



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2020; 9(2): 1670-1674

Received: 10-01-2020

Accepted: 14-02-2020

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Evaluative performance towards coconut multispecies cropping system as mixed crop with noni (*Morinda citrifolia* L.), a underutilized medicinal species

Datta Nilanjana and Sarkar TapasDOI: <https://doi.org/10.22271/phyto.2020.v9.i2ab.11097>**Abstract**

The field experiment was carried out at coconut plantation AICRP on Palms, HRS Mondouri, BCKV, W.B during 2013 - 19 to study the performance of noni (*Morinda citrifolia* L.) as mixed crop with 26 years old coconut in a non-replicated trial. Noni plants of Seedling and Tissue cultured material were taken. Plant height (230.2cm) in seedling plant was higher than in tissue culture plant (398.23 cm) The fruit yields was also higher in tissue culture plants (9704.57 kg/ha) compared to seedling plants (8206.36 kg/ha) in the 5th year after planting. B:C ratio of Coconut and Noni from tissue culture plants was 2.41 whereas it was only 2.13 for coconut and Noni from seedling plants. Initial studies have revealed that noni can be grown in coconut plantation as mixed crop very well. This crop is an important medicinal crop this date and has potential of restoring livelihood of the farmers in W.B.

Keywords: Coconut, mixed crop, noni, tissue culture**Introduction**

Coconut (*Cocos nucifera* L.) is one of the most beautiful and useful palms in the world. The coconut palm rightly eulogized as *Kalpavriksha* or 'Tree of heaven', yields more products of use to the human race than any other tree of God's creations. Coconut is used as food (solid endosperm), refreshing coconut water drink (liquid endosperm), edible oil, confectioneries and non-edible byproducts (fiber and shell). It provides not only edible products but also fuel, shelter, medicine and employment to the millions of people in the tropics, playing vital role in the socio-economic condition of India. The growth habit and canopy configuration of coconut palms strongly support different coconut based cropping systems. One of the possible ways to step up production from the land under coconut and enhance the family income is to grow compatible annual or perennial crops in association with coconut. The coconut based crop systems evolved in response to the pressure of shrinking land resource base coupled with high population density which necessitated a conscious attempt on the part of farmers to achieve their goals by living with in biophysical, ecological and economic constraints (Maheswarappa *et al.*, 2013) [8]. Rooting pattern of mature coconut palms at 7.5 m x 7.5 m spacing also does not pose any problem for the uptake of nutrients and moisture from the soil by the compatible intercrops properly arranged in the systems, as the effective root zone of coconuts is confined mainly within a 2 m radius around its base and more than 85 per cent of coconut roots are found between 30 and 120 cm depth (Kushwah *et al.*, 1973) [12].

Noni (*Morinda citrifolia* L.) also called as Indian mulberry is a large shrub or small evergreen tree (Francis, 2003) [4], propagated through seedlings or tissue culture. Recently use of noni fruit juice as a dietary supplement has increased greatly worldwide. Noni can be cultivated in all soil types though loamy soils are ideal. The tree is free from major pests and disease infestations. The seedlings are to be planted at a spacing of about 3.75 X 3.75 m. The crop can survive with moderate irrigation and can survive even in drought conditions. It is reported to have a broad range of therapeutic effects including antibacterial, antifungal, antiviral, antitumor, anthelmintic, analgesic, hypotensive, anti-inflammatory (McKoy *et al.*, 2002) [14], and immune enhancing effects. Noni has been reported to reduce the symptoms of: Arthritis, Asthma, Blemishes, Broken Bones, Cancers (Hirazumi *et al.*, 1996) [9], Diabetes (Kumar, 2007) [13],

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According to Mohd *et al.*, (2001) [15], high anti-oxidant property of Noni helps to prevent the formation of carcinogen-DNA adducts. It was hypothesized that the antioxidants in Noni may have cancer protective effects by scavenging reactive High Blood Pressure, Headaches, Hair Loss & Impotency, Immune System Failure, Indigestion, Infections, Malignancies (Tumors), Pain, Toothache *etc.* Noni is the rich source of antioxidants, oxygen free radicals and quenching lipid peroxides. Nelson (2003) confirmed that Noni can grow in a wide range of light intensities, from 0% to over 80% shade. More than 40 Universities in the world are undertaking research on the health enhancing properties of this fruit.

A coconut plant acquires a unique leaf orientation and crop geometry, manifesting the growth of multiple cropping systems along with it. In coconut plantation approximately 75% (only 22.3% used) of land resource and 55% (45-50% used) of sunlight being not utilized by the coconut (Bavappa *et al.*, 1986) [2], encouraging the growth of intercrop, mixed crop and companion crop. Keeping the importance of noni and as it is a underutilized medicinal fruit plant (Singh *et al.*, 2005) [17] in West Bengal, a field experiment was carried out to study the performance of noni (*Morinda citrifolia* L.) as mixed crop with coconut.

Materials and Methods

The experiment was carried out in a 26 years old coconut (cv. East Coast Tall) plantation spaced at 7.5 x 7.5 m of AICRP on Palms at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, during 2013-19, to study the performance of noni (*Morinda citrifolia* L.) as mixed crop with coconut in a non-replicated trial. The research station is located at 23.5° N latitude and 89° E longitudes, with an altitude of 9.75 m above the mean sea level. The soil of the experimental field was Gangetic alluvial soil (Entisol) with sandy clay-loam texture, well drained, good water holding capacity and moderate soil fertility status with pH of 6.76. Two types of noni plants: i) Seedlings: 25 number and ii) Tissue culture material: 25 numbers were taken. They were planted in the middle line of inter space of coconut lines. A block of 8 palms were taken as coconut monocrop block. The observation on different growth parameters and yield of Noni were recorded from 15 randomly selected plants per type. Yield was taken on per plant basis at harvest. Scheduled agronomical management practices with fertilizer dose @ 500: 250: 750 g NPK/palm/year was followed in coconut under both intercropped and monocrop plots. Growth parameters and yield of coconut was also taken at monocrop plot and intercropped plot.



Plate 1: Growth parameters and yield of coconut was also taken at monocrop plot and intercropped plot

Results and Discussion

Growth, Yield and quality of noni

Different comparative morphological character of the plant is presented in Table-1. The Plant height was recorded higher in noni seedling (430.02cm) compared to noni plants with tissue cultured plants (398.23cm) at the 6 years of planting. This may resultant for faster growth of seedlings than tissue culture plants. Whereas number of Primary branches and secondary branches, plant spread were recorded maximum in tissue cultured noni plants (66.8, 68.80 and 4.01) compared to seedling (64.40, 50.23 and 3.57) respectively during 2018-19. These results is in corroborate with Subramani *et al.* 2007 that comparatively improved growth with zero percentage mortality was observed and micro propagation plants in noni. Significantly maximum number of noni fruits/plant was recorded in tissue cultured plants (703.76) compared to seedling (561.83). Whereas weight of noni fruits (kg/plant) was significantly lower in seedling Noni plants (23.06 kg plant⁻¹) compared to more observe in tissue culture plants (27.27 kg plant⁻¹) in coconut garden. Both kind of noni plants started flowering 12 months after planting. It yields 8206.36 kg ha⁻¹ and 9704.57 kg ha⁻¹ in seed grown plant and in tissue cultured plants respectively in the 6th year after planting. These results are further agreed with findings by Nelson (2003) that to obtain yield of 7 t/ha/year in second year after planting to 70 t/ha after fourth year of planting in noni. The Juice content was observed higher in tissue cultured plants (65.20) compared to lowest record in seedlings (64.65). Whereas maximum TSS was recorded in seedling (13.13) compared to tissue cultured plantlets (12.63) at the end of 6th year of planting.

Table 1: Morphological and Yield parameter of Noni from seedlings

Growth and yield parameters	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Plant Height (cm)	212.2	260.05	340	420.03	526.52	430.02
No. of primary branches/plant	7.1	18.5	37.8	55.9	63.8	64.4
No. of secondary branches/plant	-	-	24.97	41.93	47.10	50.23
Plant spread (m)	1.5	1.54	1.83	3.33	3.48	3.57
No. of fruits/plant	-	32.38	38.65	315.24	490.24	561.83
Weight of fruits (kg/plant)	-	0.18	0.79	14.91	19.80	23.06
Fruit yield (kg/ha) (356 plants/ha)	-	63.84	281.24	5307.51	7046.23	8206.36
Juice content (%)	-	-	58.22	79.61	70.61	64.65
TSS (OBrix)	-	-	10.48	14.33	14.22	13.13

Table 2: Morphological and Yield parameter of Noni from tissue cultured plants

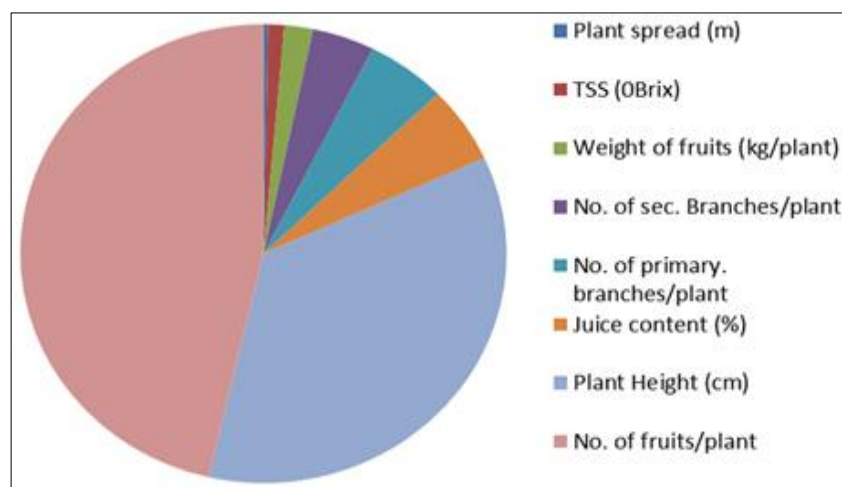
Growth and yield parameters	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
Plant Height (cm)	134.2	215.4	287.12	353.78	396.58	398.23
No. of primary. branches/plant	11.3	30.3	41.2	47.2	64.57	66.8
No. of secondary branches/plant	-	-	30.49	55.22	62.74	68.80
Plant spread (m)	1.24	1.52	2.47	3.78	3.89	4.01
No. of fruits/plant	-	67.99	69.54	397.31	552.68	703.76
Weight of fruits (kg/plant)	-	0.47	1.90	17.76	24.72	27.27
Fruit yield (kg/ha) (356 plants/ha)	-	166.69	676.4	6322.03	8797.11	9704.57
Juice content (%)	-	-	66.12	65.69	65.32	65.20
TSS (OBrix)	-	-	11.83	12.43	12.52	12.63

The comparative growth and yield performance of noni from both the sources (seedling and tissue culture) as a mixed crop in coconut is presented in Table 3 and Fig: 1. Similar findings have been recorded by Jassogne *et al.* (2013) in inter cropping of coffee with banana could be counter protective for their main crop yield. Maheswarappa *et al.*, (2017) ^[13]

recommended that adoption of noni as an intercrop in coconut plantation reported to be increase the yield of coconut by 131nuts/palm/year whereas it was only 105 nuts/palm/year when grown as coconut monocrop. Results analogous to those findings were also reported by Khandekar *et al.* (2014) ^[11] in coconut mixed crop with noni.

Table 3: Comparative growth and yield of Noni plants from seedlings and tissue cultured plants as a mixed crop in coconut garden

Growth and yield parameters	Plants from Seedlings (2018-19)	Plants from tissue cultured plants (2018-19)	F- test
Plant Height (cm)	430.02	398.23	NS
No. of primary. branches/plant	64.4	66.8	NS
No. of sec. Branches/plant	50.23	68.80	*
Plant spread (m)	3.57	4.01	*
No. of fruits/plant	561.83	703.76	*
Weight of fruits (kg/plant)	23.06	27.27	*
Fruit yield (kg/ha) (356 plants/ha)	8206.36	9704.57	*
Juice content (%)	65.65	64.50	NS
TSS (OBrix)	13.13	12.63	NS

**Fig 1:** Comparative growth and yield of Noni**Table 4:** Economic display (Rs /ha) of Noni based coconut multispecies cropping system (Mean of 2017-18 to 2018-19)

Particulars	Coconut + Plants from Seedlings	Coconut + Tissue culture plants	Coconut + Sloe crop
Yield of coconut (Nuts/palm)	97.5	97.8	81.1
Yield of coconut (Nuts/ha)	17021	17685.78	14052.03
Yield of Noni fruits (kg/plant)	21.43	26	0
Yield of Noni fruits (kg/ha)	7626.30	9250.84	0
Cost of cultivation (Rs./ha)			
1. Coconut	50000	50000	50000
2. Noni	42200	42200	0
Total	92200	92200	50000
Gross Return (Rs./ha)			
1. Coconut	187231	194543.58	154572.33
2. Noni	101354.10	120204.45	0
Total	288585.10	314748.03	154572.33
Net Returns (Rs./ha)	196385.10	222548.03	104572.33
B:C ratio	2.13	2.41	2.09

*the yield, return and B: C from noni will gradually increase and will be profitable up to 40 years

Economics

The economics of intercropping has been presented in Table 4. Economic assessment considering all inputs revealed that total variable capital requirement/ha i.e. cost of cultivation amounts to Rs. 92200 for coconut + noni (seedling and tissue culture plants' both) while the same for coconut monocrop was Rs. 50000/-. The gross return realization was Rs. 288585.1/- and 314748.03/- respectively from intercropping of seedling and tissue culture noni plants where because it was only Rs. 154572.33/- for coconut under monocrop. B:C ratio was recorded higher in tissue culture plants (2.41) compared to coconut with seedling (2.13), it was recorded 2.09 for sole coconut crop. Whereas net returns were higher in tissue culture plants (Rs 222548.03) compared to seedlings (196385.10). Similarly least net return was recorded in coconut with monocrop (Rs 104572.33). Similar findings have been observed by Singh, (2006) that five year noni plantation in bay islands gave a gross income of Rs.468750 with net income of Rs.200731. These results are in good agreement with Ghosh (2009) [5], Ghosh & Hore (2011) [7]. Intercropping will not in any way reduce the yield of coconut. However, the yield, return and B: C from noni will gradually increase and will be profitable up to 40 years. The net revenue from the coconut based cropping system combined with black pepper and banana with different nutrient management systems like application of RDF, coconut husk, mulching, biofertilizer, green manuring, vermicompost, vermish, ranged from ` 5,28,420 to 5,48,366, while the income from monocrop of coconut was Rs. 98,148 (CPCRI, 2019) [3]. Based on the market demand and soil prevailed, coconut growers can select any of the medicinal crops, grow them profitably as either intercrop or mixed crop in coconut plantation, and fetch additional return from their same coconut garden. Multispecies cropping system in coconut with organic nutrient management practices improves profit of farmer by five times (CPCRI, 2019) [3]. There was an accessory rate in coconut yield by growing noni as an intercrop in coconut garden in coastal agro-ecosystem. The present study indicates that noni is a profitable and sustainable mixed crop in a coconut plantation.

Table 5: The morphological and yield traits of coconut in the intercropping system of Noni with coconut (Mean of 2017-18 to 2018-19)

Growth/yield parameters	Coconut + Plants from Seedlings	Coconut + Tissue culture plants	Coconut (Sloe crop)
Number of leaves/palm	18.40	18.46	15.31
Number of bunch/palm	16.58	16.63	13.79
Nut yield/palm/year	97.5	97.8	81.1
Nut yield/ha/year	17021	17685.78	14052.03
Weight of nut (g)	1036	1038	987
Copra weight/nut (g)	165.76	166.08	157.92
Copra yield/palm (kg)	16.16	16.24	12.81

Yield of coconut

The morphological and yield attributes of the coconut as influenced by intercrop of noni is presented in Table 5. During experimental period coconut yield was 81.1 nuts/palm/year in monocrop block. In intercropped garden of seedling and tissue cultured noni plant's, coconut yield was increased to 97.5 and 97.8 nuts/palm/year respectively during 2017-19. Data indicates that nut yield increased during 2017-19 was to the tune of 20.22% under seedling noni plot and it was 20.59% under tissue culture noni plants compared to

mono cultured coconut yield. Similar findings were also reported by Khandekar *et al.* (2014) [11] in coconut intercrop with noni. Variations with respect to annual leaf, bunch and nut production were recorded under monocrop and intercropping system (Table 5). The plants under intercropping with seedling and tissue culture noni, produced more number of leaf (18.40, 18.46 respectively) as compared to 15.31 in monocropping, bunch (16.58, 16.63 respectively) higher than in monocropping (13.79), indicating the positive influence of companion crops on growth and yield of coconut (Ghosh *et al.*, 2007). Variation of nut weight, copra weight and copra yield under seedling and tissue culture plants were also recorded. Intercropped coconut plantation with seedling and tissue culture noni, nut weight (1036, 1038 g), copra weight (165.76, 166.08 g) and copra yield/palm/year (16.16, 16.24 kg) respectively were observed more as compared to monocropping. It was observed that coconut yield per ha under monocropping was 14052.03 nut/ha/year whereas yield was 17021 nut/ha/year and 17685.78 nut/ha/year under intercropping system, suggesting that companion crops in the coconut garden did not affect the yield of base crop but increased the productivity as a whole as recorded earlier (Chowdhury and Deka, 1997).

The additional increment in coconut yield under intercropping of noni might be resultant to the collegial effect of crop combination and biomass from the noni plant. Research conducted at ICAR-CPCRI and AICRP centers found that intercropping promoted the coconut productivity due to additional application of nutrient and water management to the intercrop (CPCRI 2014, AICRP 2014). Intercropping with herbal plants in coconut augmented the nut production than coconut without intercrop/mixed crop due to supplementary upshot of intercropping within the coconut garden (Thiruvarasan and Maheswarappa 2014)

Table 6: The leaf biomass addition from Noni plants in coconut garden

Sl. no.	Planting material	Biomass addition (kg/plant)			Biomass addition (kg/ha)		
		2017-18	2018-19	Mean	2017-18	2018-19	Mean
1	Plants from Seedlings	2.93	3.43	3.18	1043	1221	1132
2	Tissue culture plants	3.07	4.07	3.57	1092	1448	1270

The supplementation of leaf biomass from noni plants of both the source (seedling and tissue culture) is presented in Table-6. Biomass addition was higher in tissue cultured plants (3.57) compared to plants which has raised from seedlings (3.18). Similarly biomass addition kg/ha was higher in plants from seedlings (1132) compared to tissue culture plants (1270). There was an upliftment in fertility status of soil due to amalgamation of leaf litter. The coconut yield was uninterrupted by the intercropping of noni in coconut plantation. Wairagi *et al.* (2014) experimented that banana and coffee yield can only be sustained by the addition of organic sources.

Conclusions

Initial studies have revealed that noni can be grown profitably in coconut plantation as mixed crop very well without averting the yield of the main crop i.e. coconut. The package of practices are simple and do not involve intensive labor and monetary expenditure. This crop is an important medicinal

crop this date and has potential of restoring livelihood of the farmers in West Bengal. However, the yield, return and B: C from noni will gradually increase and will be profitable up to 40 years.

Acknowledgement

The authors are obliged to all who helped enormously directly or indirectly and fund for this research work received from Bidhan Chandra Krishi Viswavidyalaya has been duly acknowledged.

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