



Effect of Integrated Nutrient Management and Plant Growth Regulator on Generation of Recyclable Biomass in Coconut (*Cocos nucifera* L.) Based Cropping System

**G. Mishra^{1*}, A. K. Karna¹, S. C. Sahoo¹, S. K. Pattanayak²
and H. P. Maheswarappa³**

¹Department of Fruit Science and Horticulture Technology, OUAT, Bhubaneswar, India.

²Department of Soil Science and Agricultural Chemistry, OUAT, Bhubaneswar, India.

³Project Coordinator (Palms), AICRP on Palms, ICAR- CPCRI, Kasaragod, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i1730568

Editor(s):

(1) Dr. Ahmed Medhat Mohamed Al-Naggari, Cairo University, Egypt.

Reviewers:

(1) V. Rajalakshmi, D G Vaishnav College of Arts and Science, India.

(2) Andrezza Mara Martins, Federal University of the Valleys of Jequitinhonha and Mucuri, Brazil.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/72676>

Original Research Article

**Received 05 June 2021
Accepted 10 August 2021
Published 10 August 2021**

ABSTRACT

An experiment was conducted in the tropical coastal climate of Bhubaneswar by taking five crop combinations. Coconut was grown as main crop along with four component crops; banana, guava, pineapple and colocasia in a system. Different nutrient sources were used and crop specific growth regulators were applied at specific growth stages. The study was conducted to assess the effects of cropping system, nutrient and growth management practices on the generation of recyclable biomass from coconut as well as from the system as a whole. The biomass was calculated on the basis of dry weight of the plant products. The production of total recyclable biomass was found highest (18.5 t/ha) in the cropping system where the plants were managed with 50 % RDF+ 50 % N (organic recycling with vermicompost + in situ green manuring + vermicompost wash) with biofertilizers and plant growth regulators (PGRs). The sole cropping of coconut was found to have lowest production of the same. The cropping system which is managed with fully organic sources

*Corresponding author: E-mail: nini.gs.ag@gmail.com;

of nutrient without any growth regulator was found least among all other systems except the sole cropping. The incorporation of intercrop has increased the amount of plant recyclable biomass to the extent of double than the coconut.

Keywords: Vermicompost; RDF; monocropping; plant growth regulators.

1. INTRODUCTION

Coconut (*Cocos nucifera* L.) is an important high value perennial crop usually grown by small and marginal farmer in coastal Odisha. Due to the regular flowering and fruiting nature of coconut, it is regarded as a source of continuous income for the growers. Owing to insufficient nutritional inputs, fluctuation in market price of fruits and fruit products and the continuous environmental disturbances like cyclones, the income of the farmers varies. As per the research findings, only 23 % of land area and 30 % of active radiations are utilized by the coconut palm when it grows in recommended spacing (7.5m × 7.5m) (Maheswarappa et al., 2001). The remaining unutilized land can be successfully utilized by the incorporating some intercrops which can fit into the climate and generally don't compete with the main crop. The addition of intercrops, annual or perennial will help the farmers to gain some additional income and it will add positive impact on the main crop yield and productivity.

When it comes to the low yield of any crop the major factor lies with the insufficient nutrition given to the plant. The growth, yield and quality of coconut as well the intercrops also get affected by the nutritional management practices. Again sole practices of the inorganic nutrient sources is hazardous to the soil and for the entire ecosystem. Environmental degradation is a major threat for the world and the extensive use of inorganic fertilizers contributes largely to the deterioration of the environment. It leads to loss of soil fertility due to imbalanced use of fertilizers adversely affecting agricultural productivity and causing soil degradation [1]. Addition of organic sources of nutrients, biofertilizers can improve the biological properties of soil, improve the uptake of nutrient, by improving the mineralization and enhance the yield of the crop in a sustainable manner. Again the growth and yield of these crops can be improved further by application of specific growth regulator at specific period of growth stage and in definite concentration.

Apart from the economical yield, a huge amount of crop biomass is also produced in the high

density multi species cropping system. In coconut based high density multispecies cropping system, a huge amount of biomass is produced in the form of leaves, coconut spathe, remnant, of dried bunch etc [2]. Apart from coconut, the intercrops like banana, pineapple, guava and tuber crops produce a significant amount of biomass each year. In various regions of India, burning of agricultural crop residues has become an annual problem causing environmental hazard and affecting the health of human and other animals [3]. This biomass should be managed properly and can be successfully recycled into the system in the form of biological fertilizers like vermicompost, FYM etc. which can be included into the nutrient management regime of the crops. The coconut leaf vermicompost has C: N ratio of 9.95 with 1.8% N, 0.21% P, 0.16% K and organic carbon content of 17.84% [4]. Vermicompost is an excellent bio-fertilizer, which has been investigated to have favorable influence on the growth and yield parameters of several crops [5]. The vermicompost produced in this way will enrich the soil carbon stock, improve the yield and quality of the crop produce and will help the farmer in reducing in the cost of cultivation.

Keeping the above fact in view the present investigation entitled "Effect of nutrient management and plant growth regulator on generation of recyclable biomass in coconut based cropping system" was carried out to study the amount of recyclable biomass (t/ha) produced in the coconut based integrated cropping system with application of different plant nutrients and growth management practices during the cropping year 2016-17 and 2017-18.

2. MATERIALS AND METHODS

The present study was conducted in the experimental farm, under the Department of Fruit Science & Horticulture Technology, College of Agriculture, OUAT, Bhubaneswar during the period July 2016 to June 2018. The experimental area experiences a tropical humid climate. The average temperature and relative humidity and annual rain fall of the experimental period (2016-17 and 2017-18) the location was recorded and

is shown in Fig. 1. The soil of the research station where this experiment was carried out was sandy clay loam in texture. The physical and chemical parameters of the experimental soil is presented in Table 1.

The crop combination taken in the cropping system was coconut + banana+ pineapple + guava + taro. The coconut cv. Sakhigopal Local was grown as the principal crop at a spacing of 7.5×7.5 m. Banana cv. Poovan, pineapple cv. Queen, guava cv. Arka Amulya and colocasia cv. Muktakeshi were grown as intercrops within the coconut garden in organized manner. The integrated nutrition management (INM) practices were imposed along with plant growth regulators (PGRs). The treatments were finalized as T1: 75% of recommended NPK + 25 % N through organic recycling with vermicompost, T2: 75% of Recommended NPK+ 25% N through organic

recycling with vermicompost + PGRs^{*}; T3: 50 % of recommended NPK + 50 % N through organic recycling with vermicompost + in situ green manuring+ vermicompost wash + biofertilizers; T4:50 % of recommended NPK + 50 % N through organic recycling with vermicompost + in situ green manuring + vermicompost wash + biofertilizers + plant growth regulator^{*}; T5: Fully organic (100 % N through organic recycling with vermicompost + in situ green manuring + vermicompost wash + CCP+ biofertilizers ; T6:Fully organic (100 % organic recycling with vermicompost + in situ green manuring + vermicompost wash + CCP+ biofertilizers + PGRs^{*}; T7 : Sole cropping of coconut with 100% recommended doses of fertilizer. The experiment was designed in randomized block design (RBD), with 7 treatments replicated 3 times. The analysis and interpretation of data were done by using the method of Panse and Sukhatame [6].

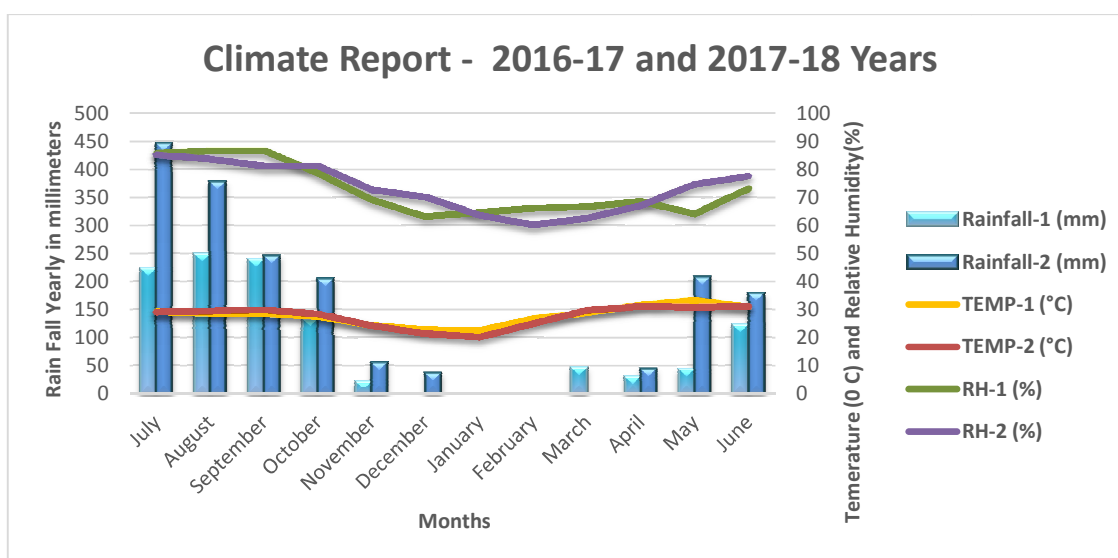


Fig. 1. Average annual rainfall, temperature and relative humidity 2016-17 and 2017-18

Table 1. Physico- chemical characteristics of experimental soil

Soil characters	Soil depth 0-30 cm
A. Mechanical composition	
Sand (%)	59.7
Silt (%)	17
Clay (%)	23.3
B. Textural class	Sandy clay loam
C. pH_w (1:2.5 = Soil: Water)	5.5
Organic carbon(g kg ⁻¹ soil)	4.60
Available nitrogen (kg/ha)	221
Available phosphorous (kg/ha)	28
Available potassium (kg/ha)	134

In the present experiment, crop specific growth regulators were used. In coconut, freshly opened inflorescences in the palm were selected for PGR (plant growth regulator) application. 2-4-D @ 30ppm along with coconut water was applied to each inflorescence two weeks after the spathe splitting. 10 ppm NAA was applied to the core of pineapple plant in the month of November, one month before the usual flowering time. For banana, 50 ppm GA₃ was applied at the time of bunch opening. NAA @ 50 ppm was applied on guava in the early stage of fruit setting.

The details of RDF (recommended doses of fertilizer) followed in the present experiment are described in Table 2. According to the doses of nutrient, each crop was managed. The NPK content of the organic sources was also estimated (Table 3) and accordingly the amount was calculated for application in different treatments. Two biofertilizer strains *Azotobacter* and *Azospirillum* were used. The different growth regulators were applied in the respective crops at the particular growth phases.

The recyclable biomass of coconut and component crops was estimated and the method adopted are described below

- Coconut: The dried fallen leaves (after removing the petiole), spathe and bunch waste (after harvesting the nuts) of coconut were collected separately as and

when fallen and dry weight was estimated. The total biomass obtained from each palm in each treatment was calculated and converted to kg/ha.

- Banana: The banana plants were removed at the ground level at the time of harvest and the weight was estimated. The plant was separated into pseudo stem and leaves. Each part was weighted separately and the sample was taken for dry weight conversion.
- Pineapple: The crown part of fruit after harvesting of the fruit and the whole plant including the roots were collected and the weight was taken. Sub sample of the plant was taken and oven dried and the weight was calculated.
- Guava: The weight of fallen leaves was taken at monthly interval by collecting them by spreading the nylon sheet and the dry weight of pruned biomass was taken and average was worked out. The dry weight pruned branch was recorded after each pruning.
- Colocasia: The biomass from colocasia was calculated on plant basis and converted to per hectare on the basis of the accommodation of number of plants /ha.

The recyclable biomass collected from each individual crop in the treatments was added to get the total recyclable biomass of the system and expressed in q/ha.

Table 2. Recommended doses of fertilizers applied in different crops in the cropping system

Crop	Recommended doses of fertilizers (g/plant/year)		
	N	P ₂ O ₅	K ₂ O
Coconut	500	320	1200
Banana	250	125	300
Pineapple	12	4	12
Guava	500	320	300
Colocasia	80 (kg/ha)	25 (kg/ha)	100 (kg/ha)

Table 3. The NPK content of the organic sources used in the system

Organic sources	Nitrogen (%)		Phosphorous (%)		Potassium (%)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
Vermicompost	1.4	1.6	0.24	0.23	0.36	0.36
Vermicompost wash	0.6	0.5	0.90	1.0	0.14	0.20
Cowpea (GM)	1.9	1.8	0.26	0.28	0.12	0.14
CCP	1.03	1.01	0.06	0.05	1.20	1.21

3. RESULTS AND DISCUSSION

Among all the crops, highest recyclable biomass was generated from the principal crop, coconut in the form of coconut leaflets, petioles, spathes, inflorescences waste etc. The biomass obtained from coconut was ranged from 7.5 to 9.2 t/ha under different treatments (Fig. 2). Among all the practices followed, mono-cropping had the lowest production of total biomass (7.5t/ha) than that much produced from coconut palms grown inside the cropping system. Recyclable biomass originated alone from coconut palm was found highest (9.2 tonnes/ha) with 50% RDF + 50 % N through organics along with biofertilizers inside the cropping system.

The increase in recyclable biomass might be due to the production of higher number of leaves, bunches (spathe & dry inflorescence) in coconut in that very treatment. The production of RBM from the coconut palms alone was found to be decreased with the sole use of either kind of nutritional sources (either pure organic form; T5 and T6 or in pure chemical sources; T7) however, the total production of recyclable biomass in the system was found to be increased in the pure organic practices due to the addition of intercrops and might be due to the system effect. The chemical fertilizers contain higher amounts of nutrients and become available more quickly than the organic sources. Addition of organic sources and biofertilizers might have improved the soil biological environments which again help the uptake of nutrient from the soil. The increase in microbial population in the soil also helps in mineralization of soil nutrient from unavailable form to available form which again improves the nutrient uptake by the roots. The application of biofertilizers like *Azotobacter* and *Azospirillum* increase the synthesis of plant growth promoters like auxin which helps crop growth further [7]. Organic sources contain small amounts of different macro and micro nutrients which generally affect the plant health in the long run [8].

The recyclable biomass production of coconut was found to be increased in the second year of experiment. The increased in production in the subsequent year might be due to the residual effects of organic sources [9] and bio fertilizers added. Coconuts being a perennial crop, the application of nutrient sources affect the plant in better way but the response is generally seen in the subsequent years. On the other hand the organic sources contain a higher portion of

carbon sources which act as an excellent food source for the soil microbes [10,11] however the amount of major nutrients like nitrogen, phosphorus, and potash is not comparable with the chemical fertilizers. Again, these sources are slow releaser of nutrients and when sole applications of these sources were done they did not meet the crop demand and the vegetative and reproductive growth got affected so as the biomass.

The total recyclable biomass produced obtained in the sole cropping of coconut was much lesser as compared to the cropping system which ranged from 7.62 tonnes/ha (2016-17) to 7.64 tonnes per hectare (2017-18) in both the years. The highest quantity of the same was produced from the crops receiving nutrient from 50 percent of RDF and 50 percent of N from organic sources along with biofertilizers and with application of PGRs on respective intercrops. The total recyclable biomass production was more or less same in the 2nd year (2017-18) that of the biomass produced during the 1st year of experiment (2016-17) (Fig. 3). The increase in the total biomass in T4 (18.5 t/ha) was contributed through the biomass added by the intercrops. The increment in intercrops biomass might be attributed by the use of crop specific growth regulators along with combination of inorganic and organic nutrient sources. The production of recyclable biomass in the CBHDCS (Coconut based high density cropping system) comprising coconut, banana, nutmeg, pineapple and tuber crops in the system was also reported 9110 kg/ha to 17612 kg/ha/year [2]. Shinde et al. [12] had also reported that the biomass generation under cropping system was more than that of monocropping in Maharashtra condition.

Analysis of the production of RB inside the cropping system revealed that the palms contributed nearly 43 percent to the total recyclable biomass produced whereas the contributions of all other crops (intercrops) were 57 percent (Fig. 4). Besides addition to the total income of the farmer by generating economical yield the intercrops produced enormous quantity of recyclable biomass which can help in sustainable production of the crops. Similarly the contribution of different treatments for biomass production was studied and it was observed that the cropping system had an impact on the palm growth and production of recyclable biomass which was enhanced by the integration of different nutrient sources. The nutrient

combination where 50% RDF was supplied and rest 50% N was supplied from organic sources with biofertilizers and growth regulators produced maximum biomass in the system. The combination was 11 per cent superior to the combination of 75% RDF + 25 % N from vermicompost. Similarly, the 50:50 ratio of combination was 25.7 % superior to complete organic package. The PGR was more effective

with complete organic combination (75%) than the other treatments. The plant growth regulators which were used in the system are generally the growth enhancing hormones (auxins and gibberellins). Auxin influences the division of the cells which affect the growth of the plant and improved the fruit yield. The gibberellins cause the cell elongation which increases the weight produces of bunch in case of banana [13].

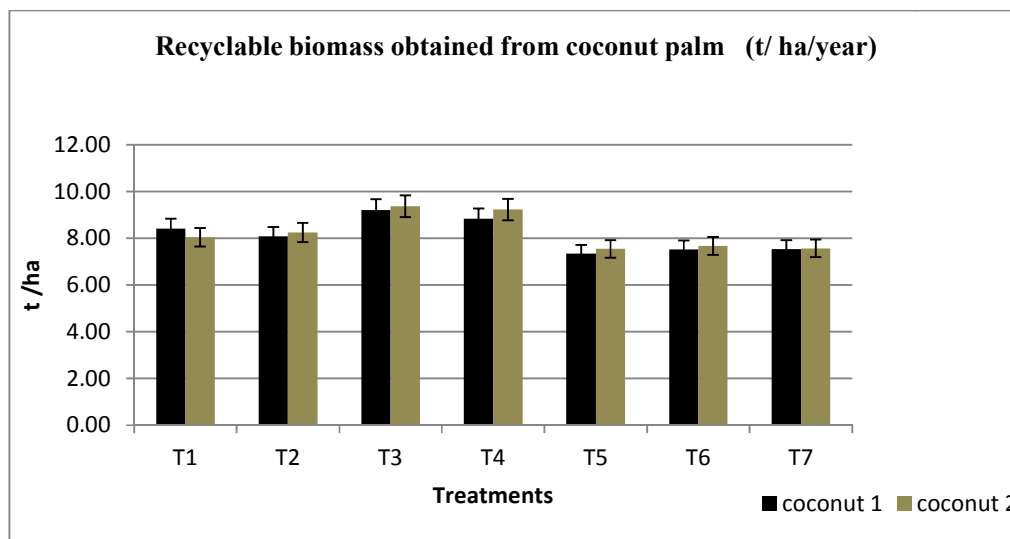


Fig. 2. Effect of cropping system and INM with or without PGR on generation of recyclable biomass from coconut palm

- Coconut 1- Recyclable biomass generated from coconut in 2016-17
- Coconut 2- Rcyable biomass generated from coconut in 2017-18

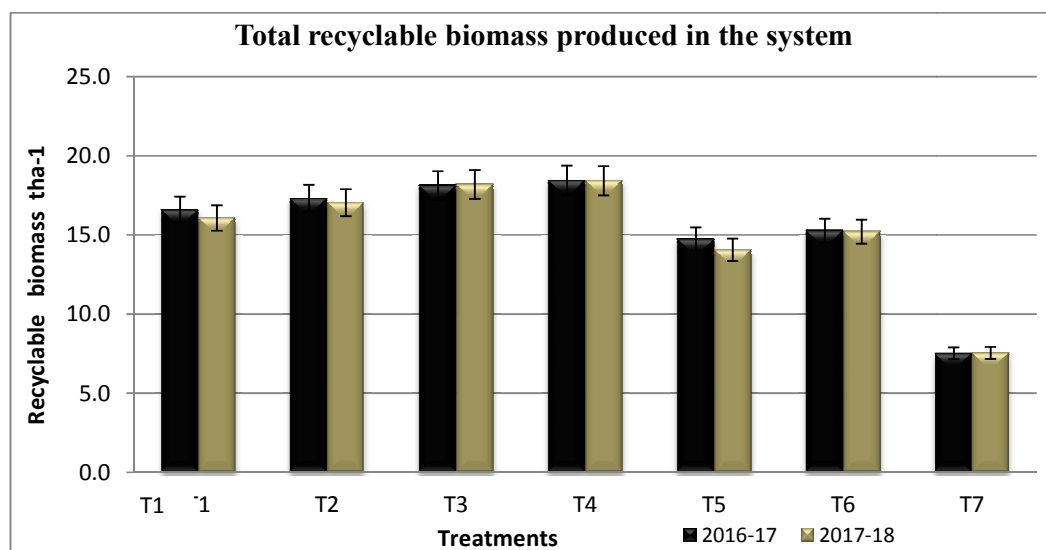


Fig. 3. Effect of cropping system and INM with or without PGR on generation of total recyclable biomass in the coconut based cropping system

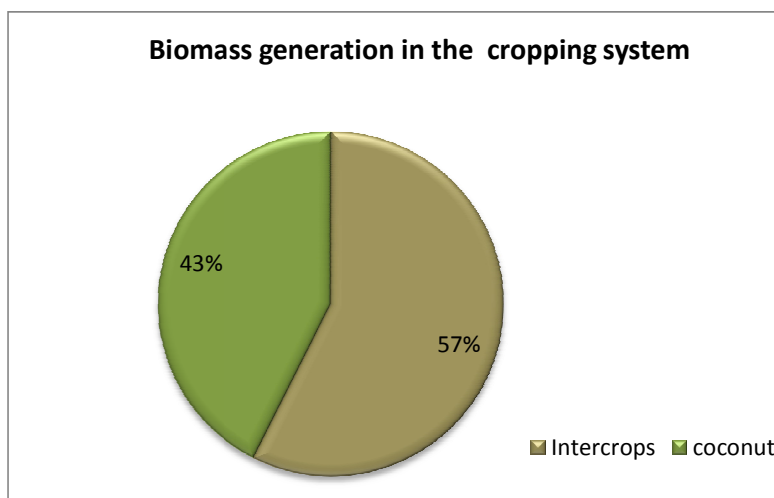


Fig. 4. Percentage of biomass produced by coconut and intercrops in the system

4. CONCLUSION

From the above experiment, it can be concluded that the addition of intercrops can add huge amount of recyclable biomass to the cropping system in addition to boosting the farmer income. This biomass can be recycled in to the system by vermicomposting which will improve the soil fertility and boost the yield of crops in sustainable manner. The production is also influenced according to different nutrient management practices. The combination of organic and inorganic sources, biofertilizers along with specific plant growth regulators enhanced the growth of plants so to the production of biomass.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Wani SP and Lee KK. Biofertilizers role in upland crops production. In Fertilizers, organic manures, recyclable wastes and biofertilizers (Tandon HLS, ed.) New Delhi, India: Fertilizer Development and Consultation Organization. 1992;91–112.
2. Maheswarappa HP. In-situ waste management in integrated nutrient management system under coconut (*Cocos nucifera* L.) based high density multi-species cropping system in tropical soils of India. Indian Journal of Agricultural Science. 2008;78(11):924–928.
3. Shyamsundar P, Springer NP, Tallis H, Polasky S, Jat ML and Sidhu H S, et al. Fields on fire: alternatives to crop residue burning in India. Science. 2019;365:536–538.
4. Gopal Murali, Alka Gupta and Thomas Gerorge V. Coconut leaf vermicompost and vermiwash. Extension folder No. 178, CPCRI, Kasargargod; 2007.
5. Ismail SA. Vermicology: The biology of earthworms. Orient Longman, India; 1997.
6. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: Indian Council of Agricultural Research. 1989;5:258-260.
7. Pattanayak SK Rao DL N and Mishra K N. Effect of biofertilizers on yield nutrient uptake and N economy of Rice- penut Cropping Sequence. Journal of Indian Society of Soil Science. 2007;48(4):769-773.
8. Anand MR, Shiva Kumar HD, Poojitha Kommireddy, Kalyana Murti K N. Secondary and micronutrient management practices in organic farming –an overview. Current Agriculture Research Journal. 2019;7(1):04-18.
9. Linhares PCF, Pereira MFS, Oliveira BS, Henriques GPSA, Maracajá PB. Produtividade de rabanete em sistema orgânico de produção. Revista Verde de Agroecologia. 2010;5.
10. Qin J, Culver D, Yu N. Effect of organic fertilizer on heterotrophs and autotrophs: implications for water quality management. Aquacult. Res. 1995;26:911-920.

11. Barkoh A, Schlechte JW, Hamby S, Kurten G. Effects of rice bran, cottonseed meal, and alfalfa meal on pH and zooplankton. N. Am. J. Aquacult. 2005;67: 237-243.
12. Shinde VV, Ghavale SL, Wankhede SM, Haldankar PM and Maheswarappa HP. Technology demonstration in coconut for higher productivity and profitability in coastal ecosystem of Maharashtra State. Green Farming. 2019;10(3):258-265.
13. Biswas PK, Lemtur K. Effect of growth regulators and certain organic sprays on Bunch Characters in Banana cv. ROBUSTA. The Asian Journal of Horticulture. 2014;9(1):269-271.

© 2021 Mishra et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

*The peer review history for this paper can be accessed here:
<https://www.sdiarticle4.com/review-history/72676>*