



## Field performance of drip irrigation system in coconut gardens

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### Abstract

Field performance of drip irrigation system installed in farmers' field was evaluated to understand the factors associated with proper adoption of technologies and to suggest meaningful interventions for successful implementation of the irrigation system. The study proved that statistical uniformity coefficient of all the plots was maintained in fair and above level. Majority of the farmers provide sufficient (32 lit per palm per day) or even more water to coconut and hence water was not a limiting factor in the productivity of the palm. However, proper distribution of the applied water within the root zone of coconut was missing in majority of the gardens. Improper location and lack of sufficient number of dripping points could be attributed to the poor wetted area within the root zone that resulted in the reduced yield. Considerable increase in the revenue could be achieved without much further investment by enhancing the wetted area.

*Key words:* Statistical uniformity, root zone, drip irrigation, performance evaluation, coconut

### Introduction

Coconut is the most important crop cultivated in Kerala state, that plays a vital role in the agrarian economy of the State. Even though Kerala receives an annual rainfall of 3500 mm, the distribution of rainfall is quite uneven. In North Kerala 75 per cent of the rainfall is received from June to August and the long period of summer results in moisture stress that adversely affect the coconut productivity. Lack of irrigation is one of the major reasons attributed to the low level of productivity of coconut in Kerala state (Rajagopal *et al.*, 2001). This situation calls for an efficient management of available irrigation water. Hence there is great scope for effectively utilizing microirrigation technologies such as drip irrigation system in our state.

The importance of irrigating coconut for sustained yield has been emphasized by many authors (Abeywardena, 1971; Varadan and Madhava Chandran, 1991). Among the irrigation systems, drip irrigation is gaining importance as it maintains the soil moisture availability and air balance in the root zone of coconut near field capacity throughout the dry season while

saving considerable irrigation water (Vidhana Achari, 1996). Water requirement of coconut under drip irrigation for littoral sandy soil (Dhanapal *et al.*, 2000) and laterite soil (Dhanapal *et al.*, 2004) has been worked out at CPCRI, Kasaragod. Dorota and Forrest (1996) reported that drip irrigation wets only a limited portion of the potential root volume, that would be adequate for most plants to perform well, along with minimum evaporation loss of water.

Many coconut growers have installed drip irrigation system in their gardens with government support. However, for successful implementation of this technology in farmers' field it is imperative that farmers are provided with the relevant information and timely technical guidance. It is worthwhile to evaluate the performance of drip irrigation system installed in farmers field so that factors associated with the proper adoption of technologies can be unearthed and meaningful interventions could be suggested for successful implementation of the irrigation system. Since no systematic studies have been conducted hitherto, a study was undertaken to evaluate the performance of drip irrigated coconut gardens in Kasaragod district.

## Materials and Methods

The study was conducted in Kasaragod district of Kerala state. The district represents the areas in northern Kerala where rainfall distribution is quite uneven and experience a long dry spell that provides scope for employing water saving micro irrigation techniques. From Kasaragod District all the four development blocks, Manjeswar, Kasaragod, Kanhangad and Nileswar, were selected for the study. The list of farmers who installed drip irrigation system in their farm was obtained from the office of the concerned Assistant Director of Agriculture. From the list of each of the four development blocks, 15 coconut farmers were selected for the study through simple random sampling.

### Field uniformity estimation

The non-uniformity of emitter discharge is the result of several factors. The more important of these are the hydraulic and emitter discharge variation ( Bucks *et al.*, 1982 ). At present several methods are used for estimating field uniformity. In the present study, statistical uniformity was worked out for analyzing the uniformity of emitters by measuring their discharge rate using a measuring jar and stopwatch as described by Bralts and Kesner (1982). The general criteria adopted for an acceptable statistical uniformity coefficient were 90% or greater - excellent, 80 to 90% - very good, 70-80% - fair, 60-70% - poor and below 60% - unacceptable.

### Volume of water applied

Quantity of water applied per palm per day was measured manually using a measuring jar to ascertain whether the farmer was irrigating palms with the recommended quantity of water.

### Root zone area wetted

Top soil around the dripping point was removed and the area of root zone wetted from the dripping point was measured using a measuring tape for this purpose.

### Number of dripping points

The actual number of dripping points installed in the system for each palm was noted.

### Discharge rate of drippers

Discharge rate of dripper is an important criterion which decides the horizontal and vertical movement of water from a dripping point. Normally more the discharge rate, larger will be the horizontal movement of water and thereby increasing the root zone area wetted (Maheswarappa *et al.*, 1997; Mathew *et al.*, 1999). If the discharge rate is more than the optimum level, water will be wasted as surface runoff. Average discharge rate

of drippers was measured in the farmers' field since it will directly affect the wetting pattern.

### Deep percolation

The root zone depth of coconut is 1 m. Whatever water goes beyond this depth will be of not much use to the palm. Deep percolation can be avoided by carefully adjusting the discharge rate of emitter. It again depends on the soil type. In sandy soil vertical movement of water will be much more than horizontal movement. Whereas in clay soils it is in the reverse order at the beginning. Deep percolation was measured by taking soil samples using soil augurs at a depth of 1 m and analyzing it for soil moisture content.

### Location of dripping point

In order to obtain maximum wetted soil within the root zone it is important to locate the dripping points equidistant around the palm at a distance of 1 m away from it. Farmers practice in this regard was observed.

## Results and Discussion

Results of the estimation of the field uniformity in terms of Statistical Uniformity Coefficient of drip irrigation is summarized in Table 1.

Table 1. Statistical uniformity coefficient of coconut garden

Statistical uniformity coefficient	Frequency	Per cent
60-70	0	0
70-80	12	20.00
80-90	29	48.30
>90	19	31.7

Statistical Uniformity Coefficient of all the plots was maintained in fair and above level. No garden belonged to poor or unacceptable categories. Majority, 80%, belonged to very good and excellent level of uniformity.

Though the mean yield observed (92 nuts/ palm/ year) is relatively high, there is a wide gap between the lowest (56 nuts/ palm/ year) and the highest (148 nuts/ palm/ year) yield obtained from the observed plots. All the selected farmers were cultivating West Coast Tall variety of coconut and were following the package of practices more or less similarly. It was also observed that there was no correlation between the uniformity and yield (Fig.1). Major emphasis of this paper is to find out the reasons for such a wide gap in yield among various drip irrigated coconut gardens so that necessary remedial measures could be suggested to reduce the gap.

For coconut, CPCRI recommends application of water @ 66% of open pan evaporation for drip irrigation. With the prevailing climatic conditions of the study area

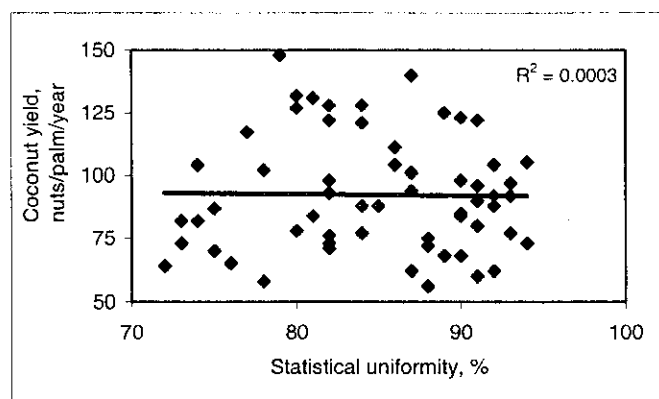


Fig.1. Effect of statistical uniformity on coconut yield

this works out to be approx. 32 lit of water per palm per day for coconut. The present study revealed that a vast majority (96.6 per cent) of the farmers were irrigating their coconut palms with more than the recommended quantity of water. Response of coconut to irrigation water in terms of yield is given in Fig.2.

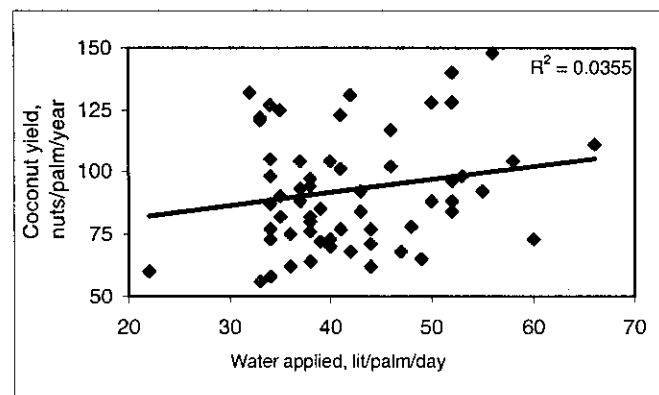


Fig.2. Response of coconut to irrigation

It is obvious that there is no significant relation between volume of water applied and coconut yield mainly because majority of the garden received much more quantity of irrigation water than the recommended amount. Therefore, poor yield in many of the observed gardens cannot be due to the amount of irrigation water. Similar type of results has been reported by many workers for Kerala conditions (Dhanapal *et al.*, 2000; Varadan and Madhava Chandran, 1991; Jose Mathew *et al.*, 1996; Saseendran and Jayakumar, 1998). Though more water was applied in many of the coconut gardens, it did not contribute towards yield because the excess water moved beyond the root zone and was not used by the palms.

Correlation between the observed parameters, coconut yield, root zone wetted, volume of water applied and statistical uniformity coefficient is given in Table 2. Significant correlation was observed between coconut yield and root zone wetted.

Table.2 Correlations of measured parameters

	Coconut yield	Root zone wetted	Vol. of water applied	Statistical uniformity
Coconut yield	1	0.796**	0.188	-0.016
Root zone wetted		1	0.132	0.061
Vol. of water applied			1	-0.036
Statistical uniformity coefficient				1

\*\* Significant at P 0.01

Effect of root zone wetted on coconut yield is shown in Fig.3. It is obvious from the figure that the area of root zone wetted has an effect on coconut yield, i.e., coconut yield increased when the area of root zone wetted increased.

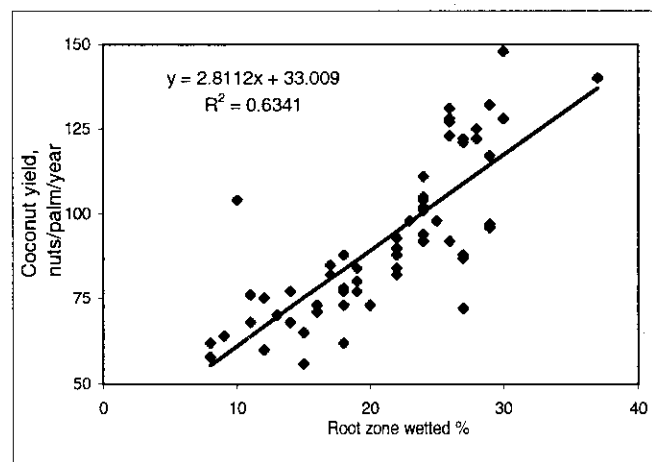


Fig.3. Effect of root zone wetted on coconut yield

The percentage of wetted soil (P) was determined by dividing the wetted volume of the soil in the root zone by the total volume of soil in the root zone of the crop. An optimum value of 'P' has not yet been established for coconut. Generally systems with high 'P' provide insurance in case of system failures due to the higher soil water reserve. From presently available information it seems that the minimum value of 'P' for tree crops is around 33% (Ilan Bar *et al.*, 1996 and Vermeiren and Jobling, 1984). A study conducted in Israel (Bielorai, 1977) found that in a grape fruit orchard, yield, fruit quality and tree development were similar in trickle irrigation wetting only 30-40% of the soil surface as compared to sprinkling.

#### Reasons for low wetted area

Wetted area in the coconut basin under drip irrigation depends on (1) number of dripping points per palm, (2) spacing of drippers, and (3) discharge rate of drippers.

The present recommendation is to provide four dripping points in sandy loam (Mathew *et al.*, 1999) and

laterite (Dhanapal *et al.*, 1995) soils and six dripping points in sandy soil (Maheswarappa *et al.*, 1997) for coconut to obtain a minimum of 30 per cent of the root zone area wetted. It was also stressed by these workers to operate the drippers at a higher discharge rate of 4 to 6 litres per hour. Operating drippers at a higher discharge rate reduces the chance of clogging (Padmakumari and Sivanapan, 1985). The drippers need to be placed equidistant around the palm at a distance of 1 m away from it.

The study showed that only 34 per cent of coconut gardens in sandy loam and laterite soils were having the recommended number of dripping points per palm. None of the coconut gardens grown in sandy soil was having the recommended number of dripping points. Though there is an upward trend (Fig.4.), the correlation between coconut yield and number of dippers is not significant.

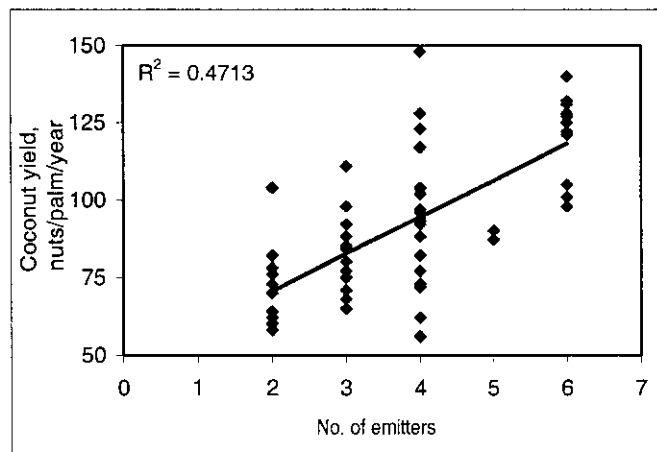


Fig.4. Effect of number of drippers on coconut yield

It is also required to keep the dripping points equidistant around the palm at a distance of 1 m away from it in order to obtain maximum wetted soil within the root zone. But from the results obtained, it can be seen that in more than 90 per cent of the coconut gardens distance of dripping points from tree trunk was less than the recommended distance and also the placement not equidistant. This was the single most important parameter that reduced the wetted area within the root zone. It is evident from the soil moisture measurements made at a depth of 1 m that considerable amount of water was lost as deep percolation. However, the amount of percolated water beyond root zone could not be quantified due to practical difficulty in taking soil samples. Discharge rate of drippers was kept at 4 lit./ hr or more in all the plots.

Experiments at CPCRI proved that applying water subsurface would help to reduce evaporation from soil surface. However, results showed that all the farmers

under study except one coconut farmer were keeping the dripping points on surface itself. Surface placement of dripping points definitely resulted in loss of water through evaporation. Sub surface placement also helps in preventing dislocation of emitters. This points to the need to make efforts to create awareness among the farmers adopting drip irrigation system about the need and importance of proper placement of emitters. It is obvious from the wide variation in coconut yield among the drip irrigated fields that with a little more care to the already installed drip irrigation system, many farmers would be able to get more economic returns without any further investment.

### Conclusion

It is evident from the study that majority of the farmers provide sufficient or even more water to coconut and hence water was not a limiting factor in the productivity of the palm. However, proper distribution of the applied water within the root zone of coconut was missing in majority of the gardens. Awareness should be created among the farmers to enhance the wetted area within the root zone of the palm by providing sufficient number of dripping points and proper placement of these dripping points within the basin. This would further improve the benefit cost ratio of otherwise costly drip irrigation system.

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