Indian J. Hort. 64(3), September 2007: 309-313

Variations in nut yield of coconut and dry spell in different agro-climatic zones of India

S. Naresh Kumar[1]*, V. Rajagopal[1a], T. Siju Thomas[1], Vinu K. Cherian[1], M.K. Ratheesh Narayanan[1], K.S. Ananda[2], D.D. Nagawekar[3], M. Hanumanthappa[4], S. Vincent[5] and B. Srinivasulu[6]

Plant Physiology and Biochemistry Division, Central Plantation Crops Research Institute, Kasaragod 671 124

ABSTRACT

Coconut is the major perennial crop in coastal areas of India. It is mainly grown under rainfed conditions in areas of high rainfall. However, these plantations face summer drought situations as the rainfall distribution is restricted to only 4 to 5 months a year, leaving remaining period as dry. The objective of the study is to quantify the dry spell and to deduce the influence of rainfall and dry spell on the nut yield in major coconut growing areas situated in different agro-climatic zones of India. *viz.*, western coastal area — hot sub-humid per-humid (represented by Kasaragod in Kerala and Ratnagiri in Maharashtra), Western Ghats — hot sub-humid per-humid (represented by Kidu in Karnataka); hot semi-arid (represented by Arsikere in Karnataka); and eastern coastal plains — hot sub-humid (represented by Veppankulam in Tamil Nadu and Ambajipeta in Andhra Pradesh). Variation in annual rainfall was from a maximum of 3337.7 mm (Kasaragod) to a minimum of 718.23 mm (Arsikere). Dry spell was longer in Ratnagiri (216 days) and Arsikere (202 days), and shorter at Kidu (146 days). The annual nut yield under rainfed conditions varied from 68 (Ambajipeta) and 66 (Kasaragod) to 41 (Arisekere) and 30 (Kidu). Impact of variations in dry spell on nut yield was discernible from the study. In view of the long duration (44 months) between the inflorescence initiation to nut maturation, the occurrence of dry spell in any one year would affect the yield for the subsequent three to four years. It can be inferred that the longer dry spell affects the nut yield for next four years to follow with stronger impact on fourth year, irrespective of the total rainfall.

Key words: Coconut, nut yield, dry spell, rainfall, agro-climatic zones.

INTRODUCTION

The coconut palm (*Cocos nucifera* L.) is a tropical plant growing mostly between 20° N and 20° S latitudes. A well distributed rainfall (annual rainfall between 130 and 230 cm), mean annual temperature of 27°C with diurnal variation of 5°C, abundant sunlight ranging from 250 to 350 Wm^{-2} with annual sunshine of 2000 hours (at least 120 h per month) are optimum conditions for good growth and nut yield in coconut (Child, 2; Murray, 5; Menon and Pandalai, 4). A rainfall of about 200 cm per year, distributed throughout is the best for proper growth and high yield. In areas of inadequate rainfall with uneven distribution, coconut palms experience moisture stress of different magnitude. The summer dry spells and restricted rainfall duration causes the rainfed plantations to face water stress situation (Naresh Kumar *et al.*, 6). Peiris and Thattil (9) used evaporation, Temp. maximum and RH for forecasting the coconut yield. Low rainfall is known to cause the reduction in yield in coconut (Rajagopal *et al.*, 11). Even though rainfall and dry spells are the most important factor influencing the coconut yields (Jacob Mathew *et al.*, 3; Peiris, 7; Peiris *et al.*, 8), there is no elaborate evidence of influence of dry spell on coconut yields in coconut growing areas in India. Coconut, being a perennial and indeterminate palm, is characterized by a continuous and prolonged reproductive phase overlapping with the vegetative phase. One inflorescence each is present in the axial of each leaf and each inflorescence is opened in about 25-35 days gap from about 5 years after planting till 60 years. For each inflorescence, from inflorescence primordial initiation to nut maturity, it takes 44 months. The critical stages of inflorescence to water stress are primordial initiation stage, ovary development stage and button size nut stage (Rajagopal *et al.*, 12).

The field experience indicated that consecutive droughts not only affect the coconut yields but also reduce the canopy size and kill the palm. Recent consecutive droughts in Pollachi area in Coimbatore district of Tamil Nadu, and Madugeri and Pavgada areas of Tumkur district of Karnataka have killed about 5 lakh palms thus affecting the coconut plantation and production of these areas causing severe perennial

* Corresponding author's E-mail: nareshkumar.soora@gmail.com; snk_66@yahoo.com

[1a] Former Director, CPCRI, Kasaragod, [2]CPCRI Seed Farm, Kidu; [3]Regional Coconut Research Station, Ratnagiri (Maharastra); [4]Agricultural Research Station, Arsikere (Karnataka); [5]Coconut Research Station, Veppankulam (Tamil Nadu) and [6]Agricultural Research Station, Ambajipeta (Andhra Pradesh).

economic loss to the farmer. Thus, it is important that the rainfall, dry spell and yield relationships are well understood with respect to coconut.

The coconut growing areas in India differ in climatic parameters. The influence of these parameters, especially dry spell on nut production, is not clearly understood. The occurrence and intensity of drought varies in different agro-climatic zones. There is lack of information on the dry spell related production of nuts in different agro-climatic zones. Hence, the aim of the present study was to relate the dry spell to nut yield in rainfed plantations in six centres representing different agro-climatic zones where coconut is grown.

MATERIALS AND METHODS

The study was carried out in five centres of All India Co-ordinated Research Project on palms and the CPCRI Headquarters at Kasaragod. The meteorological data for past 10 to 15 years were collected from the weather stations located in the major coconut growing areas situated in different agro-climatic zones of India *viz.*, Western coastal area — hot sub-humid per, humid zone (represented by Kasaragod, Lat. 74°59' E, Long 12°30' N, in Kerala state and Ratnagiri, Long. 73°18' E, Lat 16°58' N, in Maharashtra state), Western Ghats – hot sub-humid per-humid zone (represented by Kidu- Long. 75°29' E, Lat 12°40' N, in Karnataka state), hot semi-arid (Arsikere, Long. 76°15' E, Lat 13°18' N, Karnataka) and eastern coastal plains – hot sub-humid (Veppankulam, Long. 79°22' E, Lat 10°26' N, Tamil Nadu, Ambajipeta, Long. 81°58' E, Lat 16°37' N, Andhra Pradesh). The monthly rainfall data with the following corresponding fourth year nut yield were computed. Dry spells were calculated using criteria as impact of period for rain fall less than or equal to 2.5 mm as one day, for rainfall of 2.5 mm to 5 mm as 3 days and for more than 5 mm as seven days. Thus, the cumulative dry spell per year were computed. The impact period of rainfall was maintained as per agro-meteorological standards. Palmwise yield data and growing conditions were recorded from the rainfed plantations from the above mentioned locations for past 10 to 15 years. Data was collected from the plantations of comparable age across the locations. Mean yield palm^{-1} year^{-1} were computed from the yield data. The data were analyzed for each centre to get annual rainfall, percentage variation in rainfall from mean rainfall, annual nut yield, percentage of variation in nut yield from the mean nut yield and dry spells. The graphic representation of yield data superimposed over weather data was adopted for critical evaluation by giving a four-year gap between meteorological calendar year and nut yield year.

RESULTS AND DISCUSSION

The mean annual rainfall varied from a maximum of 3337.7 mm in Kasaragod to a minimum of 718.23 mm in Arsikere (Table 1). Dry spell was longer in Ratnagiri (216 days) and Arsikere (202 days) and shorter at Kidu (146 days). Impact of such variations in dry spell on nut yield was discernible. Kasaragod, Kidu and Ratnagiri had similar rainfall pattern with peaks during June, July and August, whereas Veppankulam, Ambajipeta and Arsikere had different patterns for rainfall with peaks during October-November (Fig.1). The most important yield determining factor in coconut is well distributed rainfall (Abeyawardana, 1; Rajagopal and Naresh Kumar, 10). Fluctuations in coconut yield during different years could thus be explained on the basis of variations in rainfall pattern. Western coast and ghats represented by Ratnagiri, Kidu and Kasaragod, even though have rainfall above 2,500 mm, most of it is lost as run-off to the Arabian sea as rain occurs in only 3 to 4 months of a year. Undulating topography, hard laterite soils make difficult for percolation of rain water in to deeper soil

Table 1. Mean annual rainfall and dry spell at six centres.

Centre	Annual mean	
	Rainfall (mm)	Dry spell (days)
Kasaragod	3333.7	170
Ratnagiri	2802.1	216
Kidu	2788.0	146
Ambajipeta	1161.3	186
Veppankulam	1116.4	186
Arisikeri	718.2	202

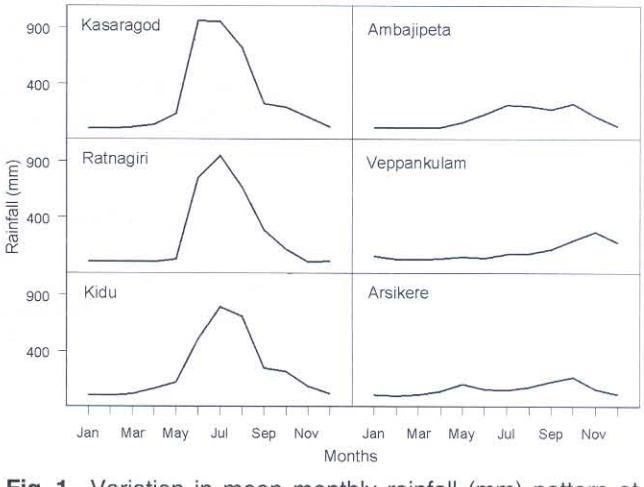


Fig. 1. Variation in mean monthly rainfall (mm) pattern at various coconut growing areas representing different agro-climatic zones.

layers. In coastal areas the soils are of littoral sandy soil type with low moisture retention capacity. Thus, palms in these areas face water scarcity during dry spells as the active root zone of coconut palm is about 20 to 50 cm from the surface of the soil. During summers, even though atmospheric temperatures are relatively low with high relative humidity compared to in land areas, soil water deficit causes water stress to palms. On the other hand in remaining three locations rainfall is low even though it is distributed relatively over longer duration. Soil types in these areas are sandy loams with better soil moisture retention capacity. In these areas summer is more severe and cause atmospheric drought situation as well due to increased vapour pressure deficit. Thus, palms in these areas face atmospheric and soil drought situations.

From Fig. 2, depicting the 15-year annual rainfall in the six centres, it is evident that some of the years were drought affected years. An attempt has been made to work out the dry spell based on the beginning and end of rainfall during the cycle. Dry spell showed marked fluctuations over the years in each centre (Fig. 3). When expressed as number of days, Ratnagiri and Arsikere had more than 200 days of dry spell compared to other centres. Clear picture emerged on the occurrence of drought when the data was expressed as percentage variation in rainfall from yearly mean (Fig. 4) . In general, all the centres exhibited 2 or 3 years of consecutive drought as also alternative drought during a 15-year cycle.

The nut yield exhibited large variations over the years in all the centres. The histograms in (Fig. 4) clearly indicate significant reduction in nut yield in each centre during 1 or 2 years either consecutively or

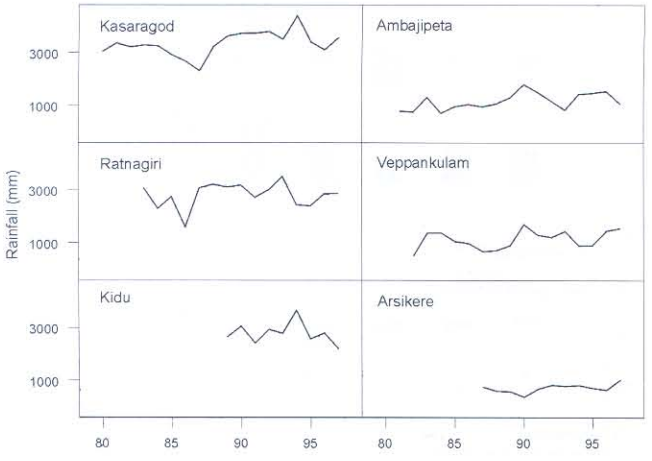


Fig. 2. Variation in annual rainfall (mm) over a period of time at various coconut growing areas representing different agro-climatic zones.

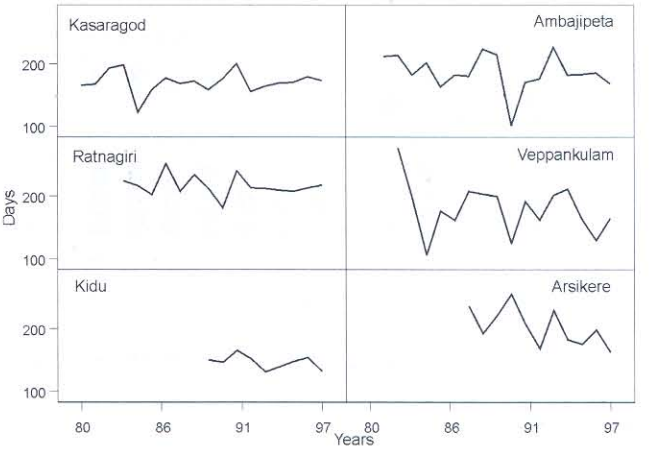
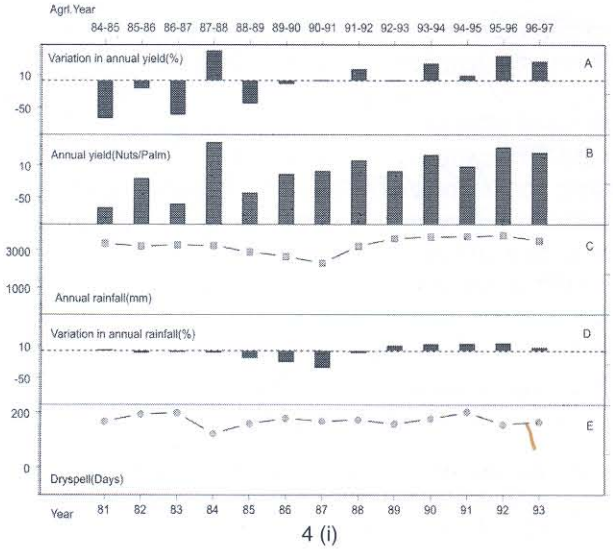


Fig. 3. Variation in dry spell (days) over a period of time at various coconut growing areas representing different agro-climatic zones.

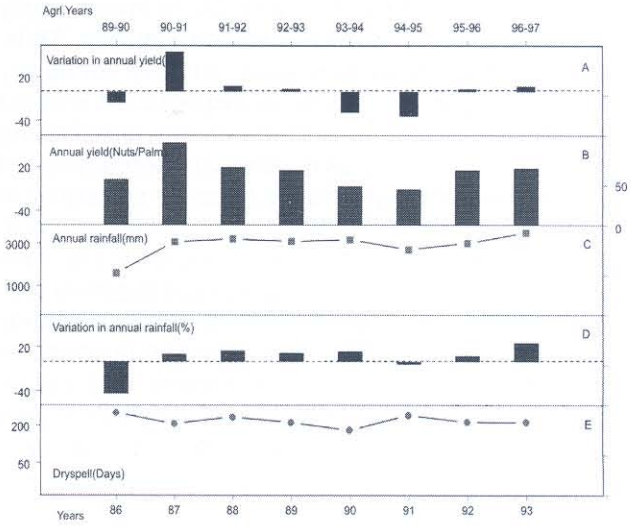
alternatively, indicating dependence of yield on the rainfall pattern, as also suggested by Abeyawardana (1). In view of long duration of 44 months between the initiation of inflorescence primordium and ultimate nut yield, with about 70% period of pre-fertilization and only 30% represented by fertilization / post-fertilization phases, any fluctuations in dry spell occurring during important stages of floral / fruit development would reflect on nut yield. Rajagopal *et al.* (12) reported the close relationship between dry spell and nut yield and identified three critical stages during the ontogeny of nut development, namely initiation of inflorescence primordium, ovary development and button size nut. It is to be noted that all these stages are available in palm at any given time, hence prolonged dry spells affect the coconut yield.

The above hypothesis was tested in each centre by superimposing the rainfall and dry spell data on the nut yield data. Agricultural year yield data were compared with the corresponding rainfall and dry spell data of previous third year. Accordingly, in Kasaragod the low nut yield in 1986-87, with high percentage variation could be traced to longer dry spell in 1982-83. Conversely lower dry spell in 1984-85 resulted in relatively high nut yield in 1987-88. A similar trend could be observed in each centre. In Veppankulam, high nut yield was recorded in 1993-94 corresponding with the short dry spell during 1990, while lower yield in 1994-95 coincided with longer dry spell in 1991.

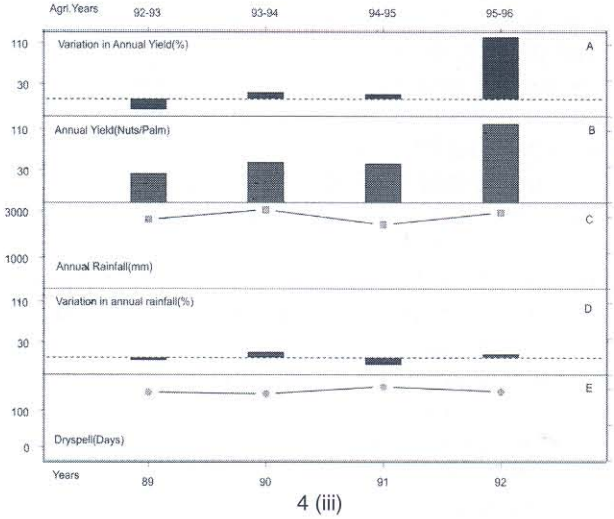
In conclusion, the coconut production varied in different centres. Depending on the rainfall pattern the yield showed fluctuations. Longer dry spell was found to affect nut yield in the fourth year irrespective of the total rainfall received.



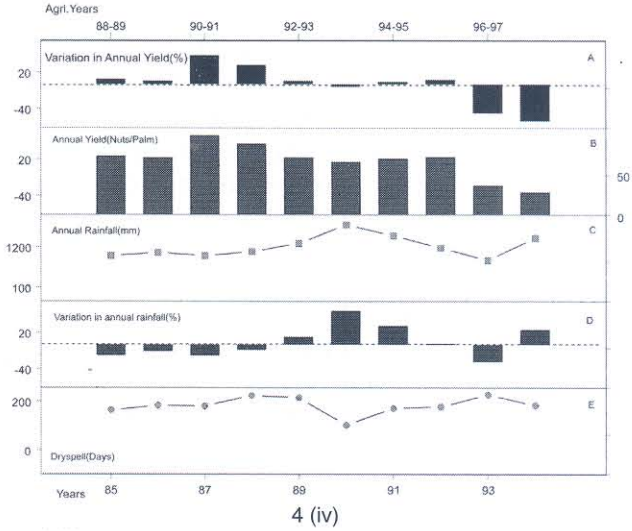
4 (i)



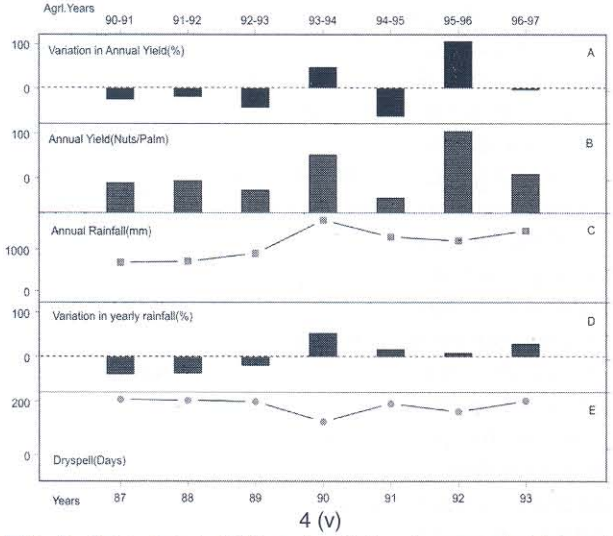
4 (ii)



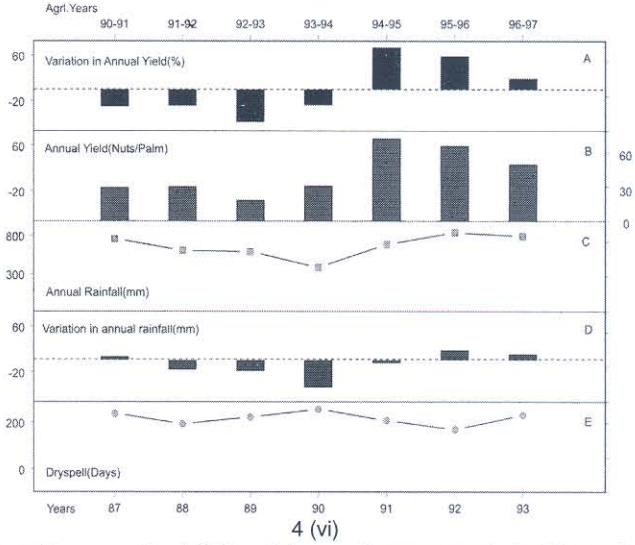
4 (iii)



4 (iv)



4 (v)



4 (vi)

Fig. 4. Annual nut yield and variation in annual yield as influenced by annual rainfall and dry spell over a period of time at: (i) Kasaragod; (ii) Ratnagiri; (iii) Kidu; (iv) Ambajipeta; (v) Veppankulam and (vi) Arsikere.

ACKNOWLEDGEMENT

This research is a part AP Cess Fund Project, ICAR, New Delhi, India. We sincerely thank Dr K.U.K. Nampoothiri, Former Director, CPCRI, Kasaragod for support and encouragements.

REFERENCES

1. Abeyawardana, 1968. Forecasting coconut crops using rainfall data. *Ceylon Coconut Quart.* **19**: 161-76.
2. Child, R., 1974. *Coconuts,* 2nd edn. Longman S. London. pp. 335.
3. Jacob Mathew, C.H., Amarnath, C.H., Vijaya Kumar, K., Mohammad, Yusuf and Balakrishnan, T.K. 1988. Variation in the nut yield of coconut as influenced by the pattern of rainfall and duration of dryspell. *Coconut Res. Dev.* **4**: 48-55.
4. Menon, K.P. and Pandalai, K.M. 1958. *The Coconut Palm: A Monograph.* The Times of India Press, Bombay. pp. 39-85.
5. Murray, D.V., 1977. Coconut palm. **In:** *Ecophysiology of Tropical Crops* (Eds., T.A. Alvim and T.T. Kozlowski). Academic Press, New York, pp. 384-07.
6. Naresh Kumar, S., Rajagopal, V., Thomas, Siju T. and Cherian and Vinu K. 2006. Effect of conserved soil moisture on the source–sink relationship in coconut (*Cocos nucifera* L.) under different agro-climatic conditions in India. *Indian J. Agric. Sci.* **76**: 277-81.
7. Peiris, T.S.G. 1989. Forecasting the crop yield of coconut estate. *Coconut Res. Dev.* **5**: 67-76.
8. Peiris, T.S.G., Thattil, R.O. and Mahindapala, R. 1995. An analysis of the effect of climate and weather on coconut (*Cocos nucifera* L.). *Expl. Agric.* **31**: 451-60.
9. Peiris, T.S.G. and Thattil, R.O. 1998. The study of climate effects on the nut yield of coconut using parsimonious models. *Expl. Agric.* **34**: 189-206.
10. Rajagopal, V. and Naresh Kumar, S. 2003. Management of abiotic stresses in coconut. **In:** *Stress Management in Oil seeds for Attaining Self-reliance in Vegetable Oils* (Eds., Mangala Rai, Harvir Singh and D.M. Hegde). ISOR Pub., DOR, Hyderabad. pp.113-136.
11. Rajagopal, V., Ramadasan, A., Kasturi Bai, K.V. and Balasimha, D. 1989. Influence of irrigation and leaf water relations and dry matter production in coconut palms. *Irrigation Sci.* **10**: 73-81.
12. Rajagopal, V., Shivashankar, S. and Jacob Mathew, C.H. 1996. Impact of dry spells on the ontogeny of coconut fruits and its relation to yield. *Plantation Res. Dev.* **3**: 251-55.

(Received: November, 2006; Revised: February, 2007; Accepted: June, 2007)