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RESEARCH ARTICLE :

Effect of drip bio fertigation on growth and yield of arabica coffee (*Coffea arabica*) var. Chandragiri

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SUMMARY : Coffee (*Cofea* spp) is one of the most commercially important plantation crops grown worldwide. Coffee occupies a place of pride in international trade next to petroleum. The most important factor that limits the production of coffee is long drought period. Drip fertigation promotes nutrient use efficiency besides ensuring water use efficiency. In recent years, biofertlizers have been found to play a greater role in the integrated nutrient management of crops. The biofertilizers are available in the form of liquid which can be applied through drip fertigation system in a précised manner. The experiment was conducted at Green Pearl Estate at Kottachedu, Yercaud during 2008 and 2009. The investigation was carried out with six year old coffee plants of cv. CHANDRAGIRI. Totally eleven treatments were laid out in a Randomized Block Design and replicated thrice. The results revealed that fertigation and bio fertigation treatments showed significant differences among the growth and yield characters studied. From the results it was observed that the treatment T_9 (Drip fertigaion 75% of NPK RDF + Liquid bio frtilizers) recorded the highest plant height, number of branches per plant, number of nodes per branch, fruit set per cent and yield. It was followed by T_{10} (Drip fertigation 100%RDF+Liquid bio fertilizers). Whereas the lowest values for plant height, number of branches per plant, number of nodes per branch, fruit set per cent and yield were recorded by T_1 (absolute control).

KEY WORDS :
Coffee-Chandragiri, Bio fertigation, Growth, Yield

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BACKGROUND AND OBJECTIVES

Coffee (*Cofea* spp) is one of the most important commercial crops grown worldwide in more than 50 countries. Coffee occupies a place of pride in international trade next to petroleum, with a total production of 3063000 MT during 2009-10 (India Coffee Organization, May, 2010) from an area of 3,88,195 hectares. In Tamil Nadu, production coffee is about 19550 MT in 31344 hectares. India has emerged as a quality coffee producer (Anonymous, 2010). Indian coffee is known for its aroma and flavor and categorized as "mildes" in world coffee. Coffee consumption has been associated with reduced risk of several diseases. Kwashiorkor, disease caused by protein deficiency, is overcome by the consumption of coffee (Mathyalagan and Ramesh, 1982). Coffee plant being perennial in nature has the dual function of nurturing the developing berries

and production of fresh wood for the succeeding crop. In normal management, Arabica bushes remain productive for nearly 35-40 years. Therefore, establishment of vigorous and healthy plants in the early years is essential for the longevity of the plantations. Since, coffee is primarily grown as rain fed crop, the irrigation requirement is same as that of amount of rainfall received (Goodyear, 2004). Irrigation is an expensive operation, but it can produce high economic responses, especially, when combined with appropriate fertilizer treatment and effective crop production by undertaking cultural operations in time (Mitchell, 1988). The most important factor that limits the production of coffee even in well managed estates is long drought period. The drip irrigation has assumed considerable importance in recent years which offers 60 per cent savings in water and is most suited for sustenance irrigation during the dry period (Anonymous, 2000). Drip fertigation promotes nutrient use efficiency besides ensuring water use efficiency. Fertigation enables the application of fertilizer uniformly and more efficiently (Patel and Rajput, 2001). The advantage of fertigation over conventional method of fertilizer application was emphasized by several workers (Shirgure *et al*., 1997). Increased agricultural productivity can be sustained through balanced fertigation besides consistent use of soil and natural resources and inputs. In recent years, bio fertilizers have been found to play a greater role in the integrated nutrient management of crops. The biofertilizers available in liquid form can be applied through drip fertigaion system in a précised manner. With this view the present investigation was carried out on coffee to study the effect of biofertigation on growth and yield.

RESOURCES AND METHODS

The experiment was conducted at Green Pearl Estate at Kottachedu, Yercaud during 2008 and 2009. The investigation was carried out with six year old coffee plants of cv. CHANDRAGIRI. The crop was planted at a distance of 1.8m x 1.8m with a plant population of 1200 plants acre^{-1}. Totally eleven treatments *viz.*, T_1 (absolute control), T_2 (Drip irrigation alone), T_3 (Soil application of NPK 50 % RDF), T_4 (soli application of NPK 75%), T_5 (Soli application of NPK 100%), T_6 (Drip fertigation 75% RDF), T_7 (Drip fertigation 100% RDF), T_8 (Drip fertigation 125% RDF), T_9 (Drip fertigation 75% RDF+Liquid biofertilizerss), T_{10} (Drip fertigation 100% RDF+Liquid biofertilizers) and T_{11} (Drip fertigation 125% RDF+Liquid bio fertilizers) were laid out in a Randomized Block Design and replicated thrice. The biometrical observations *viz.*, plant height (cm), stem girth (cm), number of branches per plant, number of nodes per branches, percentage of fruit set, and yield per plant (kg) were recorded from randomly selected ten plants from each treatment and the data were subjected to statistical analysis as suggested by Panse and Sukhatme (1985).

Method of fertilizer application :

Recommended dose of fertilizers for five year old trees of coffee plant was 70: 55: 75 kg NPK year^{-1}acre^{-1} (as per the package of practices of coffee). The fertilizer dose was increased for the second year crop to the level of 80: 62: 80 kg NPK year^{-1}acre^{-1}. Liquid bio fertilizers were applied through drip irrigation system at 50ml each in liquid form as per the Tamil Nadu Agricultural University recommendation containing Azospyrillum and Phosphobacteria. For fertigation the above fertilizers were divided in to twenty splits and applied at fortnight intervals. Biofertigation was done at monthly interval as per the technical programme.

OBSERVATIONS AND ANALYSIS

The results revealed that fertigation and bio fertigation treatments showed significant differences among the growth characters studied. The results of plant height and stem girth are presented in the Table 1. From the results it was observed that the treatment T_9 (Drip fertigaion 75% of NPK RDF + Liquid bio frtilizers) recorded the highest plant height value of 81.08cm and stem girth value of 15.78 cm in the pooled mean. It was followed by the treatment T_{10} (Drip fertigation 100%RDF+Liquid bio fertilizers) and T_7 (Drip fertigation 100% RDF alone) which registered 77.16 cm as plant height and 13.05 cm as stem girth and 77.74cm as plant height and 12.77 cm as stem girth in the pooled mean. Similarly the same treatment T_9 also recorded higher plant height values of 80.38 cm and 81.77 cm and stem girth values of 15.24cm and 16.32 cm during 2008 and 2009. It was followed by T_{10} (77.11cm and 78.43cm as plant height and 12.78cm and 13.31cm as stem girth) and T_7 (76.87cm and 78.63cm as plant height and 12.70cm and 12.83cm as stem girth). Significant increase in plant height and stem girth observed by the treatment T_9 might

be due to the better utilization of resources like water and nutrients through drip fertigtion system (Padmavathamma, 1993). Increased uptake of nutrients particularly nitrogen in drip fertigation system could be attributed to the increased plant height and stem girth. The absorbed nitrogen ultimately might have utilized by the plants in the formation of complex substances like protein and amino acids which in turn help to build up new tissues (Childers, 1966). Coffee plant well responded to fertigation through more synthesis of hormones like auxin, which might have encouraged the apical dominance that resulted in better plant height and stem girth. These findings are in line with the findings of Rashmi *et al*. (2005) and Srinivas (2006). Bio fertilizers, generally providing varied contributions to the enhancement of growth and productivity as reported by Dobbelaere *et al*. (2001). The lowest plant height values of 71.93cm and 73.13cm and stem girth values of 10.16cm and 11.18 cm during 2008 and 2009, respectively.

Marked influence by various drip and bio fertigation treatments was noticed for number of branches per plant and number of nodes per plant during both the years of experimentation. Venkataramanan (1988) reported that fertigation increased the total number of branches and number of bearing nodes in coffee. The highest number of branches per plant (17.77 and 18.20) and number of nodes per plant (14.30 and 14.60) were recorded by the treatment T_9 (75 % RDF fertigation and bio fertigation)

Table 1 : Effect of drip fertigation and biofertigation on plant height and stem girth of coffee (*Coffea arabica*) cv. CHANDRAGIRI

Treatments	Plant height (cm)		Mean	Stem girth (cm)		Mean
	2008	2009		2008	2009	
T_1	71.93	73.13	72.53	10.16	11.18	10.67
T_2	73.15	74.06	73.61	10.16	11.29	10.73
T_3	73.18	74.37	73.78	10.18	11.30	10.74
T_4	73.20	74.38	73.79	10.79	11.33	11.06
T_5	73.45	74.98	74.22	10.80	11.48	11.14
T_6	75.26	75.59	75.43	11.46	12.32	11.89
T_7	76.87	78.63	77.75	12.70	12.83	12.77
T_8	74.67	75.21	74.94	11.43	12.40	11.92
T_9	80.38	81.77	81.08	15.24	16.32	15.78
T_{10}	77.11	77.21	77.16	12.78	13.31	13.05
T_{11}	75.89	76.50	76.20	11.43	12.47	11.95
S.E.±	0.5089	0.5172		0.1014	0.0926	
C.D. (P=0.05)	1.0618	1.0788		0.2114	0.1932	

Table 2 : Effect of drip fertigation and biofertigation on number of branches per plant and number of bearing branches per plant of coffee (*Coffea arabica*) cv. CHANDRAGIRI

Treatments	Number of branches per plant		Mean	Number of nodes per branch		Mean
	2008	2009		2008	2009	
T_1	13.00	15.73	14.37	12.49	11.80	12.15
T_2	13.47	16.50	14.99	12.50	12.10	12.30
T_3	14.80	16.52	15.66	13.20	12.12	12.66
T_4	15.30	16.51	15.91	13.10	12.50	12.80
T_5	15.57	16.53	16.05	13.11	12.60	12.86
T_6	15.80	17.03	16.42	14.05	12.70	13.38
T_7	16.71	17.20	16.96	14.10	13.50	13.80
T_8	15.50	16.53	16.02	13.00	12.62	12.81
T_9	17.77	18.20	17.99	14.30	14.60	14.45
T_{10}	16.70	17.50	17.10	14.21	14.50	14.36
T_{11}	16.20	17.00	16.60	14.11	13.40	13.76
S.E.±	0.0930	0.1062		0.0851	0.0833	
C.D. (P=0.05)	0.1905	0.2215		0.1775	0.1738	

Table 3 : Effect of drip fertigation and biofertigation on percentage of fruit set and yield per plant of coffee (*Coffea arabica*) CV. CHANDRAGIRI

Treatments	Percentage of fruit set		Mean	Yield per plant (kg)		Mean
	2008	2009		2008	2009	
T_1	65.50	72.77	69.14	2.19	2.51	2.35
T_2	67.50	81.00	74.25	2.40	2.82	2.61
T_3	66.00	83.40	74.70	2.48	2.83	2.66
T_4	67.25	84.10	75.68	2.57	2.92	2.75
T_5	70.20	86.20	78.20	2.76	2.99	2.88
T_6	70.30	86.72	78.51	3.00	3.20	3.10
T_7	80.00	86.75	83.38	3.19	3.35	3.27
T_8	70.10	86.71	78.41	2.93	3.14	3.04
T_9	88.50	89.00	88.75	3.79	3.93	3.86
T_{10}	87.50	80.53	84.02	3.32	3.37	3.35
T_{11}	77.00	86.70	81.85	3.15	3.37	3.26
S.E.±	0.561	0.417		0.024	0.044	
C.D. (P=0.05)	1.169	0.868		0.049	0.092	

in both the year 2008 and 2009 respectively. It was followed by the treatments T_{10} (Drip fertigation 100%RDF+Liquid bio fertilizers) and T_7 (Drip fertigation 100% RDF alone). The treatment T_{10} and T_7 recorded 16.70 and 17.50 numbers of branches and 14.21 and 14.50 numbers of nodes per branch during 2008 and 16.71 and 17.20 numbers of branches and 13.50 and 14.10 numbers of nodes during 2009 respectively. However, lower number of branches per plant (13.00 and 15.73 during 2008 and 2009) and number of nodes per plant (12.49 and 11.80 during 2008 and 2009). In the pooled mean analysis also the same treatment T_9 recorded the highest number of branches per plant (17.99) and number of nodes per plant (14.45). It was followed by T_{10} (17.10 number of branches per plant and 14.36 number of nodes per plant) and T_7 (16.96 number of branches per plant and 13.80 number of nodes per plant). Increased number of branches per plant and nodes per branch might be due to effective and efficient utilization of water and nutrients by the plants in fertigation treatments. Nitrogen being an important constituent of chlorophyll promoted the photosynthetic efficiency in the plant system when applied in optimum quantities might be resulted in higher number of branches and nodes per branch. These findings are in accordance with the findings of Pafli (1965) and Sivakumar (2007). Whereas the lowest number of branches per plant (14.37) and number of nodes per plant (12.15) were observed by T_1.

Significant influence on fruit set per cent and yield per plant was noticed with application of fertigation and bio fertigation. Application of 75 per cent RDF fetigation and bio fertigation (T_9) registered the highest fruit set per cent of 88.59 and 89.00 and yield per plant of 3.79 kg and 3.93 kg during 2008 and 2009. It was followed by 100 per cent drip fertigation and bio fertigation (T_{10}) which registered 87.50 and 80.53 per cent of fruit set and 3.32 kg and 3.37 kg of per plant yield during both the year 2008 and 2009, respectively. Whereas, the lowest fruit set per cent (65.50 and 72.77) and yield per plant (2.19 kg and 2.51 kg) was observed by the treatment T_1.

Similar results were also observed in the pooled mean analysis for the traits per cent of fruit set and yield per plant. The treatment T_9 (75 % RDF fertigation and bio fertigation) registered the highest fruit set % of 88.75 and yield per plant of 3.86 kg during both the year 2008 and 2009 respectively. It was followed by the treatments T_{10} (Drip fertigation 100%RDF+Liquid bio fertilizers) registered 84.02 per cent fruit set and 3.27 kg of fruit yield per plant. From the results, it was observed that application of 75 per cent RDF fertigation and biofertigation (T_9) recorded higher yield than 100 and 125 per cent of RDF NPK fertigation and bio fertigation which might be due to accurate and uniform application along with the amount and concentration of specific nutrient that can be adjusted depending on the crop need as reported by Baryosef and Sagiv (1982). Similar report also made by Thakur and Singh (2004) in mango. In fertigation treatments, fertilizers were applied in soluble form nearer to the root zone along with the required quantity of water avoiding percolation loss resulted luxurious growth and increased yield. In the present study increased yield was observed by the application of bio

fertilizers might be due to the increased activity of hormones *viz.,* IAA, GA and cytokinin produced by Azospyrillum would have influenced the flower development and fruit development which inturn increase the yield. The yield increase due to Phosphobacteria inoculation was also reported by Gaur (1985). However the lowest fruit set per cent (69.14) and yield per plant (2.35 kg) was recorded by T_1 (absolute control).

Conclusion :

From the results it was inferred that drip irrigation in coffee has significant influence on growth and yield. Application of 75 per cent of recommended dose of fertilizers as water soluble fertilizers through drip irrigaton along with liquid bio fertilizers showed significant increase on plant height, number of branches per plant, number of nodes per branch, fruit set per cent and yield in coffee cv. CHANDRAGIRI.

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