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Shedding of buttons in coconut *(Cocos nucifera)*: role of carbohydrate fractions and nitrogen content in leaf subtending the inflorescence

K.V. KASTURI BAI and H.H. KHAN
Central Plantation Crops Research Institute, Kasaragod 671 124

INTRODUCTION

Flowering in coconut is a continuous process, and development and growth of inflorescence have been found to be intimately associated with the development and growth of the leaf (Patel, 10). Once the inflorescence (spadix) opens, it takes about 12 months for full maturity of buttons and harvesting of nuts. In coconut, fertilized flowers, up to 4 months of maturity are usually designated as buttons. Being a tree crop of indeterminate growth habit, the partitioning of metabolites towards vegetative and reproductive growth is a continuous process and inter linked during the entire span of its life. Production of a large number of female flowers, good fruit setting and retention of nuts have an important role in improving the production potential of palms and shedding of buttons is the major setback in coconut production. Ramadasan and Mathew (11) and Kasturi Bai and Ramadasan (5) have reported the role of carbohydrate fractions in flowering of coconut. They observed that high carbohydrate reserve in the trunk as well as high carbohydrate: nitrogen ratio (C/N) are prerequisites for commencement of flowering. Kasturi Bai and Ramadasan (5) observed high relationship between soluble carbohydrate fractions and commencement of first flowering in juvenile palms. However, reports are not available on the role of carbohydrate fractions as well as nitrogen content in subtending leaf for the development of inflorescence growing in its axil. Therefore, carbohydrate fractions and nitrogen content in the leaf subtending inflorescence at the time of opening of inflorescence and two months after opening as well as seasonal changes in carbohydrate fractions and nitrogen content in subtending leaf, in relation to female flower production and shedding of developing fruits were investigated.

MATERIAL AND METHODS

Twelve year-old coconut hybrids, viz. Chowghat Orange Dwarf x West Coast Tall (COD x WCT), Malayan Yellow Dwarf x WCT (MYD x WCT) and Malayan Orange Dwarf x WCT (MOD x WCT) growing in

red sandy loam soil in the Institute farm were selected. The palms were well-maintained with recommended cultural practices under non-irrigated condition. From each, six palms were randomly selected for the observations and each palm was treated as a single replication. Freshly emerged spadix in each leaf axil was tagged and percentage shedding was determined from flower and button count. Changes in carbohydrate and nitrogen fractions were monitored in leaf subtending inflorescence just at the time of opening of inflorescence and two months after, during which the shedding of buttons was reported to be maximum (Gangolly, 2). The observations were taken during summer months (January-March) and rainy months (June-August) for two consecutive years and mean for two years was taken for the interpretation of the results. Carbohydrate fractions were estimated as per Somogyi (12), while nitrogen content was estimated by Kjeldhal digestion method. Significance was worked out by analysis of variance and correlation coefficient as per standard method (Panse and Sukhatme, 9).

RESULTS AND DISCUSSION

Leaf to leaf variation was not significant for total carbohydrate (7.7-8.0%) or nitrogen content (1.83-1.9%). Hence, pooled data were taken for the analysis and interpretation of the results. Only the data in three hybrids during rainy season are presented (Table 1).

Total carbohydrate content did not show significant differences among hybrids or between the two stages, whereas total sugar, reducing sugar and starch content showed significant differences among hybrids as well as between two stages. An increase in reducing sugar (5.1 %) and starch content (12.7%) and a reduction in total sugar content was observed in the leaf two months after opening of the inflorescence compared to initial stage. Interaction was significant only for reducing sugar content. Among hybrids during both the stages, COD x WCT maintained higher total sugar, reducing sugar and starch content in the leaf. Significantly, higher nitrogen content (2.03%) was observed in MYD x WCT, followed by MOD x WCT and COD x WCT. Concomitant with higher nitrogen content, C:N was lower in MYD x WCT during both the stages. Higher C:N was observed in COD x WCT followed by MOD x WCT.

Female flower production was more in MYD x WCT (44) followed by MOD x WCT (35) and COD x WCT (17), where as retention after 3 months was more in COD x WCT (35.3%) than MYD x WCT and MOD x WCT (20%). This implies that shedding of buttons was lower in COD x WCT than other hybrids.

Significant correlation with button shedding was observed only between the parameters at the initial stages and not after two months of opening of the inflorescence (r^2 values not shown in the (Table 2). Except starch and nitrogen, all other parameters showed significant negative correlation (P=0.05) with shedding of buttons, while number of female flowers showed high positive correlation (Table 2). When the data on both stages were pooled, a negative correlation was observed between shedding of buttons and total carbohydrate content (r^2 = -0.240) as well as C:N (r^2 = -0.280) ratio, while total nitrogen content showed positive correlation (r^2 = 0.251).

Since significant correlation was not observed between parameters two months

Table 1. Changes in carbohydrate fractions and nitrogen content (%), C : N ratio and female flower produced (no.) in leaf subtending inflorescence during rainy (at the time of opening of the inflorescence i.e., initial) and 2 months after opening (final) during summer seasons.

Season	Hybrid	Total carbohy-drate	Total sugar	Reducing sugar	Starch	Nitrogen	C : N ratio	FFP
Rainy								
Initial	COD x WCT	7.93	3.91	2.14	4.27	1.71	4.74	17
	MYD x WCT	8.06	3.92	2.01	3.97	2.04	3.99	44
	MOD x WCT	7.84	3.51	1.85	4.14	1.92	4.13	35
Final	COD x WCT	7.97	3.73	2.23	4.95	1.68	4.79	6
	MYD x WCT	7.47	3.49	2.10	4.58	2.03	3.57	9
	MOD x WCT	7.61	3.31	1.87	4.81	1.86	4.11	7
CD (P=0.05)								
Stages		-	0.18	0.05	0.45	-	-	8.59
Hybrid		-	0.23	0.17	0.30	0.07	0.32	4.95
Interaction		-	-	0.24	-	-	-	6.99
Summer	COD x WCT	8.89	2.95	1.72	5.60	1.77	5.06	19
	MYD x WCT	8.47	2.41	1.53	4.88	1.93	4.46	32
	MOD x WCT	8.48	2.00	1.52	5.17	1.83	4.67	3.1
Mean		8.62	2.45	1.59	5.21	1.86	4.73	27
CD (P=0.05)								
Seasons		0.43	0.15	0.10	0.25	-	0.28	-
Hybrid		-	0.27	0.12	0.31	0.07	-	6.88
Interaction			-	0.20	-	0.16		-

after opening of inflorescence and shedding of buttons, only initial values were used for the interpretation of results on seasonal changes. Although significant differences were not observed in total carbohydrate content among hybrids, seasonal changes were significant with higher content observed during summer (8.6%) than rainy season (7.2%). The trend observed in carbohydrate fractions in subtending leaf corroborated with the earlier observation of Kasturi Bai and Ramadasan (5). They reported higher accumulation of insoluble carbohydrate fractions during summer season and soluble carbohydrate fractions during rainy season. Total sugar as well as reducing sugar content showed significant differences between hybrids as well as between two periods. As compared to the summer season, an increase of about 54.3% in total sugar and 25.8% in reducing

Table 2. Relationship between different parameters and shedding of buttons in coconut (correlation matrix).

Parameter	Button sheding	
	Rainy	Summer
Total carbohydrate	-0.273*	-
Total sugar	-0.352*	-
Reducing sugar	-0.338*	-
Starch	-	-
Nitrogen	-	-
C:N ratio	-0.338*	-0.302**
FFP	0.420***	0.666***

*, **, *** Indicate significance at 0.05, 0.01 and 0.001 levels, respectively and - indicate non-significance.

sugar content was observed during rainy season. Interaction was also significant for reducing sugar content. Trend in starch content was similar to that of total carbohydrate, higher accumulation being during summer (26.2%) than rainy season. Total nitrogen content also showed significant differences among hybrids. Higher content was observed in MYD x WCT during both the seasons. Although seasonal differences were not significant in nitrogen content in the leaf, interaction was significant (Table 1). However C:N showed significant difference only between the two seasons. During summer season, 10.5% increase was observed in C:N than rainy season.

Higher female flower production was observed during rainy season than summer season, though not significant. MYD × WCT recorded more number of female flowers during both the periods than others. Similarly, differences were also significant for shedding of buttons (Fig. 1). Higher shedding was observed in MYD × WCT, for rainy and summer seasons than COD × WCT and MOD × WCT during the same periods.

Correlation was worked out separately for rainy and summer seasons with button shedding (Table 2). Correlation coefficient indicated direct relationship between number of female flowers and shedding of buttons. Although total carbohydrate, total sugar, reducing sugar and C:N gave negative correlation with shedding of buttons during rainy season, only C:N was negatively correlated with button shedding during summer season. Female flower production also did not show any relationship with the constituents in subtending leaf. However, pooling the data both for rainy and summer season indicated positive correlation (r^2 = 0.261) with nitrogen content and negative correlation with C:N (r^2 = -0.285).

Shedding of buttons is a common feature in coconut and about 5 - 95% shedding has been reported by Menon and Pandalai (7). The importance of carbohydrate accumulation and mobilization in flowering and fruit setting has been reported in perennial tree crops such as coconut (Kasturi Bai and Ramadasan, 4), avocado (Liu-xuam *et al.* 6), mango (Nartvaranan *et al.,* 8). In an earlier report, Kasturi Bai and Ramadasan (5) indicated that synthesis and mobilisation of carbohydrate in leaves follow a definite pattern and is influenced by the seasonal changes in solar radiation and precipitation in coconut.

Results indicated that although significant differences were observed two months after opening of the inflorescence, significant correlation was not observed with shedding of buttons. Nitrogen content in hybrid MYD × WCT was found to be

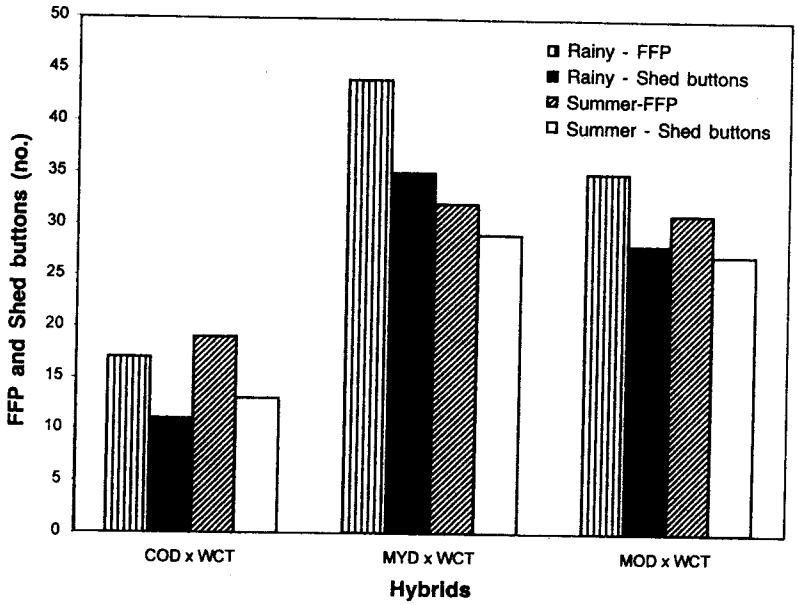

Fig.1. Female flower production (no.) and shedding of buttons (no.) in coconut hybrids during rainy and summer seasons.

comparatively more than other two and shedding of buttons also has been found to be more in this hybrid. Although significant correlation was not observed between total nitrogen content in leaf and button shedding, female flower production showed high correlation with nitrogen content.

Higher shedding of buttons observed in MYD x WCT can be attributed to higher female flower production in this hybrid leading to higher shedding. In citrus, flower and fruitlet abscission was higher in high flowering than in low-flowering trees (Garcia Luis *et al.*, 3). However, they could not get a significant relationship between mean carbohydrate status of trees and fruit setting since fruits harvested were higher in high-flowering trees. In coconut also, annual yield per palm per year was observed to be more in high-flowering hybrid MYD x WCT than COD x WCT and MOD x WCT. Caspari *et al.* (1) observed increased fruit set under elevated carbohydrate supply in grape. The lower button shedding leading to higher fruit setting observed in COD x WCT can be attributed to less number of female flowers in bunches and availability of more carbon reserves to support the development of buttons. This implies that coconut is a source-limited crop.

SUMMARY

The influence of carbohydrate fractions and nitrogen content in leaf, subtending inflorescence on female flower production and shedding was investigated in coconut. Twelve-year-old coconut palms of D x T combinations, i.e. Chowghat Orange Dwarf x West Coast Tall (COD x WCT), Malayan Yellow Dwarf (MYD) x WCT and Malayan Orange Dwarf (MOD) x WCT growing under non-irrigated conditions were used.

The observations were taken during rainy (June-August) as well as summer seasons (January-March). Significant reduction in carbohydrate fractions in leaf as well as female flower production was observed two months after opening of the inflorescence compared to initial stage. However, significant correlation was not observed between the parameters two months after opening of inflorescence and shedding of buttons. Seasonal changes were also significant for the parameters studied. During rainy season, a negative correlation between shedding of buttons and carbohydrate fractions as well as C:N ratio was observed. Whereas in summer season, only C:N ratio showed negative correlation with shedding of buttons. During both the seasons, shedding was highly correlated with number of female flowers production. Thus, coconut regulate the female flower production and shedding of buttons through the operation of a steady carbon -nitrogen metabolism which in turn is regulated by the environmental variables. However, genetical control on flower production and shedding of buttons cannot be ruled out.

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