Int.J.Curr.Microbiol.App.Sci (2021) *10*(05): 217-229

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 05 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1005.029

Studies on Effect of Coconut based Cropping System on the Yield and Soil Microbial Activity

Radhajogita Mondal*, A. C. Das and A. Bandyapadhyay

Department of Spices and Plantation Crops, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, 741252, India

**Corresponding author*

Keywords

Coconut, intercrop, yield, fungi, actinomycetes, bacteria, NPK and rhizosphere

Article Info

Accepted:
12 April 2021
Available Online:
10 May 2021

A B S T R A C T

The coconut palm (*Cocos nucifera* linn.) is the most useful palm (every part) in the world. Hence, the coconut palm is called as tree of life and tree of heaven. Coconut palms are grown in more than 90 countries of the world. India ranks 3rd with respect to its production followed by Indonesia and Philippines. Main Coconut Producing States of India are Tamil Nadu, Karnataka, Kerala, Andhra Pradesh, Odisha and West Bengal etc. The present investigation was undertaken in the coconut experimental plot where tuberose, gerbera and marigold were grown as intercrop and observations were taken during flowering season of different plants in the HRS, Mandouri, BCKV on the year 2015-16. Regarding coconut yield in treatments, maximum average nut yield of coconut was recorded in T3 treatment. Maximum population of fungi was recorded under T2 treatment, population of actinomycetes was maximum under T1 and maximum population of bacteria was recorded under T1. With the respect of NPK content of soil, T3 treatment giving better results. But the rhizosphere soil of T2 treatment shows maximum cfu count of actinomycetes and bacteria as compared to other treatments under above experiment.

Introduction

The coconut palm (*Cocos nucifera* linn.) is the most useful palm in the world. Every part of the tree is useful to human life. Hence, the coconut palm is endearingly called tree of life or 'kalpavriksha' meaning the tree of heaven. Coconut palms are grown in more than 90 countries of the world, with a total production of 62 million tonnes per year. It is a high value perennial oilseed crop grown in an area of 2.39 million ha with a production of 21,892 million nuts in India (Economic Review, 2012). India ranks 3rd with respect to its production followed by Indonesia and Philippines. The area, production and productivity of Coconut in India was recorded as 1975.81 ('000 ha), 20439.60 (million nuts),

10345 nuts/ha (Horticulture Division, Dept. of Agriculture & Cooperation, Ministry of Agriculture, Govt. of India, 2014-15).

Main Coconut Producing States in India are Tamil Nadu, Karnataka, Kerala, Andhra Pradesh, Odisha and West Bengal etc.

The morphological features of the coconut canopy necessitate its planting at a wide spacing and planted in square system with 7.5 x 7.5 m spacing. It is an established fact that the active roots of an adult coconut palm are concentrated laterally within a radius of 2 m from the base and vertically between 0.3 to 1.2 m from the surface of soil. Thus, in a pure stand of coconuts only about 25% of the soil mass is actually utilized by the coconut. A proper utilization of the remaining 75% of coconut land could be achieved by the practice of intercropping or farm diversification. The unstable copra prices in the national and international markets, small and marginal land holdings, lack of value addition facilities *etc*. have aggravated the economic difficulties to many coconut farmers.

A high efficiency in the use of available soil moisture and nutrients can be achieved by growing intercrops outside 2 m radius around the base of the palm. Growing of intercrops in coconut lands produces more food and agricultural products and commodities, providing food security for the people in both the rural and urban areas. At the same time, the practice generates jobs and livelihood, likewise enhancing farm income and purchasing power, hence, alleviating poverty in farming communities. Coconut-based high-density multispecies cropping systems (HDMSCS) involving many crops like banana, pineapple, clove, and pepper was also established. In our present experiment, floricultural crops (marigold, tuberose and gerbera) were intercropped in coconut based cropping system.

Adoption of coconut based intercropping or mixed cropping system is one of the ways to utilize the natural resources effectively. The potential for increasing the productivity per unit area of land, time and inputs through high-density multispecies cropping system is considerably higher in perennial crops (Bavappa and Jacob, 1982). Bavappa *et al.*, (1986) reported the advantages in high density multispecies cropping system involving compatible crops in coconut, with the increase in yield of coconut by 176 percent and additional income. According to Maheswarappa *et al.,* (2003), high density multispecies cropping system provided a stabilized income to coconut farmers even at times of low price of coconut. Intercropping banana, hybrid

The soil microbial biomass has been studied in several multi-storey cropping systems in different states. Coconut–cacao mixed cropping have shown greater microbiological activity than coconut monocropping system. Beneficial microorganisms are one of the most integral parts of soil system which maintain the soil health and quality to make it dynamic for nutrient turn over and sustainability of cropping systems (Mishra *et al.,* 2011; Ahemad and Kibert, 2014). A wide range of microorganisms is involved in various biotic activities such as organic matter decomposition, nitrogen fixation, solubilisation of micro and macro nutrients, maintenance of soil structure, soil borne disease suppression, plant growth promotion, siderophore production and release of hormones (Mishra *et al.,* 2008). Among them, plant growth promoting microorganism's viz. *Azotobacter chroococcum*, PSB, AM fungi and actinomycetes play vital role in agriculture by mediating plant growth by alteration of whole microbial community in rhizosphere niche through the production of various substances (Mishra *et al.,* 2009). Effect of growing floricultural crops under

coconut based cropping system on yield, nutrient uptake and soil microbiological studies is an important arena which influences a lot on that performance of main crop as well as soil health improvement.

Very minimum information is available on above mentioned studies under west Bengal condition. Keeping this in view the present investigation has been scheduled on the following objectives:-

Performance of floricultural crops as intercrop on productivity of coconut.

Performance of floricultural crops as intercrop on soil microbial population status under coconut based cropping system..

Performance of floriculture crops on soil nutrient status under coconut based cropping system.

Materials and Methods

Different experiments under prospect of coconut based multiple cropping system in alluvial plains of West Bengal were carried out in the plantation of All India Coordinated Research Project on Palms at the Horticulture Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal during the year 2015-16.

The research station is located 23.35 ^{0}N latitude and 89 ^{0} E longitudes, having an altitude of 9.75 meters above the mean sea level. The coconut plantation was established at 1982 and about 34 years old.

The floricultural crops like marigold, tuberose, gerbera were planted in the interspaces and maintained with scheduled cultural and nutrient management practices. The soil of the experimental plot was gangetic alluvial, sandy loam in texture, well drained with medium fertility status and good drainage as well as water holding capacity.

Plan of work

Experimental details

The coconut palms were spaced at 7.5 m X 7.5 m. The study was based on 4 coconut based cropping models *i.e*., i) coconut + marigold, ii) coconut + tuberose, iii) coconut + gerbera and iv) coconut monocropping.

Nutrient management of palms

All the palms under the experimental plots received uniform dose of organic manures and fertilizers. Palms were provided with 25 kg compost, 500 g N, 250 g P_2O_5 and 750 g K_2O per palm per year.

After care and management

The cultural operations like weeding, removal of leaves, cleaning of crown etc. were done periodically on need based basis.

The palms were irrigated at 15-20 days interval from October to May. Necessary plant protection measures were also taken against pests and diseases.

Experiment - 1

To study the effect of different cropping system on the yield of main crop of coconut.

Age of palm – 34 years

Planting distance of coconut – 7.5 m X 7.5 m

Planting distance of intercrops –3.5 m X 3.5 m

Number of treatments – 4

Number of replications - 5

Treatment details

T1 – coconut + marigold

T2 – coconut + tuberose

T3 – coconut + gerbera

T4 – coconut as monocrop

Observations to be recorded

Average yield of coconut (nuts /ha)

Yield of flower crops (numbers of sticks or kg / ha / year)

Experiment - 2

To study the effect of different cropping systems on soil nutrient characteristics of the coconut based cropping system experimental plots.

Observations to be recorded:

Soil analysis of N, P and K at initial stage of experimentation

Soil analysis of N, P and K after completion of the experiment

Experiment - 3

To study the effect of different cropping systems on microbial population status of different coconut based cropping system of experimental plots.

Observations to be recorded

Counting of colony forming unit of fungi (cfu x 10^{-4}/ g of soil)

Counting of colony forming unit of bacteria (cfu x 10^{-5}/ g of soil)

Counting of colony forming unit of actinomycetes (cfu x 10^{-5}/ g of soil)

Experiment - 4

Economic analysis of different coconut based cropping system.

Observations to be recorded

Yield parameter of intercrops and main crop

Number of nuts/palm/year

Number of nuts/ha/yr.

Soil N, P and K Analysis

The soil samples were collected from various crop plots in interspaces and coconut basin at 0-25 cm depth before initiation and after completion of the experiment.

Total nitrogen content of soil was determined in percentage in micro Kjeldahl method (Jackson, 1973). Available phosphorous content of soil was determined in Olsen method (Jackson, 1973).

Available potassium was determined by leaching the soil with neutral normal ammonium acetate and estimating potassium by Flame Photometer method (Murhr *et al.*, Jackson, 1973).

Procure of serial dilution and pour plate method

The viable microbial population counts were analysed by the standard technique of serial dilution and pour plating method (Pramer & Schmidt, 1965). Plates were incubated at 30^0C. The counts were taken at 4^{th} days of incubation. The results were reported as colony forming unit per g of soil. The procedures are given below

Soil sample collection, Apparatus cleaning and washing, Making of water blank, Media

preparation, Sterilization, Serial dilution, Pour plating, Incubation and Colony counting.

Benefit: cost ratio

The benefit: cost ratio for the treatments was calculated on the basis of cost of cultivation, gross return and net return. The economic assessment was carried out considering the cost of inputs and market price of the produce during the period of experimentation. Comparative economics of different coconut based cropping systems were made. Different input and output parameters considered calculating benefit: cost ratios are given below:-

Yield of intercrop

Value of intercrop

Cost of cultivation of intercrop

Maintenance cost of main crop

Return from intercrop

Net return from system

The yield of coconut and yield of different flower intercrops were taken for the present investigation.

The nitrogen, phosphorus and potassium content of the monocrop and intercrops growing soils were studied at a depth of 0-25 cm.

Results and Discussion

In the present investigation studies on the effect of different flowering crops under coconut based cropping system on yield, soil N, P and K content and soil microbial population studies have been undertaken, the results of which are being presented below :-

Effect of different flower based cropping system on yield of main crop coconut

Data presented in table no.1, in terms of annual nut yield, highly significant difference was observed among plots with different flower intercrop combinations over the control.

Regarding coconut yield in treatments with different flowers, maximum average nut yield of coconut (16525 nut/ha/year) was recorded in T3 (coconut + gerbera) treatment followed by T2 (coconut + tuberose) treatment (16503 nut/ha). Minimum average nut yield of coconut (16350 nut/ha) was recorded in treatment T1 as compared to control respectively. Regarding the production of flowering intercrops, treatment T3 (coconut + gerbera) was recorded highest stick production (242371 sticks/ ha/ yr.) followed by T2 (coconut + tuberose) treatment (185000 sticks/ ha /yr.) respectively.

Data based on nut production in table no. 1, more nuts obtained significantly from treatment T3 (coconut + gerbera). Highly significant improvements in yield were noted on coconut as more intercrops were planted as compared to those palms without intercrops.

Data revealed from above table no.2, N, P and K content of soil in the interspaces was higher than initial condition.

Nitrogen, phosphorus and potassium contents were observed more in the rhizosphere soil of T3 (coconut + gerbera) treatment as compared to initial condition with respect to T1, T2 and control treatments. But there was no significant difference between the potassium content in rhizosphere of T1 and T3 treatments.

Data revealed from table no.3, on microbial population per gram of soil (actual soil in 1

gm soil without moisture) recorded maximum population of fungi (21.4 x 10^4 cfu) under T2 (coconut + tuberose) treatment followed by T3 (coconut + gerbera) and T1 (coconut + marigold) treatments with 20.4 x 10^4 cfu and 7.1 x 10^4 cfu respectively as compared to control (coconut monocrop = 3 X 10^4 cfu). Data recorded in table no.3, on microbial population per gram of soil (actual soil in 1 gm soil without moisture) was maximum with respect to population of actinomycetes (89 x 10^5 cfu) under T1 (coconut + marigold) treatment followed by T3 (coconut + gerbera) and T2 (coconut + tuberose) treatments with 69 x 10^5 cfu and 64 x 10^5 cfu respectively as compared to control (coconut monocrop = 59 x 10^5 cfu).

Studies on microbial populations per gram of soil (actual soil in 1 gm soil without moisture) under flower based cropping system recorded maximum population of bacteria (76 x 10^5 cfu) under T1 (coconut + marigold) treatment followed by T2 (coconut + tuberose) and T3 (coconut + gerbera) treatments with 72.5 x 10^5 cfu and 43 x 10^5 cfu respectively as compared to control (coconut monocrop = 37 x 10^5 cfu).

Experiment on microbial population per unit of soil, fungal population was minimum in T1 treatment as compared to treatments T2, T3 and control.

There was no minimum difference between T2 and T3 treatments as compared to T4 treatment. But actinomycetes cfu count was recorded reverse trend as compared to fungal cfu count.

Because, T1 treatment shows highest bacterial population as compared to T2, T3 and control. There was not much difference between T2 and T3 treatments as compared to control. In case of bacterial population, T3 shows minimum cfu count, but there was difference between T1 and T2 treatments as compared to control.

Moisture content of soil

Data revealed from table no.4, the moisture content of rhizosphere soil of T2 treatment was observed maximum (17.97%) as compared to other treatments under the present experiment.

Data revealed from table no.5, on yield and economics of commercial flowering crops intercropped in coconut garden, treatment T3 (coconut + Gerbera) recorded highest B: C ratio (1.74) followed by treatments T2 (coconut + tuberose) andT1 (Coconut + Marigold) with 1.73 and 1.70 B: C ratio as compared to control respectively.

In the present study in coconut plantation, coconut recorded highest yield (16525 nut/ha/year) in treatment T3 (coconut + gerbera) followed by T2 (coconut + tuberose) treatment (16503 nut/ha) and among intercrops, gerbera plant giving higher production of sticks (242371 sticks/ ha/ yr.) followed by tuberose plant (185000 sticks/ ha /yr.) as compared to control respectively.

Investigation of flower based intercropping system in coconut plantation, on N, P and K content of soil of T3 (coconut + gerbera) treatment possess higher N, P and K content (266.85, 81.56 and 285.57 kg/ ha) as compared to initial condition with respect to T1, T2 and control treatments.

In our present study in coconut field, fungi population was more in intercropping of tuberose treatment (21.4 x 10^4 cfu/g) followed by gerbera treatment (20.4 x 10^4 cfu/g) during flowering period. There was not much difference in the fungi population of T2 and T3 treatments.

Table.1 Effect of different flower based cropping system on yield of main crop coconut and intercrop.

Flower crops	Yield of flower crops (sticks or kg/ha/year)	Average yield of coconut (nut per ha)
coconut + marigold (T1)	11852 (kg)	16350
coconut + tuberose (T2)	185000	16503
coconut + gerbera (T3)	242371	16525
Coconut as monocrop (T4)	-	16317

Table.2 Effect of different flower based cropping system on N, P and K content of soil.

Nutrients (kg/ha)	Initial	coconut + marigold (T1)	coconut + tuberose (T2)	coconut + gerbera (T3)	Coconut as monocrop (T4)
N	252.56	263.85	266.47	266.85	262.58
P	79.52	81.53	81.53	81.56	80.56
K	281.53	285.57	283.56	285.57	282.73

Table.3 Studies on proliferations of microorganisms in the rhizosphere soils of different flower based cropping system at their flowering stages

Flowering plants and main crop	Population of microorganisms											
	Fungi (cfuX10^4 per g)				Actinomycetes (cfuX10^5 per g)				Bacteria (cfuX10^5 per g)			
	R1	R2	R3	Mean	R1	R2	R3	Mean	R1	R2	R3	Mean
Coconut + Marigold (T1)	7	6.5	7.8	7.1	88	90	89	89	79	73.4	76	76
Coconut + Tuberose (T2)	21.4	21.4	21.4	21.4	68	64	60	64	56	72.5	89	72.5
Coconut + Gerbera (T3)	7	6.6	6.8	20.4	68	69	71	69	43	42	44.7	43
Coconut monocrop (T4)	2	5	3	3.3	51	46	45	47.3	28	32	34	31.3

Table.4 Studies on moisture content of rhizosphere soil

Treatment	Weight of box (g)	Weight of box + wet soil (g)	Weight of moist soil (g)	Weight of box + dry soil (g)	Weight of dry soil (g)	Moisture content (g)
coconut + marigold (T1)	25.340	88.420	63.08	73.7	48.3	14.78
coconut + tuberose (T2)	23.600	96.370	72.77	78.4	54.8	17.97
coconut + gerbera (T3)	24.720	93.040	68.32	76.9	52.18	16.14
Coconut as monocrop (T4)	25.553	92.61	68.05	76.4	51.76	16.29

Table.5

Table no.10: Yield and economics of commercial flowering crops intercropped in coconut garden (Mondouri). B: C ratio was calculated on the basis of corresponding market rates. (2015-16)

Crop	Stick Yield /ha	Nut yield/ha	Gross return/ ha (Rs)	Expenditure /ha (Rs)	Net return/ha (Rs)	B:C	Duration
Coconut + Marigold	11825 kg	16350	423650	248008	175642	1.70	Dec-February-16
Coconut + Tube Rose	185000	16503	535030	309658	225372	1.73	June15-November 15
Coconut + Gerbera	242371	16525	468214	268408	199806	1.74	Nov15-Feb-16
Mono crop	--	16317	163170	95908	67262	1.70	July14-June15

(Marigold @ Rs22/kg, Tuberose@Rs2/stick, Gerbera@ Rs1.25/stick, Coconut @ Rs 10/piece)

Fig.1 Average yield of coconut (nut per ha).

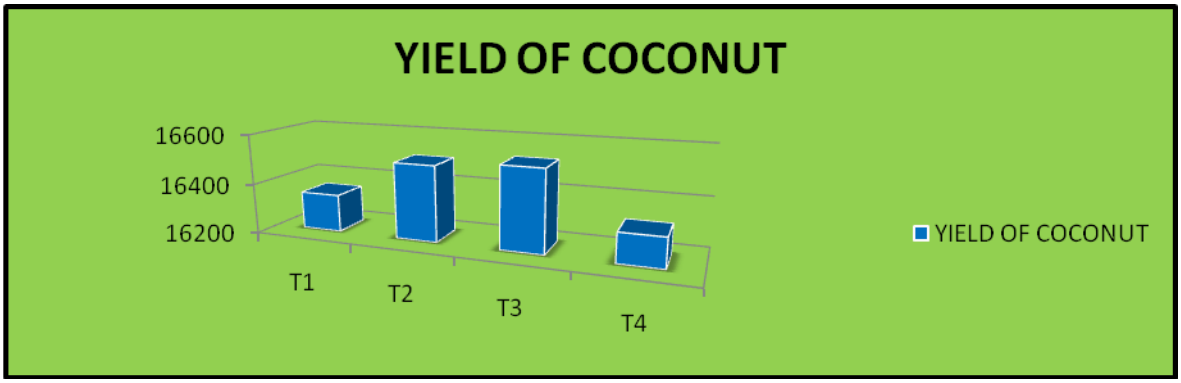


Fig.2 N, P and K content of soil (kg/ha).

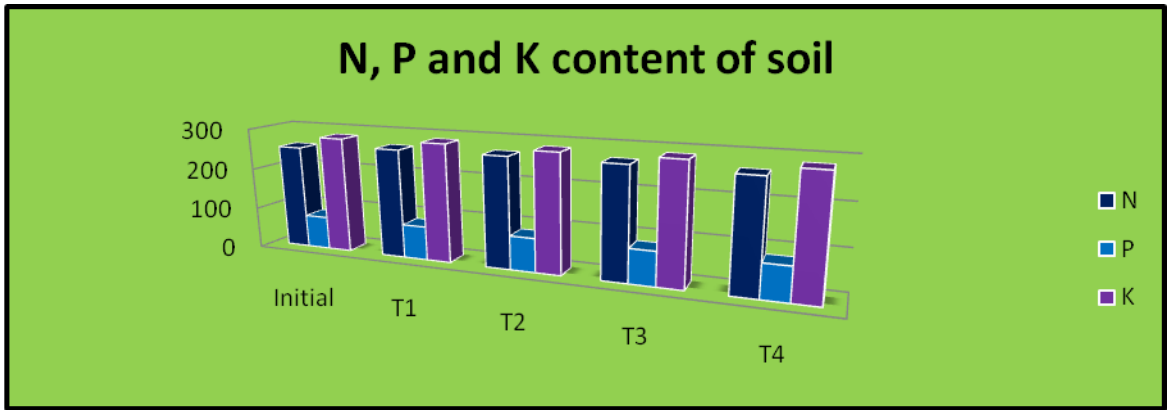


Fig.3 Counting of fungi population (cfuX10^4 per g).

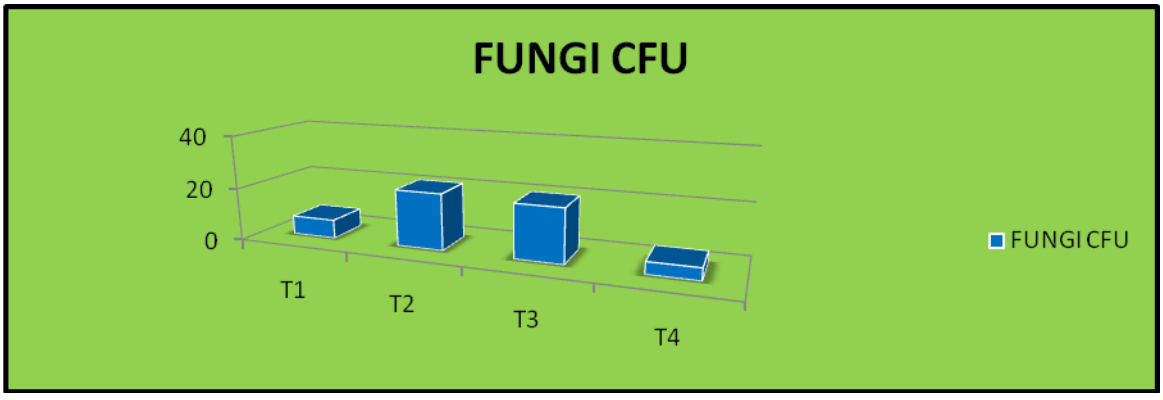


Fig.4 Counting of Actinomycetes population (cfuX10^5 per g).

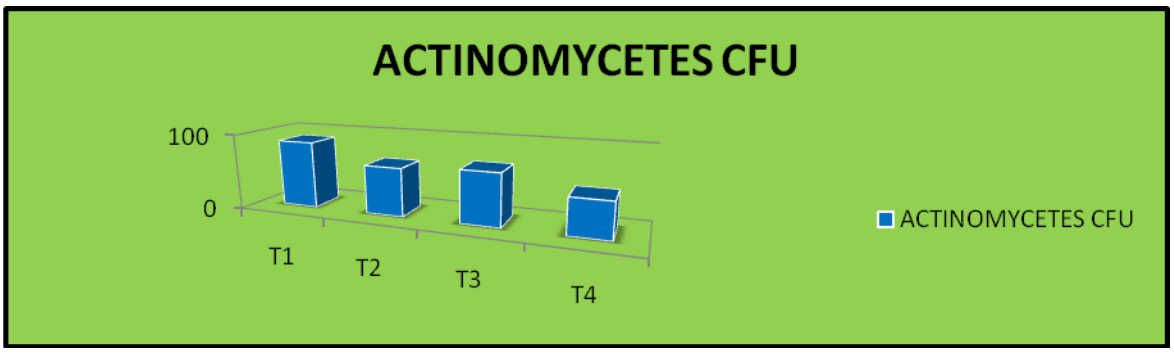


Fig.5 Counting of Bacteria population (cfuX10^5 per g).

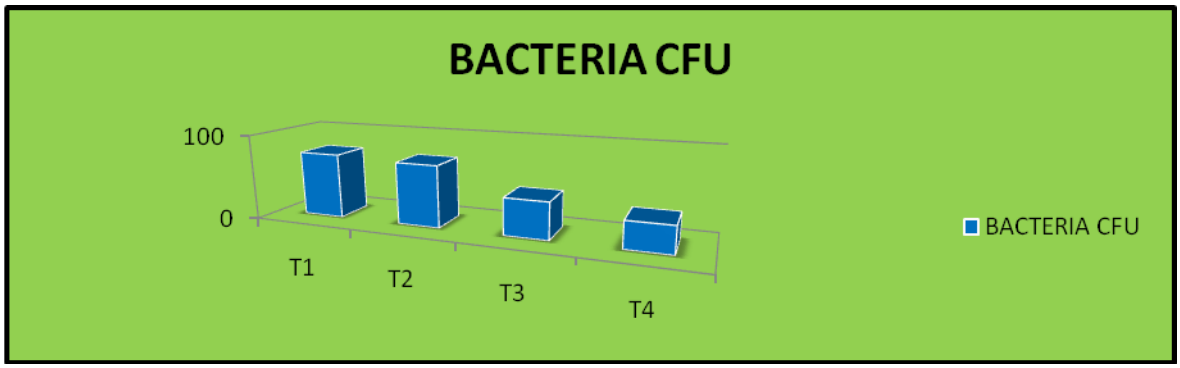
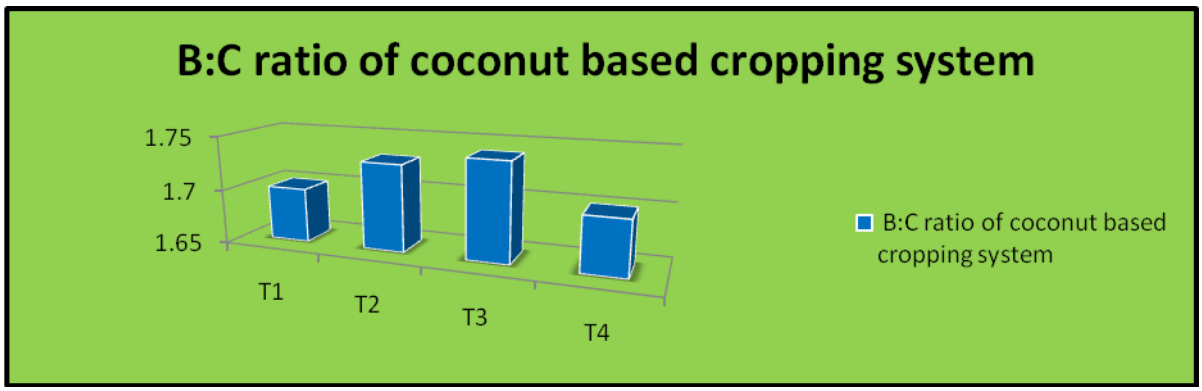


Fig.6 Intercropping marigold, tuberose and gerbera with coconut

Fig.7 B:C ratio of coconut based cropping system.



In the present experiment, higher actinomycetes population was observed in intercropping of marigold treatment (89 x 10^5cfu/g) followed by gerbera treatments (6 x 10^5 cfu/g) during flowering season. Lehmann *et al.,* (2000) reported that the dynamic increase of the microorganisms in the rhizosphere of fruit crops intercropping with floricultural crops can be explained by the favourable quantitative and qualitative composition of organic compounds provided in the form of root exudates and crop residues. This fact was further confirmed by earlier workers from the previous investigations (Al Yahyai 2009, Abouziena 2010). Significantly higher microbial populations in intercropping treatments at all stages of observation might be due to healthy and conducive environment for the microorganisms as compared to the control plots (Sarathambal *et al.,* 2015).

Data revealed from the present investigation recorded that the total actinomycetes population was significantly more in all the intercropping treatments. With progress of time, population was increased in all the treatments. The maximum bacteria population was found in intercropping of marigold treatment (76 x 10^5cfu/g) during flowering season followed by tuberose treatment (72.5 x 10^5 cfu/g) in coconut plantation during flowering period. This may be due to the fact that in intercropping conditions, more soil organic matter is available which provides nutrients to microorganisms resulting in their proliferation and later on, microorganisms take part in degradation process (Sarathambal *et al.,* 2015).

Intercropping has significant effects on microbiological and chemical properties in the rhizosphere, which may contribute to the yield enhancement by intercropping. It also leads to significant changes in the populations of microorganisms and their activities thereby influencing the microbial ecological balance in the soil and affecting the productivity of soils. The microbes play vital role in soil fertility management, such as degradation of organic matter and soil nutrient transformations. Significant stimulation in soil microbial activity was observed under coconut based cropping system could be due to better soil physico-chemical environment and adequate amount of available nutrients. These findings are in full conformity with the findings of Bopaiah and Shetty (1991), Natarajan *et al.,* (2010), Thomas and Prabhu (2003), Parab *et al.,* (2015) in onion and Sarathambal *et al.,* (2015) in mango. Soil microorganisms can act as agents of nutrient transformation and store carbon and nutrients in their own living biomass, acting as labile reservoirs for available nutrients with fast turnover (Mishra *et al.,* 2011). The amount and activity of microorganisms therefore

influence soil productivity and nutrient cycling. Increase in available P and pH in soil with organic manure perhaps accelerated the microbial activity of the soil, which in turn enhanced the available nutrient status of soil and consequently the crop yield.

Future Scope of Research

The present experiment indicated some interesting findings of immense practical utilisation on cropping pattern, soil type, microbial population in soil, nutrient management and production of intercrops and coconut. Microbial, production and nutrient parameters of four coconut based cropping system models have been studied.

But future researches aiming at relating to the microbes and nutrient up taking in soil of coconut based cropping system need to be undertaken as it was not possible to study these aspects during the present investigation.

However, immense scope is left for future research in this line mentioned below:

To study the enzymatic analysis, biomass production, organic carbon content of soil etc.

Studies on the relationship between microbial populations present in the soil of coconut based cropping system and nutrient up take by the crops (intercrop + coconut) need to be studied.

Micronutrient studies of coconut based cropping system can do in future.

The effect of soil microorganism's activities on benefit: cost ratio of coconut based cropping system can be analysed. Identification of beneficial and damaging microorganisms present in soil helping better growth, development and production of coconut and intercrops.

Other microbial population count can be done under coconut based cropping system like, N-fixers, P- solubilizers, Trichoderma, Ganoderma population etc.

Microbial population counting may be recorded at different stages of plant growth (vegetative, flowering etc).

Influence of crop diversity and level of fertiliser inputs on microbial groups in the root zone of crops may be studied.

Microbial parameters like quantity of carbon, mineralised phosphatase and dehydrogenase activities of soil may be studied.

Acknowledgement

Authors thank to Prof. A. Bandyopadhyay Dept. Of Spices and Plantation Crops, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, for his noble supervision, sagacious guidance, valuable suggestions, ever encouraging inspirations, humble behavior and tireless effort throughout the tenure of my investigation and also highly grateful to Prof. A. R. Mondal, Department of Vegetable Crops and Prof. A. Pariari, Department of Spices and Plantation Crops during my research work.

References

Bavappa, K. V. A, Kailasam, C, Khader, K. B. A, Biddappa, C. C, Khan, H. H, Kasturibai, K. V, Ramadasan, A, Sundararajan, P, Bopaiah, B. M, Thomas, V, George L. P., Misra, L. P, Balasainha, D, Bhat N. T. & Bhat S. K. (1986). Coconut and arecanut based high density multispecies cropping system. *J. Plantation crops*, 14: 22, 74-87.

Bavappa, K. V. A. & Jacob V. J. (1982). High intensity multispecies cropping – A new approach to small scale farming in the tropics. *World crop*, 2: 47-50.

Bopaiah B. M. and Shetty H. S. (1991). Microbiology and fertility in coconut-based mixed farming and coconut monocropping

systems. *Tropical-Agriculture*. 68(2): 135-138.

Bopaiah B. M. and Shetty H. S. (1991). Soil microflora and biological activities in the rhizospheres and root regions of coconut-based multistoreyed cropping and coconut monocropping systems. *Soil-Biology-and-Biochemistry*. 23(1): 89-94.

Jackson, M. L. (1973). Soil Chemical Analysis. 2nd Edition. Prentice Hall of India Pvt. Ltd., New Delhi, pp. 111-182.

Maheswarappa (*2003*) Economic significance and productivity of coconut based high density multi-species cropping system (HDMSCS) in root (wilt) affected area. Central Plantation Crops Research Institute, Regional Station, Kayamkulam - 690 533, Kerala, India. *Indian-Coconut-Journal*. 34(8): 3-5.

Maheswarappa, H. P, Anitakumari, P & Sairam, C. V. (2003). High density multispecies cropping system for root (wilt) affected coconut gardens – Its impact on productivity and economic viability, *J. Plantation crops,* 31: 11, 23-27.

Mishra S., Sharma S., Vasudevan P., 2008. Comparative effect of biofertilizers on fodder production and quality in guinea grass (*Panicum maximum* Jacq.). J. Sci. Food Agric. 88 (9), 1667–1673.

Mishra S., Sharma S., Vasudevan P., 2009. Effect of single and dual inoculation of Rhizobium with AM fungi on nodulation, fodder production and quality in two Stylosanthes species. Biol. Agric. Hortic. 26, 411–421.

Natarajan C.; Subramanian P. S. and Mohandas S. (2010). Intercropping system in coconut for East Coast region of Tamil Nadu. Coconut Research Station, Tamil Nadu Agricultural University, Veppankulam - 614 906, India. *Indian-Coconut-Journal*. 53(3): 7-11.

Parab N, Sinha S and Mishra S (2015). Coal fly ash amendment in acidic field: Effect on soil microbial activity and onion yield. SIES – Indian Institute of Environment Management, Sector-V, Nerul, Navi Mumbai 460 706, Maharashtra, India. *Applied Soil Ecology*. 96, 211–216.

Sarathambal C, Singh V. P., Barman K. K., Raghuvanshi M. S. and Dubey R. P. (2015). Intercropping and weed management effect on soil microbial activities in newly planted mango and citrus orchards. *ICAR - Directorate of Weed Research, Jabalpur Madhya Pradesh 482 004. Indian Journal of Weed Science* 47(2): 178–182.

Thomas G. V. and Prabhu S. R. (2003). Association of diazotrophic and plant growth promoting rhizobacteria with coconut palm. Crop production division, *central plantation crops research institute*, Indian council of agricultural research, kasaragod 671124, kerala, india.

www.agritech.tnau.ac.in

www.coconutboard.gov.in

www.cpcri.gov.in

www.icar.org.in

www.mapsofindia.com

www.perfectinsider.com

https//books.google.co.in

How to cite this article:

Radhajogita Mondal, A. C. Das and Bandyapadhyay, A. 2021. Studies on Effect of Coconut based Cropping System on the Yield and Soil Microbial Activity. *Int.J.Curr.Microbiol.App.Sci.* 10(05): 217-229. doi: https://doi.org/10.20546/ijcmas.2021.1005.029