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FORECASTING OF YIELD IN COCONUT BY USING WEATHER VARIABLES

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ABSTRACT

Influence of monthly averages of 11 weather variables viz. max. and min. temperature, vapour pressue (FN & AN) rel. humidity (FN & AN), wind velocity, hours of sunshine, rainfall, evaporation and number of rainy days up to 36 months prior to harvest of nuts was studied for two sets of data at Kasaragod. Based on regression analysis rel. humidity (FN), hrs. of sunshine and vapour pressure (FN) of 17-20 meteorological weeks of the previous year, temperature (Min) of 21-24 weeks, humidity (FN) of 25-28 weeks two years previous and temperature (Min.) of 29-32 weeks three years previous were identified as important for prediction of coconut yield. The prediction model using these variables could explain 91% of the variation in yield.

INTRODUCTION

Forecasting the yield of any crop in advance is important. It is all the more important in coconut, because of the violent fluctuation in production and consequent price rise or fall the country has been experiencing recently. Systematic study to forecast the yield in coconut was first done by Abeywardena (1968) in which he considered 12 rainfall variables during the different periods of the development of coconut. Recently Nair BP (1986) came out with two models to forecast the yield based on the monthly weather variables of one year earlier.

In coconut, the reproductive cycle is very long as each bunch has to go through a long cycle of nearly $3\frac{1}{2}$ years of development from primordial stages upto maturity during which period it has to face the various weather parameters and their interactions. Hence, studying the effects of weather parameters on yield at least till 3 years prior to the harvest of nuts is improtant. In the present study such an attempt was made and the variables identified at different stages were made use of for forecasting the yield.

MATERIALS AND METHODS

Meteorological observations collected from the observatory of Central Plantation Crops Research Institute, Kasaragod for the period 1953-79 along with average yield of two plots of the farm, (viz. RS 29: 252 palms and RS 28: 105 palms) for the period 1955-1982 was made use of for the study. The first plot consisted of palms of about 40-45 years and in the second plot palms were of 30-35 years age group at the begining of the period. The palms

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Table I. *Correlation coefficients between weather variables and Yield.*

Weather variables			Correlation with yield in year i + 1	i + 2	i + 3
Rainfall (TRF)	5-8 weeks	1			
		2			
		3			
	13-16 weeks	1	0.752		
		2	0.628		
		3	0.740		
	17-20 weeks	1		–0.340	
		2		–0.457	
		3		–0.364	
	41-44 weeks	1	–0.454		
		2	–0.549		
		3	–0.550		
Rainy days (TRD)	13-16 weeks	1	0.633		
		2	0.454		
		3	0.400		
	21-24 weeks	1		–0.354	
		2		–0.347	
		3		–0.247	
	25-28 weeks	1	–0.448		
		2	–0.435		
		3	–0.430		
	45-48 weeks	1			–0.368
		2			–0.379
		3			–0.370
Temperature(min) (Tmin)	5-8 weeks	1			–0.456
		2			–0.511
		3			0.476
	21-24 weeks	1		0.499	
		2		0.412	
		3		0.470	
	29-32 weeks	1			–0.339
		2			–0.387
		3			–0.226
	33-36 weeks	1			–0.353
		2			–0.398
		3			–0.366
Hours of sunshine (HRS)	5-8 weeks	1		0.353	
		2		0.385	
		3		0.377	
	17-20 weeks	1	0.475		
		2	0.437		
		3	0.490		
	41-44 weeks	1	0.431		
		2	0.419		
		3	0.440		
	49-52 weeks	1	–0.537		
		2	–0.479		
		3	–0.540		

Rel. Humidity (FN)(HFN)	13-16 weeks	2	0.442		0.443
		2	0.579		0.524
		3	0.500		0.472
	17-20 weeks	1	0.370	–0.631	
		2	0.516	–0.524	
		3	0.390	–0.608	
	25-28 weeks	1		–0.366	
		2		–0.503	
		3		–0.433	
Rel. Humidity (AN)(HAN)	25-28 weeks	1		–0.473	0.429
		2		–0.482	0.333
		3		–0.535	0.418
	29-32 weeks	1	–0.406		
		2	–0.396		
		3	–0.420		
	37-40 weeks	1			–0.341
		2			–0.453
		3			–0.498
	41-44 weeks	1	–0.422		
		2	–0.441		
		3	–0.430		
Vap. pressure (FN)(VPFN)	17-20 weeks	1	0.410		
		2	0.342		
		3	0.400		
	37-40 weeks	1			–0.339
		2			–0.354
		3			0.315
Vap. pressure (AN)(VPAN)	41-44 weeks	1	–0.418		
		2	–0.372		
		3	–0.400		

Note:
'i' corresponds to the current year
1: for yield data from RS 29 block (n = 252)
2: for yield data from RS 28 block (n = 105)
3: for weighted average of RS 29 and RS 28 blocks

were grown under rainfed conditions and received recommended doses of fertilizers. Correlations were worked out between four weekly averages of 11 weather variables considered viz. temperature (max. and min.), vapour pressure (FN and AN), rel. humidity (FN and AN), wind velocity, hours of sunshine, total rainfall, evaporation and total number of rainy days with yield of same year, yield one year ahead, yield two years ahead, and yield three years ahead separatly for the two plots and also for the weighted average of these two plots. The variables which had significant correlations with yield in both the blocks were identified as the variables important for prediction of yield. Multiple regression equations were fitted to estimate the yield based on the variables identified to predict the yield in any year based on the weather variables in the preceding one, two and three years.

RESULTS AND DISCUSSIONS

Table I gives the values of correlation

Table II. *Regression equations for forecasting yield.*

	Variables	Week	bj	SE(bj)
	Previous Year (i-1)	Eqn-1		
1.	Humidity (FN)	13-16	0.386	0.617
2.	Total rainfall	13-16	0.037	0.063
3.	Total Rainy days	13-16	1.101	0.156
4.	Temp. (min)	13-16	–0.494	1.882
5.	Vapour Pressure (FN)	17-20	1.790	1.237
6.	Rel. Humidity (FN)	17-20	0.188	0.189
7.	Hrs. of Sunshine	17-20	1.588	1.892
8.	Hrs. of Sunshine	49-52	–1.253	1.936
9.	Rel. Humidity (AN)	29-32	–0.345	0.515
10.	Rel. Humidity (AN)	41-44	–0.044	0.269
11.	Hrs. of Sunshine	41-44	0.342	1.614
12.	Total Rainy days	25-28	–0.694	0.483
	Constant		29.662	
	R^2		0.805	
	Two years earlier (i-2)	Eqn. 2		
1.	Total Rainfall	17-20	0.007	0.016
2.	Total Rainy days	21-24	0.093	0.227
3.	Temp. (Min.)	21-24	3.118	2.032
4.	Hrs. of Sunshine	5-8	2.528	3.938
5.	Rel. Humidity (FN)	17-20	–0.949	0.510
6.	Rel. Humidity (FN)	25-28	–0.795	0.771
7.	Rel. Humidity (AN)	25-28	–0.719	0.591
	Constant		168.750	
	R^2		0.586	
	Three years earlier (i-3)	Eqn-3		
1.	Total Rainy days	45-48	–0.352	0.345
2.	Temp (Min.)	5-8	–2.193	1.460
3.	Temp. (Min.)	29-32	0.664	1.246
4.	Temp. (Min.)	33-36	–1.710	1.625
5.	Rel. Humidity (FN)	13-16	1.408	0.595
6.	Rel. Humidity (AN)	25-28	1.395	0.416
7.	Rel. Humidity (AN)	37-40	–0.147	0.398
8.	Vapour pressure (FN)	37-40	–5.061	2.469
	Constant		13.979	
	R^2		0.739	

coefficients when they are significant for both the plots. This is done so as to choose only those weather variables which had consistant effects. Results and discussions are based on the correlations worked out for the weighted average yield of these two plots. It is seen from the table that 13-20 weeks (late March – mid May) is the important period as number of weather variables during this period had significant correlations with next year's yield. While rainfall, no. of rainy days and rel. humidity (FN) of 13-16 weeks had significant positive correla-

Table III. *Regression equations for forecasting yield.*

Previous Year (i-1) Variables	Weeks	4 bj	SE(bj)	Equations 5 bj	SE(bj)	6 bi	SE(bj)
1. Total Rain fall	13-16	0.101*	0.038	–	–	–	–
2. Rel. Humidity (FN)	17-20	0.375**	0.128	0.479**	0.103	0.524**	0.078
3. Hrs of sunshine	17-20	3.045*	1.103	4.426**	0.778	4.046**	0.588
4. Vapour Pressure	17-20	1.884	1.018	1.466	0.875	1.384*	0.654
Two years earlier (i-2)							
1. Temp. (min.)	21-24			3.832**	0.982	3.881**	0.733
2. Rel Humidity (FN)	25-28			–0.713	0.412	–0.600+	0.309
Three years earleri (i-3)							
1. Temp. (Min.)	29-32					–3.101**	0.773
Constant term		–42.27		–76.36		–15.51	
R^2		0.74		0.82		0.91	

+ Significant at 10% level
*Significant at 5% level
**Significant at 1% level

tion, temperature (max.) of this period had near significant negative correlation. Importance of summer rains had been also brought out by earlier workers like Patel (1938) Balasubramanian (1956), Prasada Rao (1982) and Mathew *et al* (1986). Similarly hours of sunshine, humidity (FN) and vapour pressure (FN) of 17-20 weeks had significant positive correlation with yield one year ahead. Rel. humidity (FN) and rainfall during 17-20 weeks were found to have significant negative correlation with yield two years ahead.

Efforts were made to build up models to predict yield based on weather variables one year, two years and three years preceding the year of harvest. The 12 significant variables (Ist set) preceding one year of the harvest could explain 81% of the variation in yield. Similarly, the significant variables considered two years (7 in number) and three years prior to harvest (8 in number) could explain 59% and 74% of the variation in yield respectively (Table II).

Stepwise Regression analysis was carried out to eliminate 'non contributing' variables in the Ist set. It was seen that four variables viz. TRF 13-16, HFN 17-20, HRS 17-20 and VPFN 17-20 only could explain 73% of the variation in yield. To these variables the significant variables preceding two years and three years were added one by one to see additional contribution (Table III). Finally, six weather variables viz. three variables preceding one year, two preceding two years and one preceding three years were selected.

Total rain fall of 13-16 weeks which had the highest correlation with yield one year ahead got deleted in the final stage. The actual and predicted yield (based on equation 6) for the years from 1958 to 1982 have shown close agreement excep-

ting for two years viz. 1974 and 1982. The average deviation however for this period was less than 5% from the actual value. The studies have thus shown that by the middle of May, a forecast can be given for the next year's yield with a good precision.

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