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Nutrient Management and Carbon Sequestration Potential of Rubber-based Intercropping system in Western Ghat Region of Karnataka

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ABSTRACT

The present field experiment entitled 'Nutrient management and carbon sequestration potential of the rubber-based intercropping system in Western Ghat region of Karnataka' was conducted at farmers' field of Harishi village of Soraba taluka of Shivmogga District, Karnataka, India during 2017 to 2019. The experiment was laid out in split-plot design with three replications. Two practices applied on rubber was the application of Farm Yard Manure (FYM) as an organic practice and NPK as inorganic practice and nine treatments consisting of different organic manures biofertilizers and NPK as inorganic fertilizer was applied on Bird's Eye Chilli (BEC) grown as an intercrop. The results showed that application of NPK on rubber resulted in a maximum mean annual increment in basal diameter (0.56 cm) and crown diameter (0.28 m) in one-year-old rubber and height (0.77 m), basal diameter (0.62 m) crown diameter (0.21 m) in two-year-old rubber. Among nine treatment of BEC, application of NPK resulted in higher growth parameters of rubber at both age levels. Interactions were non-significant on all growth parameters. Age and different manures also influenced the carbon sequestration potential of the system. Hence the application of NPK may be recommended for cultivation of rubber

KEYWORDS

Agroforestry system, practices, carbon sequestration, Bird's Eye Chilli, rubber

INTRODUCTION

Rubber (*Hevea brasiliensis*), is a tree belonging to the family Euphorbiaceae, also known as the Para rubber tree after the Brazilian port of Para, a native of Amazon basin and introduced to countries of tropical belts of Asia and Africa during late 19th century. It is a quick-growing, fairly sturdy, perennial tree of a height of 25 to 30 meters. It has a straight, thick trunk, somewhat soft, light brownish gray bark.

Establishment of rubber plantation in India began only in 19th century. Thailand, Indonesia, Malaysia, India, Vietnam, China, Sri Lanka, Philippines and Cambodia are the world's largest producers of natural rubber. India stands fifth in the area (6.30%), fourth in production (890 thousand tonnes) and first in its productivity (1867 kg/ha). In Kerala, area under rubber production is 5,34,228 ha contributing to 83 per cent whereas in Karnataka the area under rubber is 26,035 ha in 2006-07 increased with an area of 50,410 ha in 2015-16, distributed in nontraditional rubber growing regions of Dakshina Kannada, Uttara Kannada, Kodagu, Udupi, Shivamogga and Chikkamagaluru (Pradeep, 2015). Looking at its high productivity, the area under rubber may increase in the years to come. In Uttara Kannada district, the area under rubber is increasing over the past few years, especially in the talukas of Mundgod, Sirsi and Siddapur.

Carbon sequestration can be defined as capture and secure storage of carbon that would otherwise be emitted to or remain in atmosphere (Rawat and Rawat, 2003). Agroforestry systems can play an important role in sequestration of carbon because of their higher capacity to assimilate atmospheric carbon. Apart from this, massive reforestation has been proposed as a means of stabilizing the concentration of carbon dioxide in the atmosphere, but the rate of deforestation in tropics is high and there is a growing need for additional land. Agroforestry offers a compromise solution because it increases the storage of carbon at the same time, may enhance agricultural production rather than compete with it (Nair *et al*., 2010).

Soil moisture, nutrients and light are the three important factors which influence growth productivity of trees. Among these resources, nutrients are most essential for plant growth. It is well known that the application of manures and fertilizers have a significant impact on the growth of plants, especially in the initial stages of establishment in the field. Proper management of nutrients helps to reduce nutrient losses from the soil and improve the nutrient availability for plant growth, which in turn boosts the productivity of land and plants. Hence fertilization is one of the key inputs to ensure healthy growth of rubber trees and maintain the nutrient balance of a rubber plantation (Bangqian *et al*., 2011). Inputs and management strategies used for the production of intercrops also benefitted tree crops under agroforestry systems. Several workers have studied the effect of application fertilization to intercrop on the growth of tree species. A similar attempt was made to know the effect of fertilization on rubber and different combination of organic manures and biofertilizers applied to intercrop (Bird's Eye Chilli) on the growth of rubber and carbon sequestration potential of treatments at a different aged rubber plantation.

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MATERIALS AND METHODS

The present research work entitled "Nutrient management and carbon sequestration potential of rubber-based intercropping system in Western Ghat region of Karnataka" was carried out at farmer's fields of Harshi village of Sorab taluka, Shivmogga district, Karnataka during 2017- to 2019. Two aged rubber plantation viz., one year old plantation, planted in the year 2016 and two year old plantation, planted in the year 2015 selected as woody perennial, which was planted at spacing of 5 × 5 m and bird's eye chilli (*Capsicum frutescens*. L) was planted as intercrop at a spacing of 1 × 1 m in between the rows of rubber plants.

The experiment consisted of two main factors on rubber and nine sub-factors on bird's eye chili as detailed below.

Main factor: Two

1. Inorganic practice on rubber - (60:60:30 kg/ha NPK – 1st year)
   (Rubber Board recommendation) (120:120:60 kg/ha NPK – 2nd year)
2. Organic practice on rubber – (12 t/ ha FYM - 1st year) (24 t/ ha FYM - 2nd year)

Sub factor: Nine (on bird's eye chili)

1. 100 kg of N/ha in the form of Farm Yard Manure (FYM)
2. 100 kg N/ha in the form of Vermicompost (VC)
3. 100 kg N/ha in the form of Town Compost (TC)
4. 100 kg of N/ha in the form of FYM + 10 kg /ha of PSB
5. 75 kg of N/ha in the form of FYM + 12.50 kg /ha of *Azotobacter*
6. 75 kg of N/ha in the form of FYM +10 kg of PSB + 12.50 kg of *Azotobacter*
7. 100 kg of N/ha in the form of FYM + 10.00 kg/ha Mycorrhiza
8. Inorganic fertilizers (100:80:50 kg/ha of NPK)
9. Control (without any organic manure or biofertilizers)

The experiment was laid out in split-plot design with three replications. The experimental field was prepared by ploughing the field twice and made smooth by harrowing followed by planking. The plots were prepared to accommodate all treatments as per treatment details. The inorganic fertilizers were applied in one split during June. Application of 60:60:30 kg/ha NPK to one year old plantation and 120:120:60 kg/ha NPK to two year old plantation of rubber in the form of Urea (N), Rock phosphate (P) and Muriate of potash (K) applied by making ring basin around each plant. Likewise, organic manure (FYM) was applied at the rate of 12 t/ha to the one-year-old plantation and 24 t/ha to the two-year-old plantation of rubber. After application, the basin was covered with soil.

Bird's Eye Chilli (BEC) was grown as intercrop in between rows of rubber plants at a spacing of 1 × 1 m. Six weeks old seedlings were transplanted in the experimental plots after allotting entries randomly in each replication. There was a total of nine treatments consisting of different doses of organic manures, biofertilizers and inorganic fertilizers were applied to bird's eye chili plants after one month of transplanting in 2017-18 and in June during 2018-19. The dose of FYM, VC and TC were applied by making ring basin around each plant. While applying a combination of FYM and biofertilizers, respective biofertilizer was thoroughly mixed with FYM and then applied. The inorganic fertilizers were applied in one split and in the form of Urea (N), Rock phosphate (P) and Muriate of potash (K) in one split.

Various growth parameters of rubber like height, basal diameter and crown diameter were taken at initial and end of the experiment. Mean annual increment (MAI) in various growth parameters, namely tree height (m), basal diameter (cm) and crown diameter (m) were computed by using the following formula. [E 2.1]

$$MAI = \frac{\text{Increment of tree}}{\text{Age of tree}} \qquad E\,2(1)$$

Carbon sequestration potential (t/ha)

Carbon sequestration potential of the agroforestry system was measured by using the non-destructive method in rubber trees and destructive method in bird's eye chili**.** The amount of carbon sequestration by rubber plantation was worked out by reducing the total biomass yield to its 42 percent as suggested by Ambily *et al.* (2012) and expressed in tonnes per hectare. Estimation of carbon in leaf litter (tha^{-1}) and organic carbon content of the soil (%) was carried according to Walkley and Black (1934) method. Finally, the carbon sequestration potential of each treatment in rubber-based agroforestry system was assessed.

RESULTS AND DISCUSSION

The mean annual increment of growth parameters of one-year-old rubber as influenced by the practices on rubber plantation (P) and nutrient management (NM) on BEC is presented in Table 1.

Inorganic application as a NPK on rubber recorded maximum mean annual increment of basal diameter (0.55 cm) and mean annual increment of canopy diameter (0.26 m) which differed significantly from application of organic nutrients (application of farmyard manure) on rubber (P_1) in all growth parameters studied (0.49 cm and 0.22 m, respectively). In general, application of inorganic nutrients on rubber increased all growth increments of rubber. No significant difference was observed for height increment among practices.

Application of different nutrients and their combination (NM) on BEC affected height and canopy growth increment of rubber during the study period. Addition of NPK (T_8) to BEC plants recorded highest mean annual increment of height (0.91 m) and mean annual increment of canopy diameter (0.28 m) of rubber. The significantly lower increment was recorded in control (T_9) (0.81 m and 0.10 m, respectively). Treatments found to be on par with each other for basal diameter increment.

Interaction effect of practices on rubber (P) and nutrient management on BEC (NM) indicated non-significant for the

Table 1: **Mean annual increment of rubber as influenced by practice and nutrient management in one year old rubber under agroforestry system**

Growth stage →	Mean annual increment in one year old rubber								
	Height (m)			Basal diameter (cm)			Crown diameter (m)		
Practices on rubber (P) → / Nutrient Management on BEC (NM)↓	P^1	P^2	Mean	P^1	P^2	Mean	P^1	P^2	Mean
T_1 – Farm Yard Manure (FYM)	0.80	0.88	**0.84**	0.48	0.57	**0.53**	0.24	0.28	**0.26**
T_2 – Vermi Compost (VC)	0.81	0.86	**0.84**	0.53	0.57	**0.55**	0.25	0.29	**0.27**
T_3 – Town Compost (TC)	0.82	0.84	**0.83**	0.52	0.54	**0.53**	0.25	0.26	**0.26**
T_4 – FYM + Azatobactor,	0.83	0.84	**0.84**	0.44	0.48	**0.46**	0.23	0.25	**0.24**
T_5 – FYM + Phosphate Solubizing Bacteria (PSB)	0.86	0.87	**0.87**	0.50	0.55	**0.52**	0.20	0.25	**0.23**
T_6 - FYM + *Azotobacter* + PSB	0.82	0.89	**0.86**	0.49	0.56	**0.53**	0.27	0.25	**0.26**
T_7 – FYM + Mycorrhizae	0.87	0.88	**0.88**	0.49	0.59	**0.54**	0.22	0.29	**0.26**
T_8 – NPK	0.89	0.94	**0.91**	0.50	0.62	**0.56**	0.27	0.29	**0.28**
T_9 – Control	0.81	0.81	**0.81**	0.49	0.47	**0.48**	0.07	0.13	**0.10**
Mean of P	**0.83**	**0.87**		**0.49**	**0.55**		**0.22**	**0.26**	

For comparing means of	SEM±	CD 5%	SEM±	CD 5%	SEM±	CD 5%
Main plot (P)	0.010	NS	0.006	0.021	0.007	0.022
Sub Plot (NM)	0.070	0.021	0.022	NS	0.008	0.025
Factor (NM) at same level of P	0.029	NS	0.010	NS	0.010	NS
Factor (P) at same level of NM	0.029	NS	0.029	NS	0.012	NS

BEC : Bird's Eye Chilli; P_1- Organic practice on rubber; P_2- Inorganic practice on rubber

mean annual increment of growth parameters of rubber during the study period.

The mean annual increment of growth parameters of two-year-old rubber as influenced by the practices on rubber plantation (P) and nutrient management (NM) on BEC is presented in Table 2.

Inorganic application as a NPK on rubber registered highest mean annual increment of height (0.76 m), mean annual increment of basal diameter (0.64 cm) and mean annual increment of canopy diameter (0.22 m) which differed significantly from application of organic nutrients (application of farm yard manure) on rubber (P_1) in all growth parameters studied (0.70 m, 0.56 cm and 0.13 m, respectively). In general, application of inorganic nutrients on rubber increased all growth increments of rubber.

Application of different nutrients and their combination (NM) on BEC affected only canopy growth increment of rubber during the study period. Addition of NPK (T_8) to BEC plants recorded highest mean annual increment of canopy diameter (0.21 m) of rubber which was on par with Addition of FYM + PSB (T_5) to BEC plants (0.20 m). The significantly lower increment was recorded in control (T_9) (0.14 m). Treatments did not differ for height and basal diameter increment.

Interaction effect of practices on rubber (P) and nutrient management on BEC (NM) indicated non-significant for the mean annual increment of growth parameters of rubber during the study period.

A higher value of growth attributes viz, basal diameter and crown diameter in one-year-old rubber plants and all growth attributes in two-year-old rubber may be attributed to the quick supply of nutrient in the form of NPK fertilizer which is essential for good growth, which in turn help in the production of higher canopy diameter. More canopy area will help in absorption of a higher amount of solar radiation, resulting in increased production of photosynthesis. Increased distribution of these photosynthates into the main stem ultimately resulted in highest height, basal diameter and crown diameter.

Inorganic fertilizers are easily available nutrients and application of these inorganic fertilizers in the immature phase of rubber showed good growth and early tappabiity (Watson, 1957). These results are in line with inventions of Kumar *et al*. (2017), who revealed that the maximum growth of *Casuarina equisetifolia* (tree height - 14.75 m, dbh – 28.10 cm and canopy width - 4.8 m) was obtained with application of NPK fertilizers over the different organic manures. Similar results were obtained by Karthikakuttyama *et al*. (2000) in rubber; Singh *et al*. (2001) in *Acacia auriculiformis*; Venkatesh and Kumar (2001) in silver oak (*Grevillea robusta*); Nageshwara Rao and Jessy (2007); Timkhum *et al*. (2013) in rubber (*Hevea brasiliensis*). Also, above results are in

Table 2: **Mean annual increment of rubber as influenced by practice and nutrient management in two year old rubber under agroforestry system**

Growth stage →	Mean annual increment in two year old rubber								
	Height (m)			Basal diameter (cm)			Crown diameter (m)		
Practices on rubber (P) → Nutrient Management on BEC (NM) ↓	P^1	P^2	Mean	P^1	P^2	Mean	P^1	P^2	Mean
T_1 – Farm Yard Manure (FYM)	0.74	0.76	**0.75**	0.57	0.64	**0.60**	0.14	0.21	**0.17**
T_2 – Vermi Compost (VC)	0.70	0.76	**0.73**	0.56	0.67	**0.62**	0.12	0.20	**0.16**
T_3 – Town Compost (TC)	0.68	0.74	**0.71**	0.53	0.65	**0.59**	0.14	0.19	**0.16**
T_4 – FYM + Azatobactor,	0.71	0.75	**0.73**	0.52	0.64	**0.58**	0.12	0.26	**0.19**
T_5 – FYM + Phosphate Solubizing Bacteria (PSB)	0.70	0.81	**0.75**	0.56	0.65	**0.60**	0.14	0.25	**0.20**
T_6 - FYM + *Azotobacter* + PSB	0.68	0.78	**0.73**	0.58	0.63	**0.61**	0.13	0.24	**0.18**
T_7 – FYM + Mycorrhizae	0.71	0.76	**0.73**	0.57	0.62	**0.59**	0.16	0.23	**0.19**
T_8 – NPK	0.75	0.79	**0.77**	0.58	0.65	**0.62**	0.17	0.25	**0.21**
T_9 – Control	0.69	0.72	**0.70**	0.58	0.62	**0.60**	0.10	0.19	**0.14**
Mean of P	**0.70**	**0.76**		**0.56**	**0.64**		**0.13**	**0.22**	

For comparing means of	SEM± (Height)	CD 5% (Height)	SEM± (Basal diameter)	CD 5% (Basal diameter)	SEM± (Crown diameter)	CD 5% (Crown diameter)
Main plot (P)	0.008	0.024	0.009	0.029	0.001	0.004
Sub Plot (NM)	0.020	NS	0.014	NS	0.006	0.018
Factor (NM) at same level of P	0.011	NS	0.013	NS	0.009	NS
Factor (P) at same level of NM	0.027	NS	0.020	NS	0.008	NS

BEC : Bird's Eye Chilli; P_1- Organic practice on rubber; P_2- Inorganic practice on rubber

conformity with findings of Dar and Newaj (2007) with *Albizia procera* tree grown in agri-silviculture system.

Inputs and management strategies used for the production of horticultural crops such as BEC also benefitted rubber and improved growth attributes like height in one-year-old rubber and canopy diameter of rubber in both aged plantations of rubber under rubber based agroforestry systems. Similar findings were observed by Singh *et al.* (2008 a & b). They observed that the yield of mango increased when intercropped with cereals. Ravitchandirane and Haripriya (2011) also reported that the growth and yield of mango intercropped with Aloe and Periwinkle was higher as compared to control. This is due to the fact that all the organic manure treatments and inorganic treatment for intercrops exerted a positive influence on the growth and yield of tree component under agroforestry system. The yield of crops and trees improved due to the synergism. Similar results were also reported by Kumar *et al.* (2017) in *Casuarina equisetifolia*.

The total carbon sequestration potential of one-year-old rubber plantation has been presented in Table 3 and was found higher in rubber plants grown with the addition of FYM as organic source (11.51 t/ha) as compared to rubber plants grown with the addition of NPK fertilizer

as inorganic source (11.31 t/ha). The observation related to carbon sequestration potential with respect to nutrient management on BEC at one-year-old rubber plantation revealed highest carbon sequestration potential was observed in BEC plants grown under combined application of FYM + Azotobacter + PSB (14.32 t/ha) followed by FYM + PSB treated BEC plants (13.01 t/ha) and poor performance was noticed in BEC plants treated with NPK fertilizer (7.92 t/ha).

At second-year-old rubber plantation, a similar trend was observed where BEC plants supplied with FYM + Azotobacter + PSB (15.05 t/ha) recorded highest carbon sequestration potential as compared to BEC supplied with NPK fertilizer (8.35 t/ha).

Good performance in carbon sequestration potential in rubber plants grown with the addition of FYM as organic source might be due to the presence of a higher amount of organic carbon in the soil. Higher growth attributes of BEC such as plant height, plant spread, leaf area, number of leaves and presence of a higher amount of organic carbon in the soil of BEC plants grown under combined application of FYM + Azotobacter + PSB might be the reason for the accumulation of maximum carbon sequestration potential.

The study of Shivanna *et al.* (2006) observed that at different growth intervals of Pongamia pinnata, as growth parameters with respect to height, DBH, crown diameter increased, the biomass yield and carbon sequestration potential also increased. Above results are in line with Shivanna *et al.* (2007)

Table 3: Carbon sequestration potential as influenced by practice and nutrient management at different ages of rubber under agroforestry system

Age levels →	One year old rubber plantation			Two year old rubber plantation		
Practices on rubber (P) → / Nutrient Management on BEC (NM) ↓	P1	P2	Mean	P1	P2	Mean
T_1 – Farm Yard Manure (FYM)	11.86	12.08	**11.97**	13.10	12.65	**12.88**
T_2 – Vermi Compost (VC)	12.61	12.32	**12.46**	13.42	13.16	**13.29**
T_3 – Town Compost (TC)	10.09	9.63	**9.86**	10.59	9.90	**10.25**
T_4 – FYM + Azatobactor,	12.10	12.15	**12.13**	12.95	12.65	**12.80**
T_5 – FYM + Phosphate Solubizing Bacteria (PSB)	13.51	12.51	**13.01**	13.80	13.50	**13.65**
T_6 - FYM + *Azotobacter* + PSB	14.36	14.27	**14.32**	15.53	14.57	**15.05**
T_7 – FYM + Mycorrhizae	12.37	12.14	**12.25**	13.32	12.71	**13.02**
T_8 – NPK	7.84	8.00	**7.92**	8.31	8.38	**8.35**
T_9 – Control	8.85	8.65	**8.75**	9.43	9.33	**9.38**
Mean of P	**11.51**	**11.31**	**11.41**	**12.27**	**11.87**	**12.07**

For comparing means of	SEm ±	CD 5%	SEm ±	CD 5%
Main plot (P)	0.030	0.091	0.095	NS
Sub Plot (NM)	0.182	0.528	0.136	0.395
Factor (NM) at same level of P	0.041	NS	0.286	NS
Factor (P) at same level of NM	0.243	NS	0.205	NS

BEC : Bird's Eye Chilli; P_1- Organic practice on rubber; P_2- Inorganic practice on rubber

in Dalbergia sissoo; Sone *et al.* (2014); José *et al.* (2014); Selma *et al.* (2014) in rubber.

No significant difference was noticed for carbon sequestration potential for practices followed on rubber at two-year-old rubber plantation and interaction between practices on rubber and nutrient management on BEC (P × NM) at both ages of rubber plantation.

REFERENCES

Ambily KK, Meenakumari T, Jessy MD, Ulaganathan A and Usha NN. 2012. Carbon sequestration potential of RRII 400 series clones of *Hevea brasiliensis*. *Rubber Science* **25**(2): 233-240.

Bangqian C, Jianhua C, Jikun W, Zhixiang W and Guishui X. 2011. Development and implementation of site specific fertilizer recommendation model based on nutrient balance for rubber plantation. *Agronomy Journal* **103**(2): 464–471.

Dar SA and Newaj R. 2007. Tree growth and biomass productivity of herbaceous layer under different pruning regimes in *Alblizia procera* based agrisilviculture system. *Range Management and Agroforestry* **28**: 108-110.

José AOC, Hernán JAC and Yeraldine VV. 2014. Potential of carbon storage of rubber (*Hevea brasiliensis*) plantations in monoculture and agroforestry systems in the Columbian Amazon. *Tropical and Subtropical Agroecosystems* **17**: 231-240.

Karthikakuttyamma M, Mercykutty J and Sasidharan NAN. 2000. Soils and nutrition. In: Natural rubber agro management and crop processing. Ed. George, PJ. and Kuruvilla JC. Rubber Research Institute of India, Kottayam, Kerala, pp. 171-198.

Kumar N, Rao OP, Singh M, Singh P and Khan S. 2017. Effect of fertilizer and organic manures on growth and yield attributes of wheat and paddy variety under casuarina (*Casuarina equisetifolia)* based agrisilviculture system. *International Journal of Pure Appled Bioscience* **5**(5): 879-887.

Nageshwara Rao DVK and Jessy MD. 2007. Impact of effective soil volume on growth and yield of rubber (*Hevea brasiliensis*). *Geoderma* **141**: 332 – 340.

Nair PKR, Nair VD, Kumar BM and Showalter JM. 2010. Carbon sequestration in agroforestry systems. *Advances in Agronomy* **108**: 237-307.

Pradeep KP. 2015. Effect of integrated nutrient management practices on early growth (2nd year) of rubber (*Hevea brasiliensis*) plantation. *M.Sc. Thesis*, Univ. Agri. Sci., Dharwad, Karnataka (India).

Ravitchandirane V and Haripriya K. 2011. Intercropping with medicinal plants in mango cv. Alphonso. *Plant Archives* **11**(1): 413-416.

Rawat V and Rawat L. 2003, Climate change mitigation approach through plantation forestry in India. *Indian Forester* **129** (7): 895-904.

Selma RM, Dalziza D, Oliveira C, Jamil M, Sonia MSS, Monique L and Claudia W. 2014. Potential carbon sequestration in rubber tree plantation in the north western region of Parana State, Brazil, *Acta Science Agronomy* **36**(2): 239-245.

Shivanna H, Parashurama J, Balachandra HC and Kyatappanavar S. 2007. Potential of *Dalbergia sissoo* in carbon sequestration. *MyForest* **43**(2): 173-178.

Shivanna H, Parashurama J, Balachandra HC and Kyatappanavar S. 2006. Potential of *Pongamia pinnata* in carbon sequestration - an important biodiesel yielding plant. *MyForest* **42**(1): 5-11.

Singh BP, Ghosal S, Kumar P, Srivastava SC and Choudhary SG. 2001. Effect of fertilizer levels on plant growth and biomass production *Acacia auriculiformis*. *Indian Journal of Forestry* **24** (1): 38-42.

Singh RA, Shamim M, Singh PV, Singh MK and Pandey RK. 2008a. Agri and vege-horti systems with mango in gangetic alluvial tract of U.P. *Asian Journal of Horticulture* **3**(2): 226-228.

Singh RA, Shamim M, Singh PV, Singh MK and Pandey RK. 2008b. Cultivation of crops in association of mango under two tier system of agroforestry. *Asian Journal of Horticulture* **3**(2): 270-272.

Sone K, Watanabe N, Takase M, Hosaka T and Gyokusen K. 2014. Carbon sequestration, tree biomass growth and rubber yield of PB260 clone of rubber tree (*Hevea brasiliensis*) in North Sumatra. *Journal of Rubber Research* **17**(2): 115-127.

Timkhum P, Somsak M, Montree I and Krissada S. 2013. Nutrient assessment with omission pot trials for management of rubber growing soil. *Journal of Agricultural Science* **10**(5):10-19.

Venkatesh M and Kumar DM. 2001. Influence of nitrogen and phosphorus nutrition on initial growth of silver oak. *Indian Forester* **127**(9): 1061-1063.

Walkley A and Black TA. 1934. An examination of wet acid method for determining the soil organic matter and proposed modification of the chromic acid titration method. *Soil Science* **37**: 29-38.

Watson GA. 1957. Cover plants in rubber cultivation. *Journal of Rubber Researc. Institute. Malay*. **15**(1):2-18.

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