

MEASUREMENT OF BIENNIALITY IN COCONUT*

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ABSTRACT

Based on the rank correlation coefficients for yields obtained in consecutive years and adjacent years, an index has been worked out to measure the bienniality for coconut yields. It was found to be significant in W. C. Tall population of different age groups growing under rainfed conditions. In an irrigated plot, this index came down from 0.99 during pre-irrigation period (1961-72) to 0.57 in the irrigation period (1975-86), while it was devoid of any marked changes for the corresponding periods in the unirrigated plot, where the palms were of comparable age. Changes in the bienniality has been studied in different age groups and under different management practices also. In low yielding palms biennial rhythm was found to be less.

INTRODUCTION

Year to year fluctuation in the annual yields is a common feature in the case of most of the perennial crops and coconut is not an exception. These variations are generally attributed to genetical as well as environmental factors. In any large population, it is possible to see a large number of palms which are biennial in their bearing habits, whereas in the case of many others, the year to year variation may be highly irregular. Also a small proportion of the palms may be giving somewhat steady yield over the years. Shrikande (1958) and Pankajakshan (1960) have referred to the biennial bearing tendency in coconut. Satyabalan, Sankar and Chami (1968) have examined the regularity in the yield of coconut on the basis of CV over the years. Abeywardana (1962) also examined the different methods of calculation of biennial rhythm and has shown that it is a significant feature in coconut, but not of such a magnitude to create concern in commercial circles. Jacob Mathew and Vijayakumar (1984) have

observed that due to the biennial bearing habit shown by some of the palms, the relationship for the yields obtained between immediately preceding and succeeding years is comparatively weak, compared to the correlation obtained between alternate years.

In this paper, the regularity in bearing of yield has been studied under Kasaragod conditions and an index has been suggested to measure the intensity of bienniality in coconut. Using this index, the trends in bienniality have been studied in different yield groups, age groups and management practices in West Coast Tall population.

MATERIALS AND METHODS

Annual yield data of palms collected from the permanent yield register maintained at the Institute were utilised for this study. For demonstrating the methodology of working out the Bienniality Index (BI), sample data of a group of 26 palms for the period (1950-59) has been used (Table I). The data for 187 palms from Block D,

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Plots 4, 5 & 6 (Set 1) for the period 1957-66 were considered on the basis of yield groups (*viz.* ≤ 40 nuts, 40-60 nuts, 60-80 nuts and < 80 nuts per palm/year) to examine whether bienniality is related with yielding habits of the palm. Data from the permanent observation plot, Block B, Plot 1 (Set 2) for the period 1920-68 were used to study the influence of management practices and age on the alternate bearing tendency. While the exact ages of the palms in this plot are not known, since continuous yield data for nearly 50 years are available, it has been assumed that they were in the initial years of bearing at the beginning of this period. To study the effect of irrigation on the regularity in bearing, the yield data from Agrostology Plot (106 palms), Block A, Plot 4 (Set 3) were considered, where irrigation was introduced in 1972 in an existing adult plantation. Most of the palms were above 50 years old during that period. The period 1961-72 was considered as the pre-irrigation period and 1975-86 as the irrigation period. Data for corresponding periods from RS 29, North (Set1), where the palms are approximately of same age and growing under rainfed condition were taken as control for comparison. All the palms considered here belong to the ordinary West Coast Tall variety. They were growing in sandy loam soils, receiving the recommended management practices.

To test for bienniality and to work out a bienniality index, Spearman's rank correlation coefficients obtained between the yields in every pair of consecutive years and alternate years were calculated first. We have proceeded on the assumption that in the presence of biennial rhythm the rank correlation coefficients obtained for yields in every pair of consecutive years will be less than those for the alternate years. For testing this, the Mann-Whitney U statistic (Seigal, 1956) defined as $U = n_1n_2 + n_2$

$(n_2 + 1) / 2 - T$ where n_1 and n_2 are the number of correlation coefficients available in consecutive and alternate years respectively and T is the sum of the ranks obtained for the set of correlation coefficients between alternate years was worked out. This U is assumed to be asymptotically normally distributed for both n_1 and n_2 greater than 8. Since the maximum and minimum values of the standard normal deviate of U is found to be dependent on the number of years considered, this cannot be used for comparison of different populations, especially when they refer to varying number of years. The ratio of T with T' was considered as a measure of the intensity of bienniality, where $T' = n_1n_2 + n_1n_2/2$ is the maximum possible rank sum for alternate years when $n_1 = n_2 + 1$. Since the minimum possible value of T is $n_1n_2/2$, this ratio can vary from 1/3 to 1 only. From this ratio, with suitable changes in origin and scale of measurement, a Bienniality Index (BI) of the form $(3T - T')/2T'$ was worked out, with a range of 0 to 1, which can be used for comparing any two populations.

RESULTS AND DISCUSSION

In this study Spearman's rank correlation coefficient has been preferred over Pearson's correlation coefficient, since the correlation coefficient worked out on the basis of ranks, is expected to eliminate year/weather effect. In the sample data used (Table I), the rank correlation coefficients between consecutive years have been found to be generally low, ranging between -0.1884 and 0.3258, whereas the correlation between alternate years were in the range of 0.4691 and 0.7855. The bienniality rhythm observed on the basis of 10 year data for 26 palms is statistically significant with an index of 1.0. Abeywardana (1962) also made similar observations. When the data for the Set 1 were considered, after classifying

them into different yield groups, based on the mean yield for the 10 year period (Table II), it was found that the bienniality index was comparatively less in those palms with a low mean yield. Analysis of the data of Set 2 has shown that bienniality does not change much with age and growth of palms. In Plot 1, where the palms are being regularly cultivated and manured, bienniality was found to be significant in all the five decades considered, its intensity being slightly less in the first

decade, where the palms were probably in the early stages of bearing, with a low mean yield of 31.7 nuts. In plots 2 and 3 the bienniality index was found to be, comparatively higher during the decades where the mean yield was also higher, the only exception being 1930-39 for plot 2, where, though the mean annual yield was over 40 nuts, the biennial rhythm was not significant. Hence the differences in management practices were found to influence

Table I. Procedure for calculation of Bienniality Index in coconut (Period: 1950-59, 26 palms, Block B, Plot 1)

Base year	Rank correlation coefficients				Calculation of Bienniality Index
	Consecutive years		Alternate years		
	Actual	Rank	Actual	Rank	
1950	0.1962	6	0.4691	10	$U = n_1n_2 + n_2(n_2 + 1)/2 - T'$ $= 9 \times 8 + 8 \times 9/2 - 108$ $= 0.0$
1951	0.2371	8	0.6291	11	
1952	0.3258	9	0.6798	13	$T' = n_1n_2 + n_1n_2/2$ $= 9 \times 8 + 9 \times 8/2$ $= 108$
1953	0.1906	5	0.7299	16	
1954	0.1347	3	0.7029	14	$BI = (3T - T') / 2T'$ $= 1.0$
1955	0.1998	7	0.6421	12	
1956	0.1738	4	0.7270	15	
1957	0.0087	2	0.7855	17	
1958	-0.1884	1			
				108	

Table II. Bienniality in relation to yielding habits of the palm (Period : 1957-66, 187 palms, Block D, Plots 4,5 and 6)

Yield group	No. of palms	Mean yield	Mean CV %	Beinnality Index
≤ 40 nuts	28	25.3	56.2	0.75
40-60 nuts	59	51.1	24.4	0.97
60-80 nuts	65	69.8	22.6	1.00
> 80 nuts	35	96.3	24.5	1.00
Pooled	187	62.2	28.6	1.00

the yield and consequently the bienniality index also (Table III).

In an irrigated plot (set 3) with 106 palms, the index has been found to be as low as 0.57 for the 12 year period 1975-86, whereas for the same set of palms, during the pre-irrigation period (1961-72) it was as high as 0.99. In another rainfed garden where the palms are of more-or-less comparable age, the bienniality was significant in both the periods with indices 1.00 and 0.89 respectively. Hence it appeared that bienniality could, to a great extent, be reduced by ensuring adequate water supply.

In this study, the CV for the yields over the years for individual palms had been calculated and the average CV had also been worked out for groups of palms, for the different sets of data. It was observed in all the sets of data that the average CV was comparatively low, in the groups of palms where the mean yield was generally higher and vice-versa. Satyabalan et al (1968) have also pointed out that the incidence of irregular bearing was high among low yielders and low among high yielders. They have observed significant negative correlation between the mean yield

and CV. But in the case of bienniality a low index was observed for palms with a low average yield and vice-versa except in the case of irrigation plot. It is conventional to use CV as a measure of variability over the years. But the present study has shown that CV does not speak anything about the biennial rhythm present in the data as CV cannot distinguish between a systematic variation and irregular variation.

Though theoretically the range for this Index is from 0 to 1, in practice, for coconut it may range between 0.5 and 1.0 only. An Index of 1.0 means that all the rank correlation coefficients obtained between pairs of alternate years is greater than those between consecutive years, and it was around 0.5 when the ranks were evenly distributed in both the sets. It will be near to zero when most of the correlation coefficients between pairs of adjacent years are higher than those of alternate years. Comparison with the standard normal deviate of the U statistic showed that when data for 10, 15, 20, 25, 30, 40 and 50 consecutive years were used the index values above 0.75, 0.69, 0.66, 0.64, 0.63, 0.61, 0.60 respectively could be considered as significant at $P = 0.05$. Though

Table III. *Bienniality in relation to management practices and growth of palms (Block B, 170 palms)*

Period	Plot 1 (n=26)			Plot 2 (n=26)			Plot 3 (n=18)		
	Mean yield	Mean CV%	BI	Mean yield	Mean CV%	BI	Mean yield	Mean CV%	BI
1920-29	31.7	62.1	0.82	17.2	69.3	0.62	24.1	61.8	0.57
1930-39	50.8	53.5	0.99	41.1	68.2	0.64	24.7	68.3	0.74
1940-49	53.6	38.8	1.00	50.6	31.4	1.00	26.8	47.1	0.81
1950-59	43.9	42.9	1.00	39.7	29.9	0.79	24.6	47.5	0.81
1960-68	55.6	31.7	1.00	38.4	31.8	1.00	13.8	56.0	0.64

Plot 1 : Regularly cultivated and manured

Plot 2 : Regularly cultivated only

Plot 3 : No cultivation, no manuring

the rank correlation coefficients were not directly used in the calculation of BI, our studies with different sets of data have shown that the mean difference between the sets of rank correlation coefficients in adjacent years and alternate years is around 0.4 or more, in most of the cases, when the BI was 1.0 and between 0.3 and 0.4 when the BI was between 0.90 and 0.99, with proportionate reduction for lower values of the index.

This index can be conveniently used to compare the alternate bearing habits of different varieties and hybrids, provided data for sufficient number of years are available.

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