Journal of Agrometeorology 11 (1): 15-18 (June 2009)

Trends in weather and yield changes in past in coconut growing areas in India

S. NARESH KUMAR[1*a], M.S. RAJEEV[1] AND VINAYAN[1] D.D. NAGVEKAR[2], R. VENKITASWAMY[3], D.V. RAGHAVA RAO[4], B. BORAIAH[5], , M. S.GAWANKAR[6], R. DHANAPAL[1], D.V. PATIL[7] and K.V. KASTURI BAI[1]

Central Plantation Crops Research Institute, Kasaragod, 671124, Kerala, India;
[2]CRS, Byte, Ratnagiti, Maharastra;
[3]ARS, Aliyarnagar, Tamil Nadu,
[4]CRS, Ambajipeta, Andhra Pardesh,
[5]ARS, Arsikeri , Karnataka,
[6]ARS, Mulde, Maharastra, CPCRI-RS, Kidu, Karnataka
**Corresponding author email: nareshkumar.soora@gmail.com*

ABSTRACT

Analysis of past weather data indicated increase in maximum temperature at varied magnitudes over various coconut growing areas across the country except in southern Kerala. In case of minimum temperature, sixty percent of the locations studied showed a declining trend, widening the difference between maximum and minimum temperatures. The days above 33 ^{o}C, optimal for coconut growth and development, were in increasing trend in most of the coconut growing area while days below 15 ^{o}C are increasing in northern Kerala, plains of Karnataka and western Tamil Nadu. Annual Rainfall showed declining trend in most of the coconut growing areas with change in amount. Dry spells are in increasing trend in parts of Karnataka and Kerala. Change in coconut productivity during past three decades across the country ranged from -114 to 270 nuts/ha/year. The productivity of coconut during the study period was in increasing trend except for parts of Maharastra, Karnataka and Tamil Nadu, where consecutive droughts affected the yields.

Key words: Climate change, weather, coconut

Climate change is taking place all over the world and India is no exception. The effect of elevated CO_2 and temperature on plants is gaining more importance since the global climate has been changing. CO_2 concentration is expected to rise from its current level of 372 ppm to 550 ppm by the year 2050 and to surpass 700 ppm by the year 2100 (Prentice *et al.*, 2001). Such a rise in CO_2 concentration may lead to global warming of 1.8-4ÚC by 2100 (Meehl *et al.*, 2007) Warming may result in decreasing frost, snow and ice cover. Rain may increase in some areas and vegetation may change. The rates of chemical reactions and enzyme activities, that catalyse chemical reactions, function most efficiently at optimal temperatures which are crop specific. The likely impacts of climate related events on Indian agriculture are documented recently (Shukla *et al.*, 2002; Rao *et al.*, 2008).

India is one of the leading coconut growing nations and growth is limited to some states. The current production of coconut in India is about 12832.9 million nuts from an area of 1935 million hectare. Among those states mainly contributing ones are Kerala, Karnataka, Tamil Nadu and Andhra Pradesh. The productivity varies in different zones. Some districts give higher yield and many more lesser yield. Coconut is a C3 and source limited plant (Naresh Kumar *et al.*, 2006) and like other plants it also exhibits responses to some external parameters such as fertilizers, availability of water, temperature and carbon dioxide. In this paper, the recent past trends in weather over coconut growing areas are reported along with the recent past trends in coconut productivity.

MATERIALS AND METHODS

Daily weather data for past 30 years were collected from ten different weather stations representing major coconut growing areas in India. The data were subjected to identify errors/ out layers and were normalized before used for further analysis. Similarly coconut yield data for past 30 years from these representative districts were collected from Coconut Development Board, Kochi and was used for further analysis.

Data were subjected to trend analysis wherein the linear trends were worked out for changes in weather parameters. For this, daily, monthly and yearly data were used. Through regression analysis, magnitudes in change in weather parameters were worked out. The dry spells were worked out using the following criteria: rainy days less than 2.5 mm were ignored, days with 2.5mm to less than 5 mm rain was

Current address:[a] National Professor Unit, Division of Environmental Sciences, NRL Building, Indian Agricultural Research Institute, PUSA, New Delhi, 110 012.

taken as 3 days impact. And more than 5 mm rainfall was taken as 7 days impact (Naresh Kumar *et al.*, 2007). As far as productivity data are concerned, the trend analysis was done following the best fit trends for a data series. Regression equations were used for finding the estimated value. Difference between estimated and measured values was used for calculating the change in a given parameter over time. The magnitude of change was calculated on yearly basis.

RESULTS AND DISCUSSION

The annual average maximum temperature in coconut growing areas varied from 30 to 33 ºC while minimum temperatures ranged from 16.2 to 24.7 ºC (Table 1). Days above 33 ºC of maximum temperature were highest at Mulde in Maharastra and lowest in southern Kerala. The annual average minimum temperature was lowest (16.2 ºC) at Kidu and Arisikeri in Karnataka and a maximum of 24.7 ºC at Ambajipeta (Coastal Andhra Pradesh). Increase in average maximum temperature varied from 0.01 to 0.13 ºC/year. On the other hand, average minimum temperatures decreased in many places. The range in change varied from -0.03 to 0.03/ year. Minimum temperatures were in declining trend in coastal Maharastra, plains of Karnataka, northern coastal parts of Kerala and western Tamil Nadu. This resulted in changes in diurnal temperature differences. The change per year for difference between T max and T min varied from -0.44 in Western Ghat regions of Karnataka, represented by Kidu, to 0.24 in Western Tamil Nadu, represented by Aliyarnagar. Difference between day and night temperatures were in increasing trend in most parts of coconut growing areas except in hilly parts of south west Karnataka, where differences were decreasing. In south Kerala and Godavari districts of Andhra Pradesh, day and night temperature differences were also decreasing. Days above 33 ºC were in increasing trend in most of the coconut growing areas. This temperature is optimum for coconut growth and development. Growth, development and nut yield get affected at temperatures below 15 ºC. The days below 15 ºC are increasing over northern parts of Kerala, plains of Karnataka and western Tamil Nadu. It reveals that there is an increasing trend in maximum temperature over coconut growing areas. At the same time in sixty percent of the centers, there is a declining trend in minimum temperature.

Annual rainfall in coconut growing areas varied from 779 mm in Western Tamil Nadu to ~3500 mm in Northern Kerala (Table 2). Annual Rainfall also is in declining trend in most of the coconut growing areas with change in intensity. Days with below 2.5mm rainfall are in increasing trend in coastal Maharastra, southern western ghats of Karnataka, northern Kerala, western Tamil Nadu, and coastal Andhra Pradesh. On the other hand, in Singhdurg district of Maharastra, plains of Karnataka, central and southern Kerala the days with less than 2.5mm rain fall are declining. Relative humidity (RH) in forenoon varied from 77% in plains of Karnataka to 93% in Western Ghat areas of Karnataka. In most of the places forenoon RH is above 80%. On the other hand, afternoon RH is least in pains of Karnataka and highest in coastal Maharastra. Dry spells varied from 105 in southern Kerala to 218 in coastal Maharastra represented by Ratnagiri. Dry spells are in increasing trends in plains and Western Ghat areas of Karnataka and northern and southern Kerala, whereas reducing trends in coastal Maharastra, central Kerala, coastal Andhra Pradesh and western Tamil Nadu. Change in dry spell varied from -1.98 to 0.27 days/year. Increase in dry spell decreased coconut yields in different agro-climatic zones of India (Naresh Kumar *et al.*, 2007). Coconut requires irrigation at 66% of evaporation, during the non-rainy periods from December to May (Dhanapal, 2000) and the actual amount of water required for meeting this is dependent on age of the palm, evaporation rate, soil type and irrigation method. Irrigation during dry period is essential for establishment and growth of field planted seedlings. Providing better management, for at least 20 years after planting, helps in obtaining good yields in later years.

The analysis of past coconut productivity data from different coconut growing areas indicate wide variation in productivity (Table 3). Variation ranged from ~5,500 nuts/ ha/year in Karnataka to ~13,000 nuts/ha/year in coastal Maharastra. Coconut productivity increased over past 30 years in most parts of the coconut growing areas except for recent declining trends in Ratnagiri district of Maharastra, plains of Karnataka and Coimbatore district (Tamil Nadu). Consecutive droughts in parts of Tamil Nadu and Karnataka have reduced coconut yields (Naresh Kumar and Rajagopal, 2007). Change in coconut yields across the country ranged from -114 to 270 nuts/ha/year. Wide variations in minimum and maximum productivity in parts of Maharastra and Tamil Nadu may be due to the attainment of young coconut gardens to stabilized yield stage.

CONCLUSION

It can be concluded that increase in maximum temperature at varied magnitudes over various coconut growing areas across the country was noticed except in southern Kerala. In case of minimum temperature, sixty percent of the locations studied showed a declining trend. It reveals that the difference between maximum and minimum temperatures is widening which is likely to influence the coconut yields. The productivity of coconut during the study period was in increasing trend except for parts of Maharastra, Karnataka and Tamil Nadu, where consecutive droughts affected the yields. With the development of coconut

Table 1: Changes in day and night temperature in different coconut growing zones in India

S. No.	Centre	Dist	State	T max (ºC)		Days with above 33 ºC		T min (ºC)		ΔT (ºC)
				Average	Change/ year	Mean No of days	Change/ year	Average	Change/ year	Change/ year
1	Ratnagiri	Ratnagiri	Maharastra	30.8	0.03	80.0	1.42	24.0	-0.098	0.15
2	Mulde	Singhdurg	Maharastra	32.9	0.07	192.5	3.18	21.6	0.031	0.04
3	Arsikeri	Hassan	Karnataka	31.0	0.12	85.0	4.74	16.2	-0.054	0.17
4	Kidu	Dakshina Kannda	Karnataka	33.2	0.04	116.0	3.52	16.2	0.157	-0.44
5	Kasaragod	Kasaragod	Kerala	31.2	0.01	69.5	0.41	22.4	-0.027	0.03
6	Thrissur	Thrissur	Kerala	32.1	-0.02	125.3	-0.77	23.3	-0.003	-0.03
7	Thiruvananthapuram	Thiruvananthapuram	Kerala	31.1	0.09	46.1	2.39	23.4	0.053	0.04
8	Aliyarnagar	Coimbatore	Tamil Nadu	31.8	0.13	114.1	3.69	21.7	-0.072	0.24
9	Ambajipeta	East Godavari	Andhra Pradesh	31.6	0.10	141.0	4.88	24.7	0.309	-0.18
10	Calcutta	Howrah	West Bengal	31.7	-0.07	141.5	-0.20	22.3	-0.254	-0.04

Table 2: Changes in rainfall, RH and dry spell in different coconut growing zones in India

S.No.*	Rainfall (mm)		Days with < 2.5 mm rainfall		RH Forenoon (%)		RH Afternoon (%)		Dry spell (days)			
	Annual mean	Change/ year	mean	Change/ year	Average	Change/ year	Average	Change/year	Average	Min	Max	Change/ year
1	3035.1	10.08	15.40	1.00	80.4	NIL	75.9	0.00	218.0	192	240	-1.98
2	3072.5	- 16.98	17.25	-0.38	88.6	0.54	57.6	0.61	201.9	181	229	-0.33
3	688.1	1.16	9.65	-0.07	76.7	0.55	52.6	-0.07	199.7	167	248	0.02
4	2937.3	-2.36	14.70	0.02	93.2	NA	57.6	NA	152.7	127	277	2.87
5	3497.0	-2.50	23.17	0.06	88.6	0.01	67.8	0.02	166.1	127	216	0.27
6	2724.8	-3.59	38.67	-0.13	86.0	0.11	60.0	0.07	142.2	115	163	-0.36
7	1599.0	0.88	56.88	-0.76	NA	NA	NA	NA	104.9	61	152	2.37
8	779.0	-16.07	25.56	0.14	87.1	0.34	57.2	-0.17	189.3	166	218	-3.92
9	1196.0	-18.9	15.50	1.47	86.5	0.00	73.9	0.00	196.0	142	260	-0.67
10	1790.0	8.48	41.88	0.68	NA	NA	NA	NA	139.2	81.5	221.8	-1.52

*Serial number indicate the center as in Table 1.

Table 3: Trends in coconut productivity in India (nuts/ha/year)

State	Dist	Period	productivity in India (nuts/ha/year)			Change (nuts/ha/year)
			Max	Min	Mean	
	Ratnagiri	1976-2000	30830	4546	11055	-949.0
Maharastra	Sindhudurg	1981-1999	20112	4838	13007	580.2
	Tumkur	1975-2002	6871	4762	6392	-31.2
Karnataka	Hassan	1975-2002	5912	4152	5546	-5.3
Kerala	Kasaragod	1985-2003	7939	2315	5682	244.8
	Thrissur	1971-2003	7406	4756	6245	22.7
	Thiruvananthapuram	1971-2003	7162	3941	5615	42.7
TN	Coimbatore	1976-2003	15945	6348	10477	-90.9
AP	East Godavari	1976-2003	18024	4131	9319	412.7
	West Godavari	1976-2003	19235	4105	9406	337.2
West Bengal	Howrah	1987-2003	19367	12559	15230	406.2

simulation model (Naresh Kumar *et al.*, 2008), now it is possible to establish the impact of change in temperature and rainfall on coconut productivity.

REFERENCES

Dhanapal, R. (2000). Production technology of coconut. *In*: Training manual on 'Research Methodology and Crop Management Technologies for Coconut, Arecanut and Cocoa'. CPCRI Pub. Pp 19.

Meehl, G.A., Stocker, T.F. Collins, W.D. Friedlingstein, P. Gaye, A.T. Gregory, J.M. Kitoh, A. Knutti, R. Murphy, J.M. Noda, A. Raper, S.C.B. Watterson, I.G. Weaver A.J. and Zhao, Z.C. 2007. Global Climate Projections. In: Solomon, S., Qin, D. Manning, M. Chen, Z. Marquis, M. Averyt, K.B. Tignor M.and Miller H.L. (Eds.), Climate Change (2007): The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Cambridge University Press, Cambridge, pp. 747-846.

Naresh Kumar, S. and Rajagopal, V. (2007). Drought management in coconut garden through soil moisture conservation. *Ind. Coconut. J.* 37 (9): 11-14.

Naresh Kumar, S., Rajagopal, V. Siju Thomas, T. and Vinu K. Cherian. (2006). Effect of conserved soil moisture on source-sink relationship in coconut (*Cocos nucifera* L.) under different agro-climatic conditions in India. *Ind. J. Agril. Sci.* 76 (5): 277-281.

Naresh Kumar, S., Rajagopal, V., Siju Thomas, T., Vinu K. Cherian, Ratheesh Narayanan M. K., Ananda, K. S., Nagawekar, D. D., Hanumanthappa M., Vincent S. and Srinivasulu, B. (2007). Variations in nut yield of coconut (*Cocos nucifera* L.) and dry spell in different agroclimatic zones of India. *Ind. J. Hort.* 64 (3): 309-313.

Naresh Kumar, S., Kasturi Bai, K. V. Rajagopal V. and Aggarwal, P.K. (2008). Simulating coconut growth, development and yield using InfoCrop-coconut model. *Tree Physiol.* 28:1049–1058

Prentice, I., Farquhar, G., Fasham, M., Goulden, M. and Heinmann, M. 2001. The carbon cycle and atmospheric carbon dioxide. In: Houghton, J.T. Ding, Y. Griggs, D.J. Noguer, M. van der Linden P.J. (Eds.) Climate Change (2001): The Scientific Basis. Contributions of Working Group I to the Third Assessment Report of the Inter Governmental Panel on Climate Change, Cambridge Univ. Press. Cambridge, pp. 183-238.

Rao, G.S.L.H.V.P., Rao, G.G.S.N., Rao, V.U.M. and Ramakrishna, Y.S. (2008). Climate Change and Agriculture over India, KAU-ICAR Pub. Pp. 258.

Shukla, P.R., Sharma, P.S. and Ramana, P.V. (2002). Climate change and India- Issues, concerns and opportunities. Tata-McGraw Hill Publishing Company Limited. New Dehi. Pp 317.

Received : April 2008 ; Accepted : January 2009