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Studies on Nutrient Management of Bird's Eye Chilli Under Rubber Based Agroforestry System

Siddappa Kannur*, S. J. Patil[1] and S. S. Inamati

Department of Silviculture and Agroforestry, College of Forestry, Sirsi -581401, Karnataka, India; [1]University of Agricultural Sciences, Dharwad - 580 005, Karnataka, India
*E-mail: siddakannur@gmail.com

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ABSTRACT

Influence of organic manures and biofertilizers on growth of intercrop under different aged plantations in agroforestry system is lacking. Therefore, a field experiment on influence of age and practices on rubber and nutrient management of intercrop on growth parameters of bird's eye chilli (BEC) under agroforestry system was conducted in Soraba taluka of Shivamogga District, Karnataka, India during two successive years (2018 to 2019). In one year old and two year old rubber plants farm yard manure (FYM) was applied as organic input and NPK as inorganic practice and nine treatments consisting of different organic manures and biofertilizers combinations were applied on BEC grown as an intercrop. The results showed that practices followed on rubber had significant influence on some of the growth parameters of BEC for both years studied. The BEC plants treated with combined application of FYM, *Azotobacter* and phosphate solubilizing bacteria (PSB) registered highest in all growth parameters of BEC as compared to the rest of the treatments. Thus, combined use of FYM, *Azotobacter* and PSB on BEC under organic practice on rubber at two year old rubber plantation proved better in improving the growth parameters of BEC under agroforestry system.

Key Words:

Agroforestry, Biofertilizers, Growth parameters, Intercrop, Nutrient management.

INTRODUCTION

Bird's eye chilli (*Capsicum frutescens*. L) commonly known as suji menasu in Kannada, a small perennial herb grown as homestead crop in coastal areas of Kerala, Karnataka, Tamilnadu and north eastern states. Its fruits are small, pointed of high pungency, and are used to extract oleoresin for food and pharmaceutical

industries. It is also used for curry powder, pickle, paste and hot sauces, apart from its medicinal use (Chatterjee et al. 2012). Due to high pungency and medicinal values, dry pod fetches Rs 750 to 850 per kg. Bird's eye chilli is mainly grown as neglected homestead crop due its wild habitat and lack of awareness among the farming community. So efforts are required to promote it's cultivation on a large scale.

Rubber (*Hevea brasiliensis* Muell. Arg), primary source of natural rubber in the world, is a fast growing and one of the important constitute of agroforestry system. It is commercially and environmentally friendly cash crop mainly grown for industrial production of latex. Rubber wood is used for making diverse products such as toys, furniture and packing material constituting an additional fixed carbon sink (Anonymous 2016).

Silvi-horticulture system mainly focuses on higher income per unit area. Well maintained and established agroforestry systems bring better returns than field crops from the same piece of land. The farmer can practice intercropping during the early stages of rubber tree where the land area is not fully occupied by the rubber plant, interspace and other critical resources are available in excess which are to be made use judicially. The interspace can be utilized for growing economic horticultural crops such as bird's eye chilli which will help the farmer to generate additional income. Further, incorporation of organic manures, biofertilizers and inorganic fertilizers in rubber based agroforestry system may improve the growth of both tree and crop components in the system. Keeping above in view, the study was formulated to evaluate the effect of organic manures on rubber tree and different doses of organic manures and biofertilizers on growth of BEC intercropped under two different aged rubber plantations.

MATERIALS AND METHODS

Study site

The present study was carried out in two aged rubber plantation viz., one and two year old, planted in the year 2015 and 2016 at 5 × 5 m spacing. Both the plantations were at farmer's fields of Harshi village of Sorab taluka, Shivmogga district, Karnataka. Bird's eye chilli (*Capsicum frutescens*. L) was planted as intercrop at 1 × 1 m spacing in between the rows of rubber plants. The experiment consisted of two main factors, two sub factors and nine sub-sub factors as detailed below.

Main factor: A_1 - One year old rubber plantation and A_2 - Two year old rubber plantation; ***Sub factor*** : P_1 - Organic practice on rubber - (12 t/ ha FYM - 1st year)- (24 t/ ha FYM - 2nd year), P_2 - Inorganic practice on rubber - (60:60:30 kg/ha NPK – 1st year), (Rubber Board recommendation) - (120:120:60 kg/ha NPK – 2nd year); ***Sub sub factor***: Nine (on bird's eye chilli) (having different organic manures and biofertilizers, their combination): T_1 - 100 kg of N/ha in the form of Farm Yard Manure (FYM), T_2 - 100 kg N/ha in the form of Vermicompost (VC), T_3 -100 kg N/ha in the form of Town Compost (TC), T_4 -100 kg of N/ha in the form of FYM + 10 kg /ha of PSB, T_5 -75 kg of N/ha in the form of FYM + 12.50 kg /ha of *Azotobacter,* T_6 -75 kg of N/ha in the form of FYM +10 kg of PSB + 12.50 kg of *Azotobacter,* T_7 -100 kg of N/ha in the form of FYM + 10.00 kg/ha Mycorrhiza, T_8 - Inorganic fertilizers (100:80:50 kg/ha of NPK), T_9 -Control (without any organic manure or biofertilizers).

The experiment was laid out in split split plot design with three replications. The inorganic fertilizers were applied to rubber in one split during June in the form of Urea (N), Rock phosphate (P) and Muriate of potash (K). Different doses of organic manures, biofertilizers and inorganic fertilizers were applied to bird's eye chilli plants after one month of transplanting in 2017-18. Same was repeated in June during 2018-19. Growth parameters such as height (cm), number of branches, plant spread (cm^2), number of leaves and leaf area (cm^2) was measured by using standard

procedure for 2018 and 2019 (9 months after treatment).

The data collected on various parameters during investigation were statistically analyzed using OP STAT data analysis software version (developed by CCS, HAU Hissar Haryana) using split-split plot design.

RESULTS AND DISCUSSIONS

The age levels and practices on rubber and nutrient management on BEC on growth parameters of BEC are presented Table 1, 2 and 3.

The BEC plants grown under two year old rubber plantation produced maximum height (59.31 cm), Plant spread (10.21 cm^2) and number of leaves / plant (103.75) for 2018 and number of branches (10.21 / plant and 10.85 / plant) and leaf area (38.13 cm^2 and 40.91 cm^2) for 2018 and 2019 respectively compared to grown under one year old rubber plants. While age levels had no significant role on height, plant spread and number of leaves for 2019. Good performance of BEC plants under two year old rubber plantation may be due to addition of more leaf litter which intern improves the soil physical and chemical parameters.

Among two practices on rubber, the BEC plants grown under organic practice (application of FYM) on rubber recorded maximum height (59.26 cm and 79.18 cm), number of branches (10.23 per plant and 10.68 per plant), plant spread (224.74 cm^2 and 286.38 cm^2) and leaf area (37.58 cm^2 and 40.87 cm^2) for the year 2018 and 2019 respectively, which were significantly higher than BEC plants grown under inorganic practice (application of NPK) on rubber, while number of leaves per plant (99.10) was more for 2018 only. Organic manuring is one of the important step in providing crops with their nutritional requirement without having any adverse impact on the environment (El- Sayed et al. 2002). Increase in growth attributes of intercrop due to addition of organic fertilization on tree crop might be attributed to the effect of organic fertilizer that helpful in modifying soil chemical, physical and biological properties through increasing CEC, organic matter, moisture holding capacity and mineral nutrients availability which enhances growth attributes. The results are in accordance with findings of El- Ghadban (1998) and Abo (2008). Sehgal and Thakur (2008) also reported increase in growth parameters of *Ocimum basilicum* and *Tagetes minuta* due to the application of organic fertilization with *Morus alba* hedgerows. The management strategies and various inputs used for rubber growth proved that it also helpful to intercrops (BEC plants) and increase growth parameters under rubber based agroforestry system.

Among nine different nutrient management treatments, the treatment consisting of combined application of FYM + *Azotobacter* + PSB (T_6) to BEC plants attained the higher height (73.50 cm and 95.85 cm), number of branches per plant (13.85 and 14.62), plant spread (266.57 cm^2 and 338.41 cm^2), number of leaves per plant (125.13 and 173.25) and leaf area (41.95 cm^2 and 46.59 cm^2) for the year 2018 and 2019 respectively followed by BEC plants receiving FYM + PSB (T_5) and least in all growth parameters was recorded by BEC plants received no manures (control) (T_9).

The results revealed that combined application of FYM + *Azotobacter* + PSB to BEC is best suited to BEC plants for higher growth attributes when compared to all other sources of nutrient management. Slow and steady release of available nutrients from FYM to the plant and more transfer to aerial roots and less retention in roots comparatively apart from supply of more nutrients from the soil for protoplasmic proteins and synthesis of some other compounds and microorganisms might have helped in organic manure decomposition thereby increasing the nutrients availability. Also bio-fertilizers might have helped in production of growth regulating substances, apart from making unavailable form of nutrients to available form, also supplemented by favourable micro climate which proved for increasing plant growth. This result confirmed with Jaipaul et al.

(2011) that among the organic manures, plots supplied with chicken manure (7.5 t/ha) + bio-fertilizer resulted maximum plant height (70.73 cm) in potato. On the other hand, Yeptho et al. (2012) concluded that poultry manure @ 20 t ha^{-1} along with application of *Azotobacter* resulted in highest plant growth. Similar results found by Singh et al. (2014), Singh et al. (2015) and Reddy et al. (2017) in *Capsicum annum* L.

Table 1. Growth parameters of BEC as influenced by age and practice on rubber and nutrient management on BEC under rubber based agroforestry system

Treatments	Height (cm)		Number of branches		Plant spread (cm^2)	
	2018	2019	2018	2019	2018	2019
Age levels (A)						
A_1 –One year old rubber	56.98	77.53	9.08	9.24	216.58	276.73
A_2 –Two year old rubber	59.31	78.96	10.21	10.85	227.01	291.39
SEm±	0.367	0.735	0.025	0.019	0.983	2.466
CD 5%	1.102	NS	0.156	0.120	2.950	NS
Practices (P)						
P_1 – Organic practice on rubber	59.26	79.18	10.23	10.68	224.74	286.38
P_2 – Inorganic practice on rubber	57.03	77.31	9.05	9.41	218.85	281.74
SEm±	0.167	0.187	0.052	0.066	0.684	0.407
CD 5%	0.503	0.562	0.156	0.198	2.051	1.220
Nutrient Management (NM) on BEC						
T_1 –Farm Yard Manure (FYM)	56.55	76.46	8.53	9.00	200.93	273.80
T_2 –Vermicompost (VC)	57.16	77.87	9.58	10.07	209.08	270.97
T_3 –Town Compost (TC)	49.76	72.90	7.22	7.52	199.88	272.02
T_4 –FYM + *Azotobacter*	59.18	83.28	10.02	10.42	216.23	274.86
T_5 –FYM + Phosphate Solubizing Bacteria (PSB)	63.04	86.18	11.38	11.77	246.34	335.05
T_6 - FYM + *Azotobacter*+ PSB	73.50	95.85	13.85	14.62	266.57	338.41
T_7 –FYM + Mycorrhizae	60.72	78.33	10.73	11.10	248.78	313.32
T_8 –NPK	59.82	77.34	10.36	10.56	260.18	311.99
T_9 –Control	43.58	55.99	5.12	5.36	148.19	166.11
SEm±	0.752	0.608	0.294	0.283	2.248	4.656
CD 5%	2.126	1.719	0.882	0.849	6.353	13.158

BEC – Bird's Eye Chilli

Among interaction between age levels and practices on rubber (A × P), all interactions were significantly differed for all growth parameters except number of leaves per plant for the year 2018, where interaction consisting of two year old having organic practice on rubber resulted in maximum height (59.93 cm), number of branches (10.68), plant spread of BEC (231.29 cm^2) and leaf area (40.46 cm^2) compared to rest of the interactions. No significant difference was noticed for the year 2019 for all growth parameters. Similarly interaction between age levels on rubber and nutrient management on BEC (A × NM), the interaction having two year old rubber with combined application of FYM, *Azotobacter* and PSB (A_2T_6) recorded maximum number of leaves per plant (133.63) at 2018 and height of 96.68 cm and leaf area of 47.20 cm^2 of BEC at 2019 closely followed by interaction having one year old rubber with combined application of FYM, *Azotobacter* and PSB (A_1T_6). This

indicates irrespective of age of the rubber, combined application of organic manure and biofertilizers helps in boosting growth of the BEC. The lowest performance was observed in two year old rubber with application of NPK (A_2T_9). Irrespective of year, rest of the growth parameters was on par with each other. No significant differences were found between interaction of practices on rubber and nutrient management on BEC (P x NM) and age and practices in rubber and nutrient management on BEC (A x P x NM).

Table 2. Leaf parameters of BEC as influenced by age and practice on rubber and nutrient management on BEC under rubber based agroforestry system

Treatments	Number of leaves / plant		Leaf area (cm^2) / leaf	
	2018	2019	2018	2019
Age levels (A)				
A_1 –One year old rubber	91.84	143.92	34.38	39.21
A_2 –Two year old rubber	103.75	145.01	38.13	40.91
SEm±	1.592	0.292	0.151	0.374
CD 5%	4.777	NS	0.454	1.123
Practices (P)				
P_1 – Organic practice on rubber	99.10	145.51	37.58	40.87
P_2 – Inorganic practice on rubber	96.48	143.42	34.93	39.25
SEm±	0.333	0.617	0.541	0.187
CD 5%	1.000	NS	1.622	0.562
Nutrient Management (NM) on BEC*				
T_1 –Farm Yard Manure (FYM)	103.97	161.48	36.07	41.09
T_2 –Vermicompost (VC)	111.58	162.04	38.62	44.76
T_3 –Town Compost (TC)	89.36	140.13	32.19	36.59
T_4 –FYM + *Azotobacter*	103.87	144.61	35.58	40.98
T_5 –FYM + Phosphate Solubizing Bacteria (PSB)	113.84	156.55	38.38	42.42
T_6 - FYM + *Azotobacter*+ PSB	125.13	173.25	41.95	46.59
T_7 –FYM + Mycorrhizae	110.29	159.35	37.01	40.09
T_8 –NPK	72.21	140.75	36.06	39.11
T_9 –Control	49.90	62.02	30.46	28.94
SEm±	2.255	3.052	0.572	0.605
CD 5%	6.372	8.625	1.617	1.710

*BEC – Bird's Eye Chilli

Table 3. Growth parameters of BEC as influenced by interaction effects of age and practice on rubber and nutrient management on BEC under rubber based agroforestry system

Treatments	Height (cm)	Number of branches	Plant spread (cm^2)		Leaf area (cm^2) / leaf
Interaction – A* × P*	2018	2018	2018	2019	2018
A_1P_1	58.59	9.79	218.20	278.17	34.71
A_1P_2	55.37	8.36	214.97	275.29	34.06
A_2P1	59.93	10.68	231.29	294.59	40.46
A_2P_2	58.70	9.75	222.73	288.19	35.80
SEm±	0.237	0.074	0.967	0.575	0.764
CD 5%	0.712	0.221	2.901	1.725	2.293

Treatments	Height (cm)	No. Of leaves	Leaf area (cm^2) / leaf
Interaction – A × NM*	2019	2018	2019
A_1T_1	75.81	97.67	39.05
A_1T_2	79.00	104.16	42.77
A_1T_3	71.35	83.99	35.08
A_1T_4	83.20	91.85	39.70
A_1T_5	86.05	106.92	43.38
A_1T_6	95.03	116.64	45.98
A_1T_7	76.63	101.59	39.64
A_1T_8	76.69	71.09	38.23
A_1T_9	54.04	52.67	29.07
A_2T_1	77.11	110.28	43.13
A_2T_2	76.74	119.00	46.75
A_2T_3	74.46	94.73	38.10
A_2T_4	83.35	115.88	42.27
A_2T_5	86.32	120.76	41.47
A_2T_6	96.68	133.63	47.20
A_2T_7	80.03	118.99	40.54
A_2T_8	77.99	73.32	39.98
A_2T_9	57.94	47.13	28.81
SEm±	0.860	3.189	0.856
CD 5%	2.432	9.012	2.418

*A - Age levels: P – Practices: NM - Nutrient Management on BEC:

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