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Coconut based cropping system model with spices and tuber crops - A novel approach for higher economic return

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ABSTRACT

To improve the economic status of the coconut farmers and to make coconut cultivation profitable through adoption of coconut-based cropping systems, a three years field experiment was conducted at ICAR-All India Coordinated Research Project on Palms, HRS, Mondouri,BCKV under a 36 years old coconut plantation during the year 2016-2018 to develop a location-specific coconut-based integrated cropping system model along with its effect on coconut productivity and economic returns.The treatments comprised of seven models like Model-1 (M_1):Coconut+ Black pepper+ Sweet potato+ Onion, Model-2 (M_2): Coconut+ Black pepper+ Turmeric+ Elephant Foot Yam, Model-3(M_3):Coconut+ Black pepper+Ginger+ Colocasia, Model-4(M_4): Coconut+ Black pepper+ Coriander+ Sweet Potato, Model-5 (M_5): Coconut+ Black pepper+ Chilli, Model-6 (M_6): Coconut+ Black pepper + Onion+ Potato and Model-7(M_7): Coconut (sole) in RBD with four replications. Yields were recorded for both the coconut and intercrops and economics were also worked out. Out of the seven models maximum projected mean nut yield of 18550 numbers ha^{-1} was recorded in the crop combination Coconut+Black pepper+Turmeric+Elephant Foot Yam (M_2) followed by M_3(18536.7numbers ha^{-1}). Yield of dry black pepper was recorded maximum of127.67 kg ha^{-1} in M_3 (Coconut+ Black pepper+ Ginger+ Colocasia). Even highest B: C ratio of 1.91 with a maximum net income of Rs.410018 ha^{-1} available land was also recorded in model M_3. The above system indicated that under coconut-based cropping system Black pepper, Ginger, Turmeric, Elephant Foot Yam can be grown successfully and out of the seven models M_3(Coconut+ Black pepper+ Ginger+ Colocasia) was more remunerative and recommended for West Bengal condition.

***Keywords*:** B: C ratio, black pepper, coconut, colocasia, EFY, ginger, turmeric

Coconut farming gradually is becoming non-profitable enterprises due to fluctuation of coconut, copra and coconut oil prices. As a result, to improve the economic status of the coconut farmers and to make coconut cultivation profitable adoption of coconut based multiple cropping systems is a viable option. Coconut (7.5m x 7.5m) palms being widely spaced, provides sufficient scope for intercropping of different annual and perennial crops. Growing of different crops inside the coconut garden is an age-old practice and this idea is evolved in response to the pressure of shrinking land resource base coupled with a high population density, which necessitated a conscious attempt by farmers to achieve their goals by living within biophysical, ecological, and economic constraints. Maheswarappa *et al*. (2000) reported that based upon the rooting pattern of coconut over 95 per cent of the roots are found in the top 0-120 cm, of which 19 and 63 per cent of roots are confined to 0-30 cm top portion of the soil within a depth of 30-90 cm, respectively. The active root zone of a coconut tree is confined within the radius of 2 meters from the bole and coconut root footage only in 25 per cent of the land surface laterally (Rethinam, 2001).Therefore, the remaining 75 per cent of the land area can be used effectively for raising of intercrops. Cropping systems aim at crop diversification and intensive cropping in interspace available in the coconut and utilization of available natural resources like soil, water, light and other inputs such as fertilizers, labor etc., are efficiently utilized to produce nuts, edible and non-edible products in a profitable way. High-density multi-species cropping system (HDMSCS) involving several species of seasonal, annual, and perennial crops thus evolved to meet their demands and to achieve highly efficient use of resources (Bavappa *et al*., 1986). The choice of crop components are mostly influenced by the household preferences and also by climatic requirements and dietary habits.With this idea the technique of growing intercrops in coconut plantation has already been standardized by Nelliat (1979). In coconut gardens, the utilization of photosynthetically active radiation is 40 per cent and soil space is 23 per cent where the rest can effectively be tapped through companion crops (Shanmugasundaram and Subramanian, 1993). Growing of seasonal, annual and perennial crops in the interspace of coconut was reported

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remunerative by many researchers (Nair, 1979; Liyanage, 1974 ; Bavappa, 1976; Varghese *et al*., 1979; Santhirasegaram, 1967 and Shanthamallaiah *et al*., 1982). The basic natural resources like soil and sunlight available in coconut garden are not fully utilized under mono-cropping system. Intercropping is one of the agronomic strategies for efficient utilization of resources other than higher farm income. Considering the above the following experiment on coconut-based cropping system model with spices and tuber crops was conducted with the following objectives:

- To develop location specific coconut based integrated cropping system model for different agro-climatic regions
- To assess the effect of the cropping system model on the productivity of coconut
- To work out the economics of the model

MATERIALS AND METHODS

The experiment was laid out in RBD with four replications in COD X WCT experimental plot of AICRP on Palms, HRS, Mondouri, BCKV of a 36 years old plantation during July 2016-June 2018. The experimental site comes under the subtropical humid climate, situated at 23.5^0 N latitude and 89^0 E longitude with an average altitude of 9.75 meters above MSL. The soil of the experimental site was clay loam, well-drained with p^H6.6. The treatments comprised of intercropping of coconut in seven models like Model-1(M_1): Coconut+Black pepper (BP)+Sweet potato+ Onion, Model-2(M_2): Coconut+Black pepper+ Turmeric+ Elephant Foot yam (EFY), Model-3 (M_3): Coconut+Black pepper +Ginger+ Colocasia,Model-4(M_4): Coconut+Black pepper+Coriander+Sweet Potato, Model-5 (M_5): Coconut+ Black pepper+ Chilli, Model-6 (M_6):Coconut+Black pepper+Onion + Potato and Model-7(M_7): Coconut (sole).Yields were recorded for both the coconut and intercrops.The economics were worked out accordingly to find out a feasible intercropping system in coconut plantation under new alluvial zone of West Bengal. FYM @ 15 tonnes ha^{-1} along with recommended dose of fertilizers like for coconut @ 88.5:43.75:132 kg NPK ha^{-1}as well as for other intercrops like EFY@100:80:100 kg NPK ha^{-1}, Potato @ 125:100:125kg NPK ha^{-1}, Onion @125 : 100:125kg NPK ha^{-1}, Sweet potato @ 40:80:120 kg NPK ha^{-1}.,Turmeric@60:50:120 kg NPK ha^{-1}, Ginger @62.5:25:25 kg NPK ha^{-1}, Black pepper @ 100:40:140kg NPK ha^{-1}, Colocasia@ 40:60:120 kg NPK ha^{-1}, Onion@ 150:80:80 kg NPK ha^{-1} and Coriander@20:40:20kg NPK ha^{-1} were applied as package of practices. All the required organic manures and inorganic fertilizers were applied in two equal splits during May-June and September-October months in case of coconut and black pepper and in case of elephant foot yam, turmeric, chilli and ginger 1st dose was applied at the time of land preparation and rest 28-30 days after planting in the month of April and in case of onion, potato, sweet potato and coriander 1st dose was applied at the time of land preparation and rest 28-30 days after planting during mid-December in each year. Cultural operations and other plant protection measures were also undertaken as per the need of the cops. Observations on yield of the base crop as well as the intercrops, cost of inputs used and economic returns as per prevailing market prices, B: C ratio etc., were recorded and analyzed during the season.The coconut equivalent yield (CEY) of intercrops, system productivity as well as economics was worked out for different crops based on prevailing market price of input (Naveen Kumar *et al.,* 2017).

$$\text{Coconut equivalent yield of inter crops (Kg ha}^{-1}) = \frac{\text{Yield of intercrop}\left(\frac{\text{kg}}{\text{ha}}\right) \text{x Market price of intercrop}\left(\frac{\text{Rs}}{\text{kg}}\right)}{\text{Market price of coconut(Rs / kg)}}$$

$$\text{Total system productivity} = \text{Yield of coconut (Nuts ha}^{-1}) + \frac{\text{Yield of intercrop}\left(\frac{\text{kg}}{\text{ha}}\right) \text{x Market price of intercrop}\left(\frac{\text{Rs}}{\text{kg}}\right)}{\text{Market price of coconut(Rs / kg)}}$$

RESULTS AND DISCUSSION

Three years mean data (2016-2018) presented in table 1 on projected yield of main crop (coconut) indicated that the nut yield realized in the coconut-based cropping system model did not differ significantly among the treatments during the study period.Out of the 7 models, under coconut-based cropping system maximum projected nut yield of 18536.6 numbers ha^{-1} was recorded in the model-3 (M_3- Coconut+Black pepper +Ginger+ Colocasia) followed by model-2 (M_2-. Coconut+Black pepper+Turmeric+ Elephant Foot yam (18550numbers ha^{-1}) and lowest coconut yield of 17880.5 numbers ha^{-1} was recorded in the crop combination of Coconut+Black pepper + Onion+Potato under model-6 (M_6). The nut yield indicated that over the years, there was marginal increase or decrease in the yield under all the treatments or models. The mean maximum projected yield of dry black pepper was

Table1: Mean annual production of different spice and tuber crops grown under coconut-based cropping system (2016-18)

Crops		Projected yield ha^{-1}				Coconut equivalent yield			
	Model	2016	2017	2018	Mean	2016	2017	2018	Mean
Coconut (no's)	M_1	18054.0	17948.0	17948.0	18550.0	-	-	-	-
	M_2	18851.0	18568.0	18231.0	18536.7	-	-	-	-
	M_3	18851.0	18528.0	18231.0	18089.7	-	-	-	-
	M_4	18054.0	17963.0	17523.0	17983.3	-	-	-	-
	M_5	18054.0	18043.0	17523.0	17880.5	-	-	-	-
	M_6	18054.0	18238.0	17523.0	17873.3	-	-	-	-
	M_7	18408.0	17807.0	18054.0	17846.7	-	-	-	-
Black Pepper (kg)	M_1	94.0	111.0	90.8	98.6	5170.0	5550.0	4535.0	5085.0
	M_2	89.0	137.6	113.0	113.2	4895.0	6881.0	5136.0	5637.3
	M_3	127.0	144.0	112.0	127.7	6985.0	3115.0	5091.0	5063.7
	M_4	98.0	67.4	91.0	85.5	5384.0	3208.0	4136.0	4242.7
	M_5	87.0	67.4	101.0	85.1	4785.0	3208.0	4591.0	4194.7
	M_6	85.0	67.8	92.0	81.6	4675.0	3227.0	4182.0	4028.0
Sweet potato (T)	M_1	7.2	7.6	6.8	7.2	8640.0	8129.0	9491.0	8753.3
	M_4	7.5	7.6	6.9	7.3	9000.0	10629.0	9491.0	9706.7
	M_5	6.5	7.4	6.9	6.9	7736.0	10629.0	9491.0	9285.3
Onion (T)	M_1	6.4	6.4	6.1	6.3	8680.0	6400.0	5564.0	6881.3
	M_6	5.0	6.4	6.1	5.8	7680.0	7314.0	5564.0	6852.7
Turmeric (T)	M_2	6.4	7.3	8.9	7.5	11556.0	11978.0	14544.0	12692.7
EFY (tonnes)	M_2	19.9	19.6	27.6	22.2	18840.0	26114.0	30054.0	25002.7
Ginger (T)	M_3	8.3	8.2	8.8	8.4	38272.0	34375.0	41364.0	38003.7
Colocasia (T)	M_3	5.8	9.6	8.2	7.9	4627.6	6982.0	7466.0	6358.5
Coriander (T)	M_4	0.6	0.6	0.6	0.6	3094.0	3091.0	2979.0	3054.7
Chilli (T)	M_5	2.4	2.4	2.3	2.4	9600.0	7963.0	7987.0	8516.7
Potato (T)	M_6	7.5	7.5	7.8	7.6	7500.0	7500.0	7800.0	7600.0

(M_1: Coconut+ Black pepper +Sweet potato+ onion, M_2: Coconut + Black pepper+ Turmeric+ Elephant Foot yam, M_3: Coconut Black pepper Ginger+ Colocasia, M_4: Coconut Black pepper Coriander+ Sweet Potato, M_5: Coconut+ Black pepper+ Chilli, M_6: Coconut + Black pepper + onion + Potato andM_7: Coconut (sole). (T means Tons). Average market price:Coconut@Rs10piece^{-1}, Onion@ Rs10 kg^{-1}, Potato @ Rs10 kg^{-1}, Sweet Potato @ Rs12 kg^{-1}, Ginger@ Rs46 kg^{-1}, Turmeric-@ Rs18 kg^{-1}, Chilli @ Rs40 kg^{-1}, Coriander-@ Rs 60 kg^{-1}, Colocasia-@ Rs8 kg^{-1}, Elephant Foot Yam @15 kg^{-1}, Black Pepper @Rs 550 kg^{-1}).

Table 2: System productivity (SP) & economics of coconut based cropping system model with spices and tuber crops (2016-18)

Models	SP	Cost of cultivation (Rs)				Gross income (Rs) (Inter crops + coconut)				Net income (Rs)				B:C ratio			
	Mean	2016	2017	2018	Mean	2016	2017	2016	Mean	2016	2017	2018	Mean	2016	2017	2018	Mean
M_1	38703	220951	206336	190452	205913	405440	411899	406281	407873	184489	205563	215829	201960	1.83	1.0	2.13	1.65
M_2	61883	309775	328489	329861	322708	650755	698949	747628	699111	340980	370460	417767	376402	2.10	1.13	2.27	1.83
M_3	67963	300277	349820	338562	329553	687351	737694	793669	739571	387074	387874	455107	410018	2.29	1.11	2.34	1.91
M_4	34851	200160	209141	168966	192756	360380	366341	375423	367381	160220	157200	206457	174626	1.80	0.75	2.22	1.59
M_5	39963	234372	244513	202914	227266	401754	418346	435509	418536	167382	173833	232595	191270	1.71	0.71	2.15	1.52
M_6	34653	218956	245261	214871	226363	377436	354816	354829	362360	158480	109555	139958	135998	1.72	0.45	1.65	1.27
M_7	18090	90490	99656	93194	94447	184080	186974	198594	189883	93590	87318	105400	95436	2.03	0.88	2.13	1.68

(M_1: Coconut+ Black pepper +Sweet potato+ onion, M_2: Coconut + Black pepper+ Turmeric+ Elephant Foot yam, M_3: Coconut Black pepper Ginger+ Colocasia, M_4: Coconut Black pepper Coriander+ Sweet Potato, M_5: Coconut+ Black pepper+ Chilli, M_6: Coconut + Black pepper + onion + Potato andM_7: Coconut (sole).Average market price: Coconut (dry) @Rs10 piece-^{1}, Onion@ Rs10 kg^{-1}, Potato @ Rs10 kg^{-1}, Sweet Potato @ Rs12 kg^{-1}, Ginger@ Rs46 kg^{-1}, Turmeric-@ Rs18 kg^{-1}, Chilli @ Rs40 kg^{-1}, Coriander-@ Rs 60 kg^{-1}, Colocasia-@ Rs8 kg^{-1}, Elephant Foot Yam @15 kg^{-1}, Black Pepper @Rs 550 kg^{-1})

registered under model-3 (127.7 kg ha^{-1}) and lowest in model-6 (81.6 kg ha^{-1}). The mean maximum projected yield of sweet potato per ha available land was recorded under model-4 (7.29 tons ha^{-1}) and minimum in model-5 (6.9 tons ha^{-1}). The highest mean projected yield of onion was recorded under model-1(6.31tonnes ha^{-1}) and lowest in model-6 (5.8 tons ha^{-1}).The system also recorded projected turmeric yield of 7.5 tonnes ha^{-1} available land in model-2 (M_2), elephant foot yam 22.2 tons ha^{-1} available land (M_2), ginger 8.4 tonnes ha^{-1}(M_3), colocasia 7.9 tonnes ha^{-1}(M_3), coriander 0.6 tonnes ha^{-1}(M_4), chili 2.4 tonnes ha^{-1}(M_5) and potato 7.6 tonnes ha^{-1}(M_6).

Coconut equivalent yield of intercrops and total system productivity

Coconut equivalent yield (CEY) of the intercrops and system productivity of coconut-based cropping system were worked out and is presented in Table 1 and 2. The three years mean coconut equivalent yield of intercrops showed a significant difference among the cropping sequences. Cropping sequence in M_3 (Coconut+Black pepper +Ginger+ Colocasia) recorded highest coconut equivalent yield of 38003.7 nuts ha^{-1}and system productivity(67963 nuts)followed by M_2sequence (Coconut+Black pepper+ Turmeric+ Elephant Foot yam.) with CYE of 25002.7 nuts ha^{-1}and system productivity of 61883 nuts, respectively. This higher coconut equivalent yield and higher system productivity in these cropping sequences may be attributed due to relatively better performance of the companion crops other than the main crop and also better market prices for their produce. As all these companion crops are long durational in nature needs regular irrigation for long time maintenance other than fertilizers which might have a positive effect on higher nut yield in these two sequences here. Similar increase in coconut equivalent yield in coconut-based cropping system was reported by Basavaraju *et al.* (2008) and Krishna Kumar *et al.* (2011).

From the economic analysis presented in Table 2, it has been observed that out of seven models, the model-3(Coconut+ Black pepper+ Ginger+ Colocasia) recorded maximum cost of cultivation (Rs. 329553 ha^{-1}available land), maximum gross income (Inter crops + coconut) of Rs. 739571ha^{-1}, mean highest net income (Rs.410018) and mean maximum Benefit Cost ratio (1.91). Hence, the model-3 was most remunerative. Ghosh and Bandyopadhyay (2011) also reported that Coconut+ black pepper+ pineapple (*e.g.*, Model-V) was more remunerative with the highest net return of Rs. 45600 ha^{-1} followed by Model-IV (Rs. 36050 ha^{-1}).

This result indicated that crop diversification could help the farmers to realize better returns even if the price

Table 3 : Nutrient status of different cropping system model

Models	N(kg ha^{-1}) Pooled	P (kg ha^{-1}) Pooled	K (kg ha^{-1}) Pooled
M_1: Coconut+Black pepper+Sweet potato+ onion	265.01	83.69	291.28
M_2: Coconut+Black pepper+ Turmeric+ Elephant Foot yam	271.23	84.47	291.88
M_3: Coconut Black pepper Ginger+ Colocasia	271.63	83.05	292.39
M_4: Coconut Black pepper Coriander+ Sweet Potato	267.97	82.91	288.32
M_5: Coconut+ Black pepper+ Chilli	268.30	83.55	291.28
M6: Coconut + Black pepper + onion+Potato	271.31	85.84	292.32
M_7:Coconut (sole)	268.08	82.48	290.88
SEm(±)	**0.28**	**0.20**	**0.37**
LSD(0.05)	**0.84**	**0.60**	**1.10**
Before experiment	**264.07**	**82.02**	**288.11**

of one commodity gets reduced in any year. Girijadevi and Muraleedharan Nair (2003) obtained higher net income by intercropping various combinations of component crops such as banana, ginger, turmeric, elephant foot yam and vegetable cowpea in coconut garden. Raveendran (1997) also reported that elephant foot yam and banana were found ideal as companion crops for coconut. Under coconut based high density multi species cropping system in root wilt affected garden, growing of tuber crops like amorphophallus, dioscoria and colocasia resulted in higher net income (Maheswarappa *et al*., 2003).

Soil nutrient status

Based upon the soil test analysis presented in table-3, it is clear that after completion of the experiment maximum nitrogen accumulation (271.63kg ha^{-1}) was recorded in the model M_3 followed by M_6 and M_2 (271.31 and 271.23kg ha^{-1}, respectively) which were at par with each other though before experiment it was recorded as 264.07kg ha^{-1}. Maximum P accumulations was recorded in the model M_6(85.84kg ha^{-1}) and maximum K accumulation was recorded in the model M_3 (292.39 kg ha^{-1}) followed by M_6 (292.32 kg ha^{-1}) which are at per with each other though before experiment it was recorded 288.11 kg ha^{-1}.

From the above tables it is clear that overall performance of the model Coconut+ Black Pepper + Ginger + Colocasia was excellent followed by Coconut + Black Pepper + Turmeric + Elephant Foot Yam. This may be due to introduction of partial shade loving high value long durational broad-leaved crop as companion crop in the coconut-based cropping system model which encouraged long durational management with a positive effect on soil moisture conservation in the root zone of coconut through natural mulching, the effect of which was reflected through increasing coconut yield other than yield of companion crops. Similar results were reported by MathewKutty and Kutti Krishan, (1989), Das (1991) and Nelliat (1979).

It is well accepted that intercropping system under coconut is more profitable than mono-cropping, which promises to the farmers with additional productivity of crops, besides additional employment generation. ginger, turmeric, colocasia, and elephant foot yam can be recommended as companion crop along with black pepper in coconut-based cropping system model for better economic return and Coconut +Black Pepper + Ginger + Colocasia combination was excellent in terms of B: C ratio (1.91) and Net income (Rs.410018 ha^{-1}).

REFERENCES

Basavaraju, T.B., Hanumanthappa, M., Kusagur, N. and Boraiah, B. 2008. Coconut based cropping systems for maidan tract of Karnataka. *J.Plantn.Crops,***36**: 98-102.

Bavappa, K.V.A., Abdul Khader, K.B., Biddappa, C.C., Khan, H.H., KasturiBai, K.V., Ramadasan, A., Sundararaju, P., Bopaiah, B.M., Thomas, G.V., Misra, L.P., Balasimha, D., Bhat, N.T. and ShamaBhat, K. 1986. Coconut and arecanut based high density multi-species cropping systems. *J.Plantn.Crops,***14**: 74-87.

Bavappa, K.V.A. 1976. Coconut in Indian economy. *Intensive Agric*.,**14**: 4-5.

Das, P.K. 1991$_b$. Economic viability of coconut based farming systems in India. *J. Plantn. Crops*, **19**: 191-201.

Ghosh, D. K. and Bandyopadhyay, A. 2011. Productivity and profitability of coconut based cropping systems with fruits and black pepper in West Bengal.*J. Crop Weed*,**7**:134-137.

Girijadevi, L. and Muraleedharan Nair, V.M. 2003. Economics of coconut based intercropping systems. *J.Plantn. Crops*, **31**: 45-47.

Krishna Kumar, V., Maheswarappa, H.P., Jayasekhar, S. and Shanavas, M. 2011. Economic evaluation of high-density multispecies cropping system in root (wilt) disease affected coconut *(Cocos nucifera*) area in Kerala. *J.Plantn. Crops,***39**: 125-130.

Liyanage, M. De S. 1974. Some useful guidelines towards organized intercropping. *Ceylon Coconut Planters Review,* **7:** 93-97**.**

Maheswarappa, H.P., Subramanian, P. and Dhanapal, R. 2000. Root distribution pattern of coconut in littoral sandy soil. *J. Plantn.Crops,* **28**: 164-166.

Maheswarappa, H.P., Anithakumari, P. and Sairam, C.V. 2003. High density multispecies cropping system for root (wilt) affected coconut garden - Its impact on productivity and economic viability. *J.Plantn. Crops,* **31:** 23-27.

MathewKutty, T.I. and KuttiKrishan, K.R. 1989. Banana: The best companion crop for coconut. *Indian Coco. J.*,**20**: 14-16.

Nair, P.K.R.1979.Intensive multiple cropping with coconuts in India: Principles,programmes and prospects. Verlag Paul-Parey, Berlin and Hamburg.pp.147.

Naveen Kumar, K.S., Maheswarappa, H.P. and. Basavaraju, T.B. 2017.Productivity and economic benefits of coconut based vegetable cropping systems under central dry zone of Karnataka. *J. Plantn.Crops,* **45**:49-56.

Nelliat, E.V. 1979. Multistoried cropping: In multiple cropping in coconut and arecanut gardens(eds.) E.V. Nelliat and K.S.Bhat, *Tech. Bull*. 3, CPCRI, Kasaragod, India pp. 39-41 on intercropping with different field crops in maidan tract of Karnataka. *Proc. PLACROSYM V*., Kottayam, India pp. 402-404.

Rethinam, P. 2001. Research output and farmers adoption of technology on coconut based farming system- The Indian experience. *Indian Coco. J.,***32**: 3-11.

Raveendran, C.S. 1997. Nutrient-moisture-light interactions in a coconut based cropping system. Ph.D. Thesis. Kerala Agricultural University, Trissur, Kerala.

Santhirasegaram, K. 1967. Intercropping of coconuts with special reference to food production. *Ceylon Coco. Planters Review,* **5:**12-24.

Shanmugasundaram,V.S. and Subramanian. 1993. Coconut based integrated farming systems. *Indian Coco. J.*, **24**: 3-4.

Shanthamallaiah, N.R., Gowda,T.N.V., Krishnamanohar, R. and Shivayogishwar, B., Subbiah, K., Helkiah, J., Ravi Kumar, V. and Rajagopal, C.V. 1982. Effect of the combined application of organic and inorganic fertilizers on yield and nutrient uptake of Chilli. *South Indian Hort.,***30**: 45-47.

Varghese, P.T., Nelliat, E.V. and Balakrishnan, T.K. 1979.Beneficial interaction of coconut cocoa combination. *Proc.PLACROSYM 1*, Kottayam, India.