Research Paper

ADVANCE RESEARCH JOURNAL OF
C R P
IMPROVEMENT
Volume 3 | Issue 2 | December, 2012 | 157-159

Wetting and rooting pattern of cocoa (*Theobroma cacao* L.) as influenced by drip and micro sprinkler irrigation

■ C. KRISHNAMOORTHY AND K. RAJAMANI[1]

AUTHORS' INFO

Associated Co-author :
[1]Department of Horticulture, TNAU Information and Training Centre, CHENNAI (T.N.) INDIA
Email : rjmanicbe@rediffmail.com

Author for correspondence :
C. KRISHNAMOORTHY
Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, COIMBATORE (T.N.) INDIA
Email : plantdoctorkrishna@gmail.com

ABSTRACT : A field experiment to study the influence of drip and micro sprinkler irrigation on wetting and rooting pattern of cocoa (*Theobroma cacao* L.) was conducted at the Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during January 2010 to December 2011. The wetting and rooting pattern was critically analyzed and the study revealed that the vertical movement of the moisture was higher than the horizontal movement in the drip irrigation system. When comparing drip and micro sprinkler irrigation, the surface rooting pattern in sprinkler irrigated trees indicated the same pattern as that of drip irrigation while, depth wise rooting pattern indicated that, 63 per cent of roots were present in the top 30 cm of soil and 17 per cent between 30 - 45 cm depth. In micro sprinkler irrigation, the active lateral roots were concentrated at surface of the soils (0 - 15 cm) and drip irrigation the roots are at 15 to 30 cm depth.

Key Words : Fertigation, Drip, Micro sprinkler, Water soluble fertilizers, Straight fertilizers, Wetting pattern, Rooting pattern

How to cite this paper : Krishnamoorthy, C. and Rajamani, K. (2012). Wetting and rooting pattern of cocoa (*Theobroma cacao* L.) as influenced by drip and micro sprinkler irrigation, *Adv. Res. J. Crop Improv.*, **3** (2) : 157-159.

Paper History : Received : 06.10.2012; **Revised :** 25.10.2012; **Accepted :** 26.11.2012

Cocoa (*Theobroma cacao* L.) the 'Food of Gods' is one of the most important plantation crops consumed worldwide and around 40 - 50 million people depend on cocoa for their livelihood (World Cocoa Foundation, 2011). Cocoa is cultivated mainly in Africa, Asia, Central America and South America and major cocoa producing countries are Ivory Coast, Ghana, Indonesia, Nigeria, Cameroon, Brazil, Ecuador and Malaysia. The annual production is around 3 million tonnes with an estimated value of $ 5.1 billion (World Cocoa Foundation, 2010). Ivory Coast leads in production occupying 38 per cent of total world cocoa production followed by Ghana (21 per cent), Indonesia (13 per cent), Nigeria (5 per cent), Cameroon (5 per cent), Brazil (4 per cent), Ecuador (3 per cent), Malaysia (1 per cent) and others (10 per cent). West Africa alone contributes nearly 70 per cent of the world cocoa production.

India offers considerable scope for cocoa cultivation, production and further development. Though cocoa has been known as the beverage crop even before tea and coffee, it is relatively a new crop to India. Cocoa is intercropped in coconut and arecanut and is a good companion to these crops. Four states *viz*., Kerala, Andhra Pradesh, Tamil Nadu and Karnataka share the major cocoa production in India. The current area is estimated to be 46,318 ha with production of 12,954 MT. The national productivity is 550 kg dry beans per ha. Kerala leads in production with an area of 11,044 hectares contributing 6344 MT of cocoa beans with a productivity of 592 kg per hectare. Tamil Nadu occupies third in cocoa cultivation and the area reported under this crop is 15,000 ha with an annual production of 350 MT (DCCD, 2011).

More than 80 per cent of active roots in cocoa are located within the radius of 30-60 cm, surface application of the required fertilizers are to be applied between 30-60 cm distance from the main trunk under conventional system of irrigation.

In Tamil Nadu, a dose of 100:40:140 g NPK $tree^{-1}$ $year^{-1}$ is generally recommended (TNAU, 2004) for cocoa. The tap roots (1.2 m deep) in cocoa acts as physical support and only lateral roots (20 - 30 cm) absorbs the moisture and nutrients. As cocoa is very sensitive to moisture stress and water logging, irrigation should be at its optimum level for better growth. Hence, the present study was aimed to evaluate the fertigation system involving drip, sprinkler irrigation methods on wetting and rooting pattern in cocoa.

RESEARCH PROCEDURE

Field experiments were conducted at Department of Spices

and Plantation Crops, Tamil Nadu Agricultural University, Coimbatore during January 2010 to December 2011 to find out the effect of fertigation on wetting and rooting pattern in cocoa. The age of the cocoa trees was six years which were intercropped with coconut of 30 years old. Cocoa was spaced at 3 x 3 m between the two rows of coconut. Besides, one cocoa plant was planted in between two coconut trees within the coconut row. The population of cocoa trees maintained was @ 500 plants per ha.

The drip line was laid out as per the spacing of cocoa trees *i.e.* 3 x 3 m. For each tree in case of drip irrigation, two drippers were installed @ 8 lph (litres per hour) dripper^{-1}. Two half sub circle micro sprinklers were installed per tree @ 60 lph micro sprinkler^{-1} to cover the entire basin. The micro sprinkler type was half sub circle with a height of 30 cm and it sprinkled an area of 60 cm. A venturi assembly was used for mixing fertilizer with irrigation water.

The experiment was laid out in Randomized Block Design (RBD) with thirteen treatments replicated thrice. The details of the treatments are as follows, T_1 - 100 per cent of RDF as surface application (100:40:140 g NPK plant^{-1} year^{-1}) with flood irrigation (Control), T_2 - 75 per cent RDF as WSF through fertigation by drip irrigation, T_3 - 100 per cent RDF as WSF through fertigation by drip irrigation, T_4 - 125 per cent RDF as WSF through fertigation by drip irrigation, T_5 - 75 per cent RDF as straight fertilizers through fertigation by drip irrigation, T_6 - 100 per cent RDF as straight fertilizers through fertigation by drip irrigation, T_7 - 125 per cent RDF as straight fertilizers through fertigation by drip irrigation, T_8 - 75 per cent RDF as WSF through fertigation by micro sprinkler irrigation, T_9 - 100 per cent RDF as WSF through fertigation by micro sprinkler irrigation, T_{10} - 125 per cent RDF as WSF through fertigation by micro sprinkler irrigation, T_{11} - 75 per cent RDF as straight fertilizers through fertigation by micro sprinkler irrigation, T_{12} - 100 per cent RDF as straight fertilizers through fertigation by micro sprinkler irrigation, T_{13} - 125 per cent RDF as straight fertilizers through fertigation by micro sprinkler irrigation.

For surface application and irrigation (T_1), an annual application of 100 g N, 40 g P_2O_5 and 140 g K_2O per tree per year in two split doses was made as per recommendation. The fertilizers were applied in two equal splits, the first dose in first week of April and the second dose in first week of September. Surface irrigation was done once in seven days interval. For drip and micro sprinkler treatments (T_2 to T_{13}), the fertilizers were applied through drip and micro sprinkler irrigation system (fertigation) at weekly intervals and the irrigation was resorted once in a day (20 litres tree^{-1} day^{-1}).

Wetting front advance and depth of wetting in drip and micro sprinkler systems were recorded for different times of emissions, before and after irrigation. The soil moisture contour map was plotted using the computer software package 'surfer' of windows version. The rooting pattern was studied in drip irrigated trees and micro sprinkler irrigated trees. The soil was removed, without causing any damage to the lateral and tap roots and the root pattern was studied. The active roots which were present in cocoa trees (drip and micro sprinkler system) were marked and the percentage worked out.

RESEARCH ANALYSIS AND REASONING

The results obtained from the present investigation have been discussed in the following sub heads:

Wetting pattern:

Wetting pattern were observed in drip and micro sprinkler irrigated experimental plot (Table 1). The diameter and depth of wetted zone for various times of emission from a 8 lph emitter in drip system and 60 lph in micro sprinkler system were observed for the soils of the experimental sites under dry condition. In drip irrigation, the wetting pattern in front advance was recorded every 15 minutes upto 90 minutes. The values were 9.0, 11.4, 13.9, 15.2, 15.7, 16.0 cm for 15, 30, 45, 60, 75, 90 minutes, respectively. The depth wise wetting pattern recorded at the same time interval and the values pertinent to the time were 12.3, 17.0, 20.2, 25.6, 28.1, 34.2 cm. The vertical movement of the moisture was higher than the horizontal movement in the drip irrigation system. In case of micro sprinkler system, the wetting pattern in depth was recorded and the values were 15.1, 19.3, 22.0, 25.2, 27.4 and 30.0 for 15, 30, 45, 60, 75, 90 minutes, respectively.

In drip system, the diameter of the horizontal wetted zone during different times of emission is graphically represented. As the time increased, the rate of increase of wetted zone diameter decreased. This was due to the increased area for downward movement of water as the lateral wetting increased. The behavior of time vs. horizontal wetted diameter confirmed the findings of Arunadevi *et al*. (2005) in mulberry and Vijyakumar (2004) in bhendi. The depth advancement depended on the infiltration characteristics of the soil.

Table 1 : Effect of drip and micro sprinkler irrigation on wetting pattern in cocoa

Time (min)	15	30	45	60	75	90
Drip irrigation						
Wetting front advance (From emitter) (cm)	9.0	11.4	13.9	15.2	15.7	16.0
Depth of wetting (From emitter) (cm)	12.3	17.0	20.2	25.6	28.1	34.2
Micro sprinkler irrigation						
Depth of wetting (From emitter) (cm)	15.1	19.3	22.0	25.2	27.4	30.0

Table 2 : Effect of drip and micro sprinkler irrigation on rooting pattern (Lateral roots in %)

Drip irrigation							
Surface (cm)	0 - 15	15 - 30	30 - 45	45 - 60	60 - 75	75 - 90	> 90
%	10	25	30	15	8	7	5

Depth (cm)	0 - 15	15 - 30	30 - 45	45 - 60	> 60
%	25	30	22	13	10

Micro sprinkler irrigation							
Surface (cm)	0 - 15	15 - 30	30 - 45	45 - 60	60 - 75	75 - 90	> 90
%	10	20	30	20	7	7	6

Depth (cm)	0 - 15	15 - 30	30 - 45	45 - 60	> 60
%	33	30	17	10	10

Rooting pattern:

Drip irrigation :

The rooting pattern along the upper surface of soil in drip irrigation and fertigation system indicated that 10 per cent of lateral roots were present at 15 cm from trunk, 25 per cent of lateral roots between 15 – 30 cm, 30 per cent of roots between 30 – 45 cm, 15 per cent of roots between 45 – 60 cm, 8 per cent of roots between 60 – 75 cm, 7 per cent roots between 75 – 90 cm and 5 per cent beyond 90 cm from trunk, respectively. The depth wise rooting pattern indicated that 25 per cent of roots were found between the first 15 cm depth from ground level, 30 per cent between 15 – 30 cm depth, 22 per cent between 30 – 45 cm depth, 13 per cent at 45 – 60 cm depth and 10 per cent of roots beyond 60 cm depth (Table 2).

Micro sprinkler irrigation :

The rooting pattern along the surface of soil in micro sprinkler irrigation and fertigation system indicated that 10 per cent of lateral roots were present at 15 cm from trunk, 20 per cent of lateral roots between 15 – 30 cm, 30 per cent of roots between 30 – 45 cm, 20 per cent of roots between 45 – 60 cm, 7 per cent of roots between 60 – 75 cm, 7 per cent roots between 75 – 90 cm and 6 per cent beyond 90 cm from trunk, respectively. The depth wise rooting pattern indicated that 33 per cent of roots were found between the first 15 cm depth of soil from ground level, 30 per cent between 15 – 30 cm depth, 17 per cent between 30 – 45 cm depth, 10 per cent at 45 – 60 cm depth and 10 per cent beyond 60 cm depth (Table 2).

The active roots of cocoa trees pertaining to drip and micro sprinkler fertigation indicated interesting observations. The surface rooting pattern under drip irrigation revealed that nearly 80 per cent of the roots were distributed within 60 cm from the trunk indicating the effective area for irrigation and application of nutrients. The depth wise rooting pattern in drip irrigation indicated that 55 per cent of lateral roots were present in top 30 cm depth of soil, 35 per cent of roots between 30-60 cm depth.

The surface rooting pattern in sprinkler irrigated trees indicated the same pattern as that of drip irrigation while, depth wise rooting pattern indicated that, 63 per cent of roots were present in the top 30 cm of soil and 17 per cent between 30-45 cm depth. These suggest that the effective area for irrigation and nutrient application have to be done at 60 cm between the trunk and the water should percolate at least upto the top 30 cm of soil irrespective of the method of irrigation.

LITERATURE CITED

Arunadevi, K., Selvaraj, P. K., Ranghaswami, M.V. and Krishnan, R. (2005). Effect of drip fertigation on mulberry leaf growth attributes; leaf yield and leaf quality characters. *Crop Res.*, **33** : 237 - 243.

TNAU (2004). Crop Production Techniques of Horticultural Crops, Tamil Nadu Agricultural University, Coimbatore and Directorate of Horticulture and Plantation Crops, Chennai. pp. 289.

Vijayakumar, G. (2004). Maximizing the fertilizer use efficiency in bhendi under drip irrigation. M.Sc. Thesis, Tamil Nadu Agricultural University, Coimbatore, T.N. (INDIA).

WEBLIOGRAPHY

DCCD (2011). Directorate of Cashew and Cocoa Development. (*http://dacnet.nic.in/cashewcocoa /stat.htm*).

World Cocoa Foundation (2010). World Cocoa Foundation (*http://www.worldcocoafoundation.org/*).

World Cocoa Foundation (2011). World Cocoa Foundation (*http://www.worldcocoafoundation.org/*).

****