of the fruit, length of the fruit, thickness of the husk, thickness of shell, weight of the husk, nut water content, embryo weight and embryo length of individual nuts were recorded. TSS of nut water was estimated using refractometer and polyphenol content of husk was determined as per Bray and Thorpe (1). In order to study the effect of season on vivipary, the observations were recorded at bimonthly intervals (November 2011, January 2012,

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March 2012, May 2012, July 2012 and September 2012). Weather parameters (maximum temperature (°C), minimum temperature (°C), relative humidity (%), rainfall (cm) and total numbers of rainy days during the preceding 45 days of recording observations on vivipary were documented.

RESULTS AND DISCUSSION

The studies on extent of vivipary in dwarf varieties of coconut of different maturity group indicated that none of 10- and 11-month-old seed nuts exhibit vivipary, except in 11-month-old MOD during the month of July. The results of vivipary recorded at bimonthly intervals from 12-month-old seed nuts of different varieties are presented in Table 1. Malayan dwarf varieties exhibit significantly higher vivipary compared to CGD and WCT. Highest vivipary of 40% was observed in MOD during September 2012. Average vivipary was highest in MYD (23.9%) and was at par with MOD (16.1%) and MGD (15.6%). Lowest vivipary was observed in WCT (0.55%) followed by CGD (3.33%). There was significant difference in percentage of vivipary recorded during different months. Highest vivipary (20%) was recorded during November followed by September (17.3%) and July (16.7%). The lowest was during January (2.7%) followed by May (9%) and March (6%). There was no viviparous germination in any of the 10-month-old seed nut of dwarf varieties indicating that atleast 10 months is required for attaining physiological maturity of the embryos.

Vivipary noticed was correlated with fruit and nut traits of different varieties (Table 2). Among the different nut traits, fruit weight, fruit length, nut water and polyphenol contents in the husk were positively correlated, whereas, the TSS of nut water, husk thickness, husk weight and shell thickness were negatively correlated with vivipary. It is reported that the thickness of the husk contributes both to floating ability and to slow germination (Harries, 8). The thick husked coconut with long, angular fruit having a high proportion of husk at the ends and in ridges along the length corresponding to the fundamental tri-carpellate ovary has an egg-shaped (ovoid) nut inside with a thick shell, a kernel rich in oil and a small cavity that aids buoyancy (Figs. 1 & 2). It never germinates viviparously on the palm but falls spontaneously when mature and takes 60 to 220 days to achieve 90% germination (Whitehead, 14). The thinner husk allows the embryo to germinate more quickly taking 30 to 140 days and often beginning while still on the palm. In our studies also, husk thickness and shell thickness shows negative correlation with vivipary. However, results are not statistically significant suggesting that vivipary is not influenced by any individual nut or fruit characters but may be due to the influence of a set of characters which has a combined effect.

To analyze the influence of climatic conditions on vivipary, weather parameters during the preceding 45 days of harvest were recorded (Table 3). The lowest vivipary was exhibited during January followed by March. The reason may be due to the low relative humidity, number of rainy days and cumulative rainfall during that period which did not favour vivipary. In order to work out the exact duration of favourable weather influencing vivipary, the entire weather data for 45 days was further split into four (10, 20, 30 and 45 days prior to harvest) and vivipary was individually correlated with these four periods. Table 4 shows the correlation of vivipary with different weather parameters. Vivipary was positively correlated with average relative humidity, minimum temperature, number of rainy days and cumulative rainfall whereas maximum temperature had negatively correlation. In squashes (*Sechium edule*) grown in hill stations of India, the seed germinates, while it is inside the fruit. This happens when the seed is still attached to the plant under excessive moisture conditions (Majumdar *et al.,* 10). Vivipary reported in Dutch white clover is favoured by excessive atmospheric moisture or wet condition experienced by the plant

Table 1. Vivipary (%) in some coconut varieties.

Variety	Nov	Jan	March	May	July	Sept	Average
MGD	10	6.67	3.3	20	30	23.3	15.56[a]
MYD	36.67	-	23.3	23.3	36.67	23.3	23.89[a]
MOD	30	6.67	3.3	3.3	13.3	40	16.11[a]
CGD	16.67	-	-	-	3.3	-	3.33[b]
WCT	3.3	-	-	-	-	-	0.55[b]
Average	20[a]	2.67[c]	6[bc]	9[bc]	16.67[ab]	17.3[ab]	12

Mean values followed by the same letter are not significantly different by ANOVA (p = 0.05)
CV: 51.98 $CD_{0.05}$ variety = 1.65 $CD_{0.05}$ month = 1.81

Table 2. Nut characters in different coconut varieties and correlation between vivipary and nut parameters.

Variety	Fruit wt. (kg)	Fruit length (cm)	Husk thickness (cm)	Nut water vol. (ml)	TSS (°Brix)	Phenol content in husk (mg/100 g)	Husk wt. (kg)	Shell thickness (mm)
MGD	1.186	21.26	6.152	214.32	1.92	1.35	0.600	0.30
MYD	1.129	19.91	5.42	177.2	3.31	1.34	0.486	0.26
MOD	1.174	21.28	5.79	192.11	2.61	1.36	0.486	0.28
CGD	0.741	20.13	5.39	64.56	4.04	1.14	0.372	0.25
WCT	1.354	21.61	6.244	183.89	3.23	1.36	0.372	0.39
Correlation coefficient	0.182	0.033	-0.097	0.537	-0.633	0.452	-0.080	-0.538

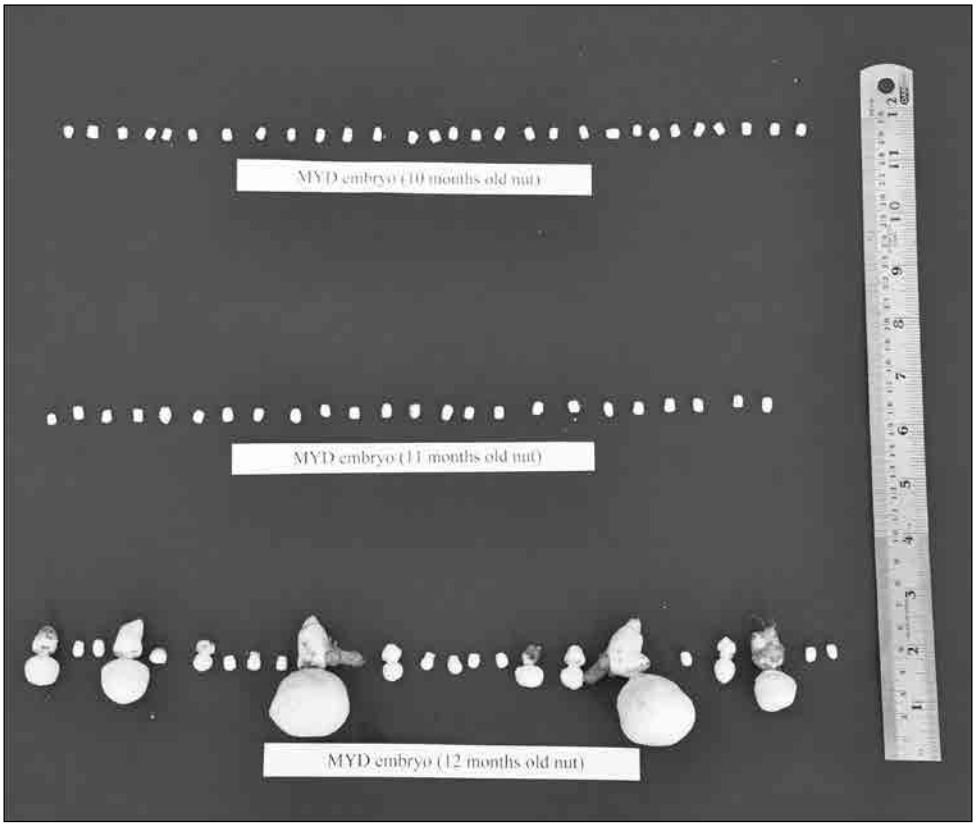

Fig. 1. Vivipary in MYD embryos.

Table 3. Weather parameters at 45 days prior to experimentation.

Month	% vivipary	Min temp. (°C)	Max temp. (°C)	RH (%)	Rainfall (cm)	Rainy day(s)
Nov 11	23.33	24.65	29.47	84.96	264.24	30
Jan 12	3.34	23.39	28.45	80.47	83.82	8
Mar 12	7.48	24.21	31.28	71.02	8.37	1
May 12	11.65	25.68	32.01	82.02	298.44	23
July 12	20.82	24.76	28.93	89.53	576.12	33
Sept 12	21.65	23.89	27.89	90.11	703.62	40

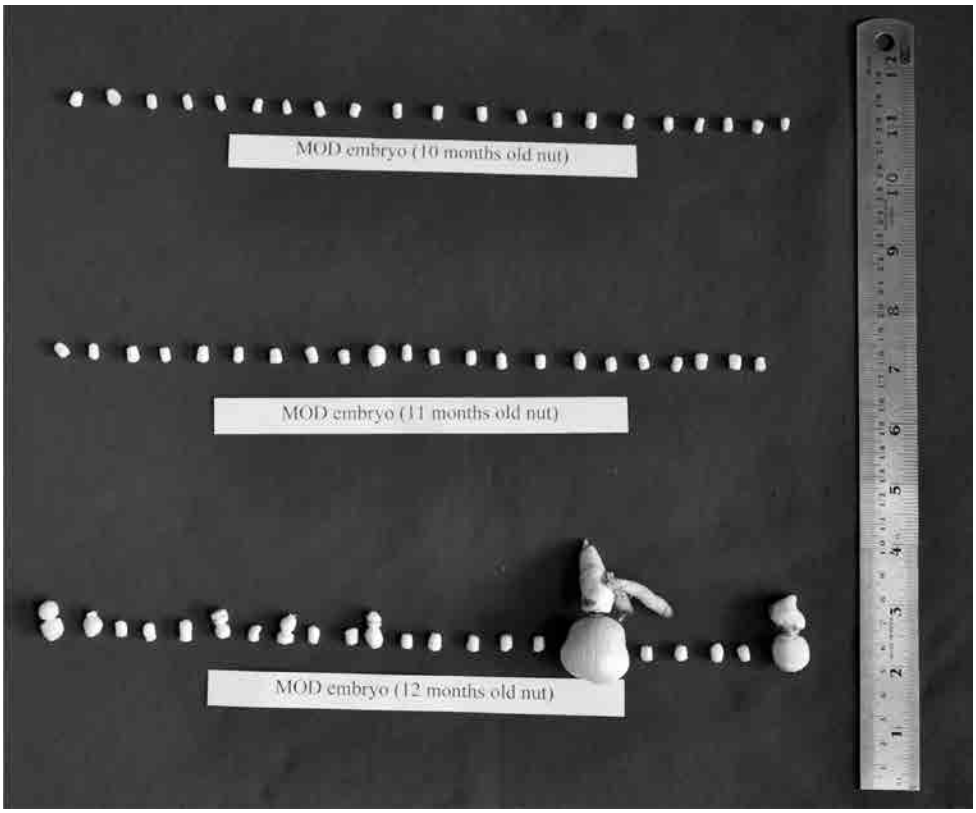

Fig. 2. Vivipary in MOD embryos.

Table 4. Correlation coefficients between vivipary and weather parameters.

Weather parameter	10 days preceding	20 days preceding	30 days preceding	45 days preceding
Min temp (°C)	0.156	0.114	0.082	0.294
Max temp (°C)	-0.440	-0.460	-0.496	-0.344
Rainy days	0.572	0.823*	0.890*	0.898*
Total rainfall	0.484	0.703	0.734	0.769
RH (%)	0.712	0.797	0.816*	0.761

after seed ripening. In sweet orange, vivipary occurs due to increased humidity in garden atmosphere or due to coincidental rain, heavy irrigation, and sudden lowering of temperature (Singh and Chauhan, 13) and also in chillies (Yadav *et al.*, 15). Viviparous germination was also reported in papaya in the rainy season of July when relative humidity was more than 90% (Chakraborty and Chaudhuri, 2). Coconut fruit takes 11-12 months from fertilization to maturity and hence the climatic conditions prevailing for a longer duration may influence vivipary. In our study, it was evident that there was no significant correlation for the vivipary with weather data recorded 10 and 20 days preceding the harvest indicating that the weather conditions preceding 20 days prior to maturity do not have any influence on vivipary. Further, a positive significant correlation was observed for both relative humidity (%) and number of rainy days preceding 30 days prior to maturity. This suggests that weather conditions preceding 30 days of harvest influence the incidence of vivipary.

In general, mature nuts of coconut are harvested when at least one nut in the oldest bunch starts becoming dry. In tall cultivars, it takes 11-12 months from the date of inflorescence opening to become a mature seed nut, whereas in dwarfs, nuts will mature in 10-11 months. The physiologically matured fruits should be harvested without much delay so as to avoid the viviparous germination. Vivipary in coconut does not seem to be economical, as it will not allow

seed storage, resulting in loss of kernel and copra quality, thus reducing the marketability of the nuts. The occurrence of vivipary in *C. nucifera* L. var. Andaman Green Dwarf reported from Andamans (Sankaran *et al*., 12) can be interpreted as an adaptive reproductive strategy that enables seedlings to establish more rapidly and subsequent dispersal by water or other means. Coconut has been reported to be dispersed by sea water currents around the world. The viviparous germinated nuts are not suitable for long distance sea dispersal and hence a natural selection for non-viviparous types might have been predominant during the dispersal of coconut. It is believed that the slow germinators are dispersed by floating and quick germinators by boating, thus confirming the centres of diversity for slow germinators in the Indian ocean, quick germinators in Malesia and introgressed types in the Pacific (Harries, 8).

Occurrence of vivipary in Malayan Dwarfs can be interpreted as an adaptive reproductive strategy that favours establishment of seedlings in the event of adverse weather conditions. Although we do not have conclusive explanation for vivipary in dwarf coconut varieties, it is presumed that various intrinsic and extrinsic factors in the palms, along with soil condition, temperature and dry spell followed by high humidity induced by heavy rainfall may be involved. It can be concluded that to avoid vivipary, the physiologically matured fruits of Malayan Dwarfs should be harvested without much delay. If harvesting is delayed by few days, most of the seeds germinate under high humid conditions, thus reducing the seed nut quality. Further studies need to be undertaken to see the influence of stage of harvesting on germination of seed nuts.

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