HIGH DENSITY PLANTING DESIGNS AND CANOPY ARCHITECTURE MANAGEMENT PRACTICES FOR IMPROVING COFFEE PRODUCTIVITY IN WESTERN GHATS OF KARNATAKA

C. BABOU*, RUDRAGOUDA, KISHOR MOTE, NAGARAJ GOKAVI, A. N. MANJUNATH AND Y. RAGHURAMULU

Central Coffee Research Institute, Coffee Research Station Post - 577 117

e-mail: kcbabou@gmail.com

ABSTRACT
Multi location field experiments were initiated with an objective to standardize suitable planting designs and pruning methods to get sustainable yield in arabica coffee. Results revealed that adoption of high density planting system like hedge row system with training on multiple stem training without topping and cyclic pruning after each harvest recorded significantly higher yield attributes such as number of bearing nodes per branch and higher clean coffee yield (1473 kg/ha) and followed by hedge row system with training on single stem system and rock-n-roll pruning and square system of planting at closer spacing with training on multiple stem training without topping and cyclic pruning after each harvest (1399 and 1354 kg/ha respectively). The same treatment combination showed significantly lesser incidence of leaf rust and coffee white stem borer (3.01 and 3.30 % of plant population/ha respectively) compared to the control (9.37 %).

INTRODUCTION

Higher density of planting has been used in coffee plantations in order to increase yield. Several studies (Braccini *et al.*, 2005 and Pereira *et al.*, 2007) have shown that greater yields per unit area are achieved due to the increase in the number of plants per area. Under reduced spacing conditions, plants produce thinner stems and smaller canopy diameters when compared to plants grown on a wider spacing (Martinez *et al.*, 2007 and Rajbir, *et al.*, 2016).

Plant management in coffee plantations is an essential maintenance operation carried out for achieving potential yields and it involves training and pruning of the plants. Bush management is important to maintain optimum number of bearing nodes every year for achieving potential yields in a given variety. Canopy architecture may also indirectly minimize the build-up of pests and diseases (Basu and Amitava, 2014 and Rajbir, *et al.*, 2016). Recently, modified pruning methods such as cyclic and rock-n-roll pruning are practiced by few innovative planters (Raghuramulu, 2009 and Biradar *et al.*, 2012). Hence, this study was initiated to assess the influence of planting densities and pruning methods on yield performance of *Coffea arabica* and monitor the pest and disease incidences.

MATERIALS AND METHODS

Multi location trials were initiated during 2006-07 in the main (Balehonnur) and sub-station (Chettalli) of Central Coffee Research Institute, Karnataka. Arabica coffee cv Chandragiri were used for these experiments and laid out with randomized complete block design (RCBD) with 7 treatments and 3 replications. Yield parameters, clean coffee yield, pest and disease incidences were recorded in 25 randomly selected plants for five consecutive years from 2010 to 2015. The data were subjected to statistical analysis as per the method of Gomez and Gomez (1984). Other cultural operations like fertilization, weed management and plant protection measures were practiced as per the recommendations of Coffee Guide (2014). The treatment details are;

T_1 : Square system of planting at recommended spacing (6′ x 6′) + training on single stem system + regular light pruning (Control).

T_2 : Square system of planting at closer spacing (5′ x 5′) + training on single stem system + rock n roll pruning of alternate rows once 3 - 4 crops.

T_3 : Square system of planting at recommended spacing (6′ x 6′) + training on single stem system + rock-n-roll pruning of alternate rows once 3 - 4 crops.

T_4 : Square system of planting at closer spacing (5′ x 5′) + training on multiple stem training without topping + cyclic pruning after each harvest.

T_5 : Hedge row system (6′ x 3′) + training on single stem system + rock n roll pruning of alternate rows.

T_6 : Hedge row system (6′ x 3′) + training on multiple stem training without topping + cyclic pruning after each

Table 1: Effect of different planting designs and pruning methods on yield attributes, clean coffee yield, coffee leaf rust and white stem borer (pooled data of five years from 2010 to 2015)

| Treatments | Yield attributes | | | | Clean coffeeyield (kg/ha) | | Number of plants affected (% of plants)/ha | | | |
| | Bush spread (cm)/plant | | No. of bearing nodes/branch | | | | Leaf rust | | White stem borer | |
	CCRI	Chettali	CCRI	Chettali	CCRI	Chettali	CCRI	Chettali	CCRI	Chettali
T_1	127	118	6	4	875	604	228 (7.63)	257 (8.60)	280(9.37)	250 (8.36)
T_2	148	140	11	9	1336	876	194 (4.51)	196 (4.55)	206 (4.79)	191 (4.44)
T_3	135	129	9	7	935	724	201 (3.07)	215 (3.28)	218 (3.33)	197 (3.01)
T_4	156	148	14	12	1354	890	183 (4.25)	199 (4.62)	206 (4.79)	190 (4.42)
T_5	168	161	17	15	1399	1010	181 (3.03)	194 (3.25)	205 (3.43)	184 (3.08)
T_6	175	166	20	17	1473	1091	180 (3.01)	188 (3.15)	197 (3.30)	178 (2.98)
T_7	149	137	10	8	1295	866	192 (3.48)	200 (3.63)	203 (3.68)	189 (3.43)
SEm±	4.7	4.1	0.8	0.8	41.6	53.6	9.3	5.5	5.7	6.6
CD (0.05)	14.4	12.7	2.4	2.5	128.3	165.3	28.8	16.9	17.6	20.4

harvest.

T_7 : Paired row system* (3' x 6' x 7') + training on single stem system + rock-n-roll pruning of alternate rows once 3-4 crops. *(Inter row x Intra row x Between paired rows).

RESULTS AND DISCUSSION

Coffee yield and yield attributes

High density planting system such as hedge row system of planting (T_5 & T_6) with modified canopy pruning treatments like cyclic (T_4 & T_6) / rock-n-roll (T_2, T_5 & T_7) recorded higher yield attribute like bush spread (cm)/plant and number of bearing nodes/branch (Table). Among the different treatments, hedge row system (6' x 3') with training on multiple stem training without topping and cyclic pruning after each harvest (T_6) recorded significantly higher clean coffee yield (1473 kg/ha) and followed by hedge row system (6' x 3') with training on single stem system and rock-n-roll pruning of alternate rows (T_5) and square system of planting at closer spacing (5' x 5') with training on multiple stem training without topping and cyclic pruning after each harvest (T_4) (1399 and 1354 kg/ha respectively). Higher clean coffee yield was achieved in hedge row system of planting and this might be due to higher plant population (6050 plants/ha) and it is more amenable for farm operations as each plant can be reached easily and more utilization of air and sunlight from the natural system. The high density of plants in a unit area helps in assured higher production levels (Dalal *et al.*, 2013; Pratibha and Goswami, 2013; Pandey *et al.*, 2015 and Arti Sharma *et al.*, 2016). The least clean coffee yield was observed in control treatment (875 kg/ha). Similar trend has been observed in field trail at Chettalli and showed that adoption of hedge row system of planting design with canopy management practices such as cyclic/rock-n-roll pruning (Table).

Pest and disease incidences

Results revealed that high density planting method such as hedge row system of planting (T_5 & T_6) with cyclic (T_4 & T_6) / rock-n-roll pruning (T_2, T_5 & T_7) recorded significantly lesser coffee white stem borer and leaf rust incidence (Table). Among the treatment combinations, hedge row system with training on multiple stem training without topping and cyclic pruning

after each harvest (T_6) recorded significantly lesser incidence of leaf rust (3.01) as well as white stem borer (3.30). Similar trend has been observed in experiment at Chettalli. This may be due to maximum bush spread acts as barrier for white stem borer. Modified canopy architecture may also indirectly minimize the build-up of pests and diseases (Babou *et al.*, 2013 and Basu and Amitava, 2014).

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