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Effect of young tea (*Camellia sinensis* (L.) O.Kuntze) on arecanut yield in intercropping system

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Abstract
Experiment was laid out in Randomized Complete Block Design (RCBD) with five treatments and four replications, spacing of arecanut was followed 2.70 m X 2.70 m in both intercropping with tea and sole crop, experiment was carried out in the Department of Plantation Crops and Processing, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India, work was done during June 2016 to May 2017, treatments were like T_1(Arecanut + Tea (Control)), T_2(Arecanut +Tea (FYM@ 2.0kg+1/2 RDF)), T_3(Arecanut +Tea (VC@ 1.0kg+1/2RDF)), T_4(Arecanut + Tea(FYM@2.0kg+RDF)), T_5(Arecanut +Tea (VC@1.0kg+RDF)). In case of arecanut, fertilizers were applied in both inter cropping with tea and sole crop of arecanut given recommended dose of fertilizers i.e., NPK @ 100:40:140 g/palm/year. The experiment results showed positive effect of tea growing as inter crop in arecanut garden, where as inter cropping of arecanut with tea showed yield difference when compared with arecanut sole crop. However among the treatments T_5 (Arecanut + Tea ((VC@1.0kg+RDF)) recorded maximum arecanut yield, whereas minimum arecanut yield was recorded in treatment T_1 (Arecanut+ Tea (control)). When sole and intercrop yields were compared yield advantage was noticed in intercropped with tea due to congenial microclimatic conditions in arecanut based cropping system, improved microbial activity and soil fertility.

Keywords: Arecanut, farm yard manure, intercropping, sole crop, tea and vermicompost

Introduction
Arecanut (*Areca catechu* L.) is an important cash crop in the Western Ghats, Estern Ghats, East and North Easternregion of india. Areca plant is a tall stemmed erect palm, reaching varied heights, depending upon the environmental conditions. Production of arecanut in the world was about 10.33lakh tones from an area of 8.29lak hectares in 2009-2010, India ranks first in term of both area (47%) and production (47%) of arecanut. The economic part of the palm is called as 'betel nut' and is mainly used for masticatory purpose in many parts of Asia. It has several alternate uses and all parts of the palm are useful. It is essentially a crop of small and marginal holders with insufficient income to sustain dependent families. Arecanut with its compact crown, raised well above the ground (10–15 m), allows more sunlight to transmit to ground and maintains high humidity. Arecanut palms planted at a spacing of 2.7m x 2.7 m could use only 30% of the land area and roots were confined to only about 75 cm radius from the base of the palm Shama Bhat and Leela (1968) [14]. About 61% of all the roots and 51% of fine roots are concentrated within a radius of 50 cm from the trunk of the palm Shama Bhat and Leela (1969) [15], Nelliat *et al.*, (1974) [12]. The orientation and structure of arecanut canopy permits 32.7- 47.8% of incident radiation to penetrate down to the ground depending on spacing of arecanut, it was further reported that light interception varied between 57 to 64% in arecanut planted at 2.7m x 2.7 m, while it went up to 97.2% with the presence of intercrops Muralidharan (1980) [9]. Production and profitability of arecanut is undergoing significant changes during the last decade due to recurrent problems like erratic rainfall, pests, diseases and price fluctuations, the practice of well planned and executed inter/mixed cropping is fundamental for increasing the productivity and income per unit area. Inter cropping in arecanut gives ample scope to overcome the soil, weather and crop constraints by improving resource use efficiency, the beneficial effects of crop combinations, agro meteorology, fertility management, rhizosphere microorganisms, light use efficiency etc., should be considered to develop suitable crop combinations with arecanut Bavappa *et al.*, (1986) [2]. Initial period of 5-6 years is ideal for growing annual and biennial crops, in later years, mixed cropping with other shade tolerant crop species is advocated in arecanut garden. Intercropping in arecanut showed ample evidence for maximum resource use efficiency and generation of supplemental income

from the plantations Muralidharan (1980) [9]. There is ample evidence to show that arecanut as a sole crop does not utilize the natural resources and the importance of intercropping as a source of additional income during off-season and also as a safeguard against the uncertainties of returns from monoculture gardens, utilizing space and light fully (Shama Bhat and Leela 1969) [15].

Materials and methods

The experiment was laid out in Randomized Complete Block Design (RCBD) with five treatments (T_1 to T_5) and four replications (R_1 to R_4) for (Arecanut+ Tea), spacing of areca nut was followed 2.70 m X 2.70 m in both intercropping with tea and sole crop, age of areca nut palms 11years old when tea was interplanted in arecanut garden, the arecanut variety used for the study was Mohitnagar. A sole block of arecanut was maintained and this could not be included in the statistical analysis as sole crops. Whereas experiment was carried out in the Department of Plantation Crops and Processing, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal, India, work was done during June 2016 to May 2017, with the following treatments are T_1(Arecanut + Tea (Control)), T_2(Arecanut +tea (FYM@ 2.0kg+1/2 RDF)), T_3(Arecanut +Tea (VC@ 1.0kg+1/2RDF)), T_4(Arecanut + Tea(FYM@2.0kg+RDF)), T_5(Arecanut +Tea (VC@1.0kg+RDF)), planting material used for the experiment of tea was biclonal seed stock of TS-462 for tea, interplanted in arecanut garden with spacing of 110 cm X 60 cm (single hedge), maintaining a distance of 60 cm from the base of the arecanut palm. However, nutrients for the experiment was organic matter as farm yard manure (FYM@2.0 kg/plot) and vermicompost (VC @1kg/plot) only for tea, while recommended dose of fertilizers for tea [Young tea mixture (NPK:10: 5: 10) @ 200 kg/ha/year], as per recommendation of Tea Research Association (TRA). In case of arecanut, fertilizers were applied in both inter cropping with tea and sole crop of arecanut given recommended dose of fertilizers i.e., NPK @ 100:40:140 g/palm/year.

Results and discussion

I) fresh yield of arecanut (kg/palm and tons/ha)

Arecanut fresh yield both (kg/palm and tons/ha) was showed statistically significant difference among the treatments. Maximum fresh arecanut yield was recorded in the treatment T_5 (23.71kg/palm and 30.98 tons/ha), followed by T_4 (22.58 kg/palm and 28.90 tons/ha), and T_3 (21.49 kg/palm and 27.38 tons/ha), whereas minimum arecanut yield was observed in T_1 (19.97 kg/palm and 24.83 tons/ha). Inter cropping of arecanut with tea showed more yield, whereas sole crop yield was low (18.56 kg /palm and 23.03 tons/ha) when compared to the any inter crop treatment among the treatments.

Under inter cropping of arecanut with tea; arecanut yield was more when compared with sole crop yield of arecanut. There are several reports supporting the yield increase in arecanut due to inter or mixed cropping system. Tea did not showed adversely affect the yield of arecanut in the present study, Girish *et al*., (2003) [6] also reported that inter/mixed cropping in arecanut plantation has promoted more growth and yield of main crop of arecanut as indicated by increased number of leaves (fronds) and increased yield per palm compared to sole crop. Similar trends in yields were reported from an experiment conducted at Kannara (Kerala) from 1975-81 by Nair *et al*., (1985) [11]. In these condition arecanut might have been used the manures and fertilizers of tea apart from normal recommended dose of fertililizers to the arecanut.

II) Chali Yield (kg/ha)

Maximum Chali yield was observed in treatment T_5 (25.12 kg/ha), in case minimum chali yield was recorded in T_1 (20.46kg/ha), after treatment T_5, chali yield was recorded like treatment T_4 (23.82 kg/ha), T_3 (22.84 kg/ha) and T_2 (21.52 kg/ha). However chali yield was showed that significant difference among the treatments. Whereas, inter cropping of arecanut with tea showed that chali yield was given high when compared to the arecanut sole crop chali yield (19.35kg/ha).

The growing of tea as a inter crop with arecanut did not show any negative effects either on the growth or production of the latter in the present investigation. Similar observations were also recorded by Girish *et al*., (2003) [6] that yield of chali (processed nuts) revealed that, the mixed cropping systems such as T6 (Arecanut +Cordamom +Pepper) and T8 (Arecanut +Cordamom +Banana +Pepper) recorded higher yield than sole crop of arcanut and other systems of crop combinations also yielded similar magnitude of yield of mono cropping. Intercropping of MAPs in arecanut was found economical reported by (Sujatha *et al.*, 2011) [18].

III) Dry Kernel (kg/palm)

Dry kernel (kg/palm) was not statistically significant difference among the treatments. However arecanut dry kernel (kg/ha) was more in intercropping with tea, when compared to the sole crop (2.33 kg/palm). Maximum dry kernel was reported in treatment T_5 (3.43 kg/palm) whereas minimum dry kernel was reported in treatment T_1 (2.64 kg/palm) among the treatments.

Abdulkhader *et al*., (1992) [1] also reported satisfactory yield performance of arecanut in a study on the high density multispecies cropping systems including pepper banana cocoa clove coffee and pineapple. A similar positive trend on the yield of arecanut due to inter cropping was reported by (Muralidharan and Krishnamurthy 1985) [10].

IV) Fresh Nut Weight (g)

Fresh nut weight of arecanut was recorded more in intercropping with tea among the treatments when compared to sole arecanut nut weight (37.03 g). Fresh nut weight was showed significant difference among the treatments. However maximum arecanut fresh nut weight was observed in treatment T_5 (54.94 g), followed by T_4 (49.69 g), T_3 (45.29 g) and T_2 (43.07 g), whereas minimum arecanut fresh nut weight was observed in treatment T1 (40.46 g).

It was evident from Padma *et al*., (2018) [13] that growing of patchouli as intercrop in coconut recorded the highest nut yield followed by palmarosa compared with coconut mono cropping. This attributes to 55.3 per cent increase in nut yield/palm in intercropping system of coconut + patchouli followed by coconut + palmarosa (43.5 per cent) when compared to monocrop of coconut. Singh *et al.,* (2014) [17] also recorded similar trend in guava that, the flowering time was slightly advanced by 5-10 days due to intercropping as compared to sole crop of guava. It might be due to timely application of manures and fertilizers and irrigation to the intercrops. The percentage of fruit setting was also recorded higher in intercrop trees as compared to sole crop of guava, which clearly indicates that the intercropping of seasonal summer vegetables has no any adverse effects on flowering and fruiting of guava.

V) Volume (cc)

Arecanut volume was showed that significant difference among the treatments. maximum arecanut volume was recorded in treatment T_5(85.21 cc), whereas minimum arecanut volume was recorded in treatment T_1(70.90 cc) after treatment T_5, arecanut volume was recorded in treatment T_4(79.72 cc), T_3(77.83 cc) and T_2(74.48 cc). Coming to the inter cropping of arecanut with tea was showed more volume of arecanut when compared to the sole crop arecanut volume (67.14/cc).

The congenial microclimate due to intercropping with tea might have favored the growth and yield ofarecanut. However, similar observations were made by Maheswarappa (1997) [7] in intercropping systems of coconut + kacholam and coconut+ arrow root; and Ghosh *et al*., (2007) [5] in coconut + arrow root and coconut + sarpagandha. Increased nut yield of coconut when intercropped with herbal plants compared to pure coconut was also reported by Maheswari *et al.*, (1985) [8].

VI) Husk Fresh and Dry Weight (g)

Arecanut husk fresh and dry weight was almost similar to the intercropping of arecanut with tea when compared with sole crop of arecanut husk fresh and dry weight. Husk weight was not statistically significant difference among the treatments, however maximum husk fresh and dry weight (34.80g and 10.57g) was showed in the treatment T_5, followed by T_4(33.05g and 10.45g), T_3(33.38g and 10.11g) and T_2(30.94g and 10.09g) whereas minimum arecanut husk fresh and dry weight was recorded in the treatment T_1(29.77 g and 10.03g). However, Similar observations or slight reduction were also reported in yield of arecanut due to mixed cropping with banana and pineapple was reported by Singh *et al*., (1982) [16] from a study conducted in north Bengal region.

VII) Kernal Fresh and Dry Weight (g)

Kernel fresh and dry weight was not statistically significant difference among the treatments. Whereas maximum kernel fresh and dry weight was reported in treatment T_5 (15.03 g and 10.11 g) followed by treatment T_4 (14.76 g and 9.96 g), treatment T_3 (14.63 g and 8.93 g) and T_2 (14.55 g and 8.54 g), incase minimum kernel fresh and dry weight was reported in treatment T_1 (14.22 g and 8.49 g). Coming to the intercropping of arecanut with tea among the treatments showed similar observation when compared to the sole crop of kernel fresh and dry weight (14.58 g and 9.35 g). Sujatha *et al*., (2006), also reported that, the kernel yield of arecanut was not affected adversely due to intercropping of MAPs in initial years.

Table 1: Arecanut sole crop yield

Parameters	Values
Fresh yield (kg/palm)	18.56
Fresh yield (tons/ha)	23.03
Chali yield (kg/ha)	19.35
Dry kernal (kg/ palm)	2.33
Fresh nut weight (g)	37.03
Volume(/cc)	67.14
Fresh husk weight (g)	32.55
Fresh kernal weight (g)	14.58
Dry husk weight (g)	10.23
Dry kernal weight (g)	9.35

Table 2: Arecanut yield intercroping with tea

Treatments	Fresh yield (kg/palm)	Fresh yield (tons/ha)	Chali yield (kg/ha)	Dry kernal (kg/ palm)	Fresh nut weight (g)	Volume (/cc)	Fresh husk weight (g)	Fresh kernal weight (g)	Dry husk weight (g)	Dry kernal weight (g)
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean
T_1(Arecanut + Tea (Control))	19.97	24.83	20.46	2.64	40.46	70.90	29.77	14.22	10.03	8.49
T_2(Arecanut +tea (FYM@2.0kg+1/2 RDF))	20.31	26.16	21.52	2.86	43.07	74.48	30.94	14.55	10.09	8.54
T_3(Arecanut+Tea (VC@1.0kg+1/2RF))	21.49	27.38	22.84	3.02	45.29	77.83	33.38	14.63	10.11	8.93
T_4(Arecanut+Tea (FYM@1/2.0kg+RDF))	22.58	28.90	23.82	3.22	49.69	79.72	33.05	14.76	10.45	9.96
T5(Arecanut+Tea (VC@1.0kg+RDF))	23.71	30.98	25.12	3.43	54.94	85.21	34.80	15.03	10.57	10.11
SEM	0.77	1.24	0.94	0.26	2.32	2.36	2.28	0.79	0.64	0.58
C.D.(0.05)	2.37	3.81	2.89	NS	7.13	7.26	NS	NS	NS	NS

Conclusion

An experiment concluded that there was a positive effect of tea growing as inter crop in arecanut garden, where as inter cropping of arecanut with tea showed yield difference when compared with arecanut sole crop. However among the treatments T_5 (Arecanut + Tea ((VC@1.0kg+RDF)) recorded maximum arecanut yield, whereas minimum arecanut yield was recorded in treatment T_1 (Arecanut+ Tea (control)). When sole and intercrop yields were compared yield advantage was noticed in intercropped with tea due to congenial microclimatic conditions in arecanut based cropping system, improved microbial activity and soil fertility.

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