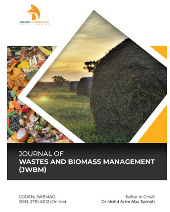
ZIBELINE INTERNATIONAL PUBLISHING

ISSN: 2710-6012 (Online)
CODEN: JWBMAO

Journal of Wastes and Biomass Management (JWBM)

DOI: http://doi.org/10.26480/jwbm.01.2020.19.23



RESEARCH ARTICLE

PERFORMANCE OF MANURE DERIVED FROM KITCHEN WASTES USING EFFECTIVE MICROORGANISMS (EM) AND INDIGENOUS MICROORGANISMS (IMO) TECHNOLOGY ON GROWTH AND YIELD PARAMETERS OF OKRA (*Abelmoschus esculentus* L.) AT BIRATNAGAR, NEPAL.

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ARTICLE DETAILS

Article History:

Received 25 June 2020
Accepted 26 July 2020
Available online 11 August 2020

ABSTRACT

An experiment was conducted at Biratnagar, Nepal in completely randomized block design to study the effect of effective microorganisms (EM) and indeginous microorganisms (IMO) along with recommended dose of fertilizers (RDF) on the growth and yield parameters of okra (variety: Arka Anamika). The 6 treatments viz. control, EM enriched manure, IMO enriched manure, RDF, RDF+EM, RDF+IMO and control were replicated thrice. The study showed that indeginous microorganisms when incorporated with recommended dose of NPK fertilizer (RDF+IMO) can produce best result in terms of yield and economic return. Rigorous study in multi location and more crops is suggested to develop an integrated nutrient management plan and household waste management.

KEYWORDS

completely randomized block design, microorganisms, RDF+IMO, waste management.

1. INTRODUCTION

The pace of urbanization and industrialization is being rapid which have created a major impact on the environment by pollution, global warming and health hazards. Coupled with population brust, they are causing in increased generation of complex solid waste (Singh et al., 2011). Rapid and uncontrolled urbanization, lack of public awareness, and poor management by municipalities have intensified environmental problems in towns in Nepal, including unsanitary waste management and disposal (ADB, 2013). Developing countries are generating huge quantity of solid wastes as they lack proper waste segregation and proper disposal facilities (Ngoc and Schnitzer, 2009). Open burning and open dumping are mostly practiced in these countries which not only create pollution and affect the urban landscape but also make unsustainable waste management practice (Amritha and Kumar, 2017). Waste management is the biggest problem for the present generation and challenge for the future doomed to live in this dumping yard called as earth because of haphazard waste management practices (Kale and Yehuda, 2018).

On average, at Nepal, households with monthly expenditures of NRs 40,000 ($417) and above generate more than twice as much waste as households with monthly expenditures of less than NRs5,000 ($52). Households in Terai municipalities generate nearly 80% more waste than those in mountain region municipalities. For institutional establishments, the average daily waste generation was 4.0 kilograms (kg) per school and 1.4 kg per office. Similarly, the average daily waste generation of commercial establishments was 1.4 kg per shop and 5.7 kg per hotel or restaurant. The analysis of household waste composition indicated that the highest waste category was organic waste with 66%, followed by plastics with 12%, and paper and paper products with 9%. The composition analysis of institutional wastes revealed 45% paper and paper products, 22% organic wastes, and 21% plastics. In total, 37% of municipal solid wastes in Nepal is disposed of in sanitary landfills, although not necessarily in a sanitary manner. Of the total budget, the municipalities spend an average of 10% for SWM, of which 60%–70% is used for street sweeping and collection, 20%–30% on transport, and any remaining small amount for final disposal. On average, municipalities spend about NRs 2,840 ($30) per ton of waste for collection, transport, and disposal (ADB, 2013). The Government of Nepal enacted the Solid Waste Management Act of 2011 effective from 15 June 2011. The objectives of the act include maintaining a clean and healthy environment by minimizing the adverse effects of solid waste on public health and the environment. The local bodies, such as municipalities, have been made responsible for the construction, operation, and management of infrastructure for collection, treatment, and final disposal of MSW. The act mandates local bodies to take the necessary steps to promote reduce, reuse, and recycle (3R), including segregation of MSW at source. It also provides for the involvement of the private sector, community-based organizations (CBOs), and nongovernment organizations (NGOs) in SWM through competitive bidding (Acharya, 2017).

When solid wastes are burned or incinerated, it realeases polychlorinated dibenzo-p-dioxins, dibenzofurans (PCDD/Fs), noxious and toxic gases whereas when they are openly dumped emits greenhouse gas (e.g., CH4, CO2 and N2O) causing air pollution and global warming (Sharma, et al., 2018). The biodegradable wastes generated in developing countries is one

Quick Response Code	Access this article online	
	Website: www.jwbm.com.my	**DOI:** 10.26480/jwbm.01.2020.19.23

Cite The Article:S. Khanal, S. Mishra And L. Dhakal(2020).Performance Of Manure Derived From Kitchen Wastes Using Effective Microorganisms (EM) And Indigenous Microorganisms (IMO) Technology On Growth And Yield Parameters Of Okra (*Abelmoschus Esculentus L.*) At Biratnagar, Nepal. *Journal Of Wastes And Biomass Management, 2(1): 19-23.*

of the largest sources of anthropogenic greenhouse gases emissions (Tian, et al., 2013). In this context, integrated solid waste management done through agricultural recycling of organic wastes can be more sustainable and eco-friendly approach than traditional methods of waste disposal and energy recovery (Sharma, et al., 2018). Recycling of organic waste into compost/vermicompost in agricultural field is loaded with following benefits:

• Sustainable alternative to chemical fertilizers and conservation of limited and non-renewable rock phosphate utilized as chemical P fertilizer (Hait and Tare, 2012)
• Improvement in soil nutrient profile and structure with reduced soil erosion
• Better aalternative to climate change mitigation due to reduced GHG emissions from waste decomposition in open dumps
• Conservation of land resource due to reduced amounts of landfilled waste
• Reduction in volume of wastes from dumpsites and minimize environmental pollution thereby causing better management (Schulz and Römheld, 2017).

Agricultural wastes are defined as the residues from the growing and processing of raw agricultural products such as fruits, vegetables, meat, poultry, dairy products, and crops. They are the non-product outputs of production and processing of agricultural products that may contain material that can benefit man but whose economic values are less than the cost of collection, transportation, and processing for beneficial use (Agamuthu, 2009). Along with agricultural wastes, food wastes have become a hot issue in recent years. Uneaten food and food preparation from residences, commercial establishments such as restaurants, and institutional industrial sources like school cafeteria and factory lunchrooms are termed as food wastes.

Out of total, 75% of material in today's landfill is recyclable or compostable, while 50-70 % of the weight of a foodservice's garbage consists of compostable items (Saravanan et al., 2013). Composting can be used for managing food wastes as it is a sustainable method and it produces bio-fertilizers, causes relatively low air and water pollution, is cost friendly and assit in generating income from their products (Li et al., 2013). Effective microbe or microorganisms (EM) is a type of microbial inoculant developed by Teruo Higa (1970s) which can be applied in compost production to accelerate the microbial degradation (Mbouobda et al., 2014).

As stated, that the EM consist of mixed cultures of beneficial, naturallyoccurring micro-organisms such as photosynthetic bacteria (e.g., *Rhodopseudomonas palustris*, *Rhodobacter sphaeroides*), lactobacilli (e.g., *Lactobacillus plantarum*, *L. casei*, and *Streptococcus lactis*), yeasts (e.g., *Saccharomyces spp.*), and *Actinomycetes* (*Streptomyces spp.*) (Zavaid, 2010). These microorganisms as follows: photosynthetic bacteria (phototrophic bacteria) are independent self-supporting microorganisms and they synthesise amino acids, nucleic acids, bio-active substances and sugars, using root secretions, organic matter (carbon), sunlight, and geothermal heat from the soil (Condor et al., 2007). Some researchers stated that the use of effective microorganisms have a number of applications, including agriculture, livestock, gardening and landscaping, composting, bioremediation, cleaning septic tanks, algal control and household uses (Khaliq et al., 2006). In this regard, this study was done inorder to study the effectivenss of effective microorganisms in generating compost using food wastes.

2. MATERIALS AND METHODS

2.1 Selection of study area

Biratnagar metropolitan city was selected for the purpose of the study. It is the capital of province no 1, Nepal. Its total area is 76.99 km^2 and has population of 214,663 with 105,836 females and 108,827 males (Biratnagar Metropolitan, 2020). The altitude ranges from 62 m to 76m above sea level. It is bordered by two rivers - Singhiya in the east and Kesaliya in the west. It is located in the Indo-Gangetic plain at 26^{0}28'N and 86^{0}19'E and is bordered by international boundary with India in the south. The area is composed mainly of quaternary sediments with very fertile soil mixed with clay, silt and sand. The climate at Biratnagar is subtropical monsoon type. The mean annual temperature ranges from about 25^{o}C to 30^{o}C and the maximum and minimum temperature is 42^{o}C and 5^{0}C respectively. The annual precipitation ranges from about 1595-2279 mm. More than 80 percent of the total annual rainfall occurs in four summer months (June to September). Average sunshine duration ranges from 6.97-7.23 hrs/day and average wind speed ranges from 1.2 km/hr. -1.8 km/hr (ADB, NEPAL: Preparing the Secondary Towns Integrated Urban Environmental Improvement Project., 2008).

2.2 Collection and preparation of Indiginous microorganisms (IMO)

Indigenous Micro-organisms (IMO) were collected from Following steps as given by were followed during this process (Abu-Bakar and Ibrahim, 2013):

i. One third of 1.8 m × 0.7 m sized plastic container was filled with cooked rice. The wasted rice was collected from nearby resteurants and houses nearby.
ii. Plastic was used to wap the container to protect it from rodents, insects, direct sunlight and rainfall.
iii. The container was then buried 10cm deep in the soil for seven days and was covered by dried leaves.
iv. Formation of white micellium indicated that the IMO was ready. Now 1:1 ratio of IMO 1 and molasses was made and kept in shade for seven days.
v. It was then diluted by adding 10gm of such fermented extract in 1 litre distilled water. It was then properly stirred.
vi. 8kg of rice bran was added to this solution and kept in plastic container which was then covered by straw and kept as such for 5 days.
vii. The solution was mixed with soil collected from a bamboo forest located at the bank of Kesalia River at the ratio of 1:1. It was kept as such for a week after which white micellium was noticed.

2.3 Collection and preparation of Effective microorganisms (EM)

i. EM-1 supplied by EMCO-Nepal was used for the purpose.
ii. A thick layer of rice bran was added at the bottom of a bucket.
iii. Food wastes were added to bucket and EM-1 was sprinkled to it. Waste layers were added until it was full.
iv. The bucket was full on 1 week time.
v. It was kept as such to facilitate pickling of food waste for 2 weeks.
vi. A trench was dug and the wastes were kept to it.
vii. Soil and ash was added over it and kept as such for two weeks. The mixture was used as manure.

2.4 Land preparation and planting

2.4.1 Description of site selected

The experiment was conducted at Biratnagar for 88 days from April 5, 2019 to July 1, 2019 from sowing to economic harvesting. The site was with latitude 26.48^0 and longitude as 87.24^0.

2.4.2 Treatment details

The land was cleared, ploughed and harrowed before laying the plots. The experimental design was randomized complete block with three replications. Treatments were control, EM only, IMO only, RDF only, RDF+EM and RDF+IMO. The treatment detail is shown in table 1. The NPK content of EM and IMO fertilizers was assessed which is shown in the table 2. Soil characteristics were analyzed at lab of Nepal Agriculture Research Council. The detail is shown in table 3.

Table 1: Description of treatments used in the research

Symbol	Description
T1	Control
T2	EM enriched manure
T3	IMO enriched manure
T4	RDF (Recommended dose of fertilizer)
T5	RDF+ EM enriched manure
T6	RDF+ IMO enriched manure

Note: The recommended dose of fertilizer as given by NARC is 200:180:60 Kg/ha.

Table 2: Organic matter, NPK content and ph of manure used

Type of fertilizers	Organic matter (%)	N	P	K	pH
EM enriched manure	33.59	2.7	2.24	1.41	6.6
IMO enriched manure	35.33	2.9	3.08	1.79	6.8

Table 3: Description of soil properties at research field

Description	Properties
Soil type	Alluvial and loamy
Organic matter percentage	3.1
Soil pH	6.3
Nitrogen (%)	0.17
P_2O_5(kg/ha)	54.96
K_2O (Kg/ha)	340.69
Sand %	42.6
Silt %	39.67
Clay %	17.73

The spacing of 50cm × 30cm and wide spacing of 1m around the research plot was used. Spacing of 75cm was used to separate the treatments and replications. The size of each plot was 2.5m × 1.8m. The research filed covers the entire area of 163.8 m^2. The number of plants in each plot were 30 out of which 18 were border plants and 12 plants located at inner side were the source of 5 sample plants in each plots.

The seeds were soaked overnight and were sowed. The recommended dose of fertilizer as given by Nepal Agriculture Research Council for okra is 200:180:60 kg/ha so for the plot prepared, 90:81:27 g NPK/ha was applied. 1.33 T/ha (600 gm per prescribed plot) of IMO and EM enriched manure were applied.

2.4.3 Data collection

2.4.3.1 Vegetative parameters

Table 4: Vegetative parameters of okra considered during study

S.N.	Parameters	Recorded at (Days after sowing)	Way of doing
1.	Plant height	20, 40,50 and 60	Measured from base to the tip
2.	Plant diameter	20, 40,50 and 60	Measured just below the 1st node
3.	Number of leaves	20, 40,50 and 60	Fully grown leaves were counted

2.4.3.2 Reproductive parameters

Table 5: Reproductive and yield parameters of okra considered during study

S.N.	Parameters	Recorded at (Days after sowing)	Way of doing
1.	Number of buds	40, 50, 60 and 70	Total number of floral buds were counted
2.	Number of flowers	40, 50, 60 and 70	Total number of open flowers were counted
3.	Number of fruits	40, 50, 60 and 70	Total number of fruits were were counted
4.	Yield	3 days interval after 45 DAS	Collected and weighed. Harvesting was done 20 times and were weighed.

2.4.4 Data entry and analysis

The data were entered in MS-EXCEL 2013 and were imported in R Studio where one-way ANOVA was performed.

3. RESULT AND DISCUSSION

3.1 Vegetative parameters

The effect of different fertilizers on plant height was not found to be significant at 20 DAS, 40 DAS and 60 DAS. However, significant difference was observed at 50 DAS. Maximum plant height was observed in RDF+ IMO enriched manure which was at par with RDF+ EM enriched manure and RDF whereas significantly higher than other treatments as shown in table 6.

Table 6: Effective of different fertilizers on plant height of okra

	Plant height (cm)			
	20 DAS	40 DAS	50 DAS	60DAS
Control	6.3	51.79	73.21^c	104.29
EM enriched manure	6.5	56.21	78.45^b	117.19
IMO enriched manure	6.6	60.90	78.76^b	117.93
RDF (Recommended dose of fertilizer)	6.8	61.48	85.26^{ab}	115.23
RDF+ EM enriched manure	7.1	62.30	87.92^a	118.61
RDF+ IMO enriched manure	7.3	63.21	88.75^a	118.78
SEM (±)	0.16	1.19	1.69	1.67
LSD (0.05)	0.90	8.94	8.97	12.2
CV (%)	6.89	8.86	7.21	6.16
F test	Ns	Ns	*	Ns

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

At 20DAS and 40 DAS, there was no significant difference in the plant diameter, whereas, significant difference was noted in later dates. RDF+ IMO enriched manure showed maximum plant diameter than other treatments at 50 DAS and 60 DAS. It was at par with RDF+ EM enriched manure but significantly higher than other treatments. Detail is shown in table 7.

Table 7: Effect of different fertilizers on plant diameter of okra

	Plant diameter (cm)			
	20 DAS	40 DAS	50 DAS	60DAS
Control	0.53	1.18	1.34^a	1.46^a
EM enriched manure	0.56	1.26	1.48^b	1.75^b
IMO enriched manure	0.55	1.27	1.5^b	1.76^b
RDF (Recommended dose of fertilizer)	0.59	1.28	1.35^a	1.79^b
RDF+ EM enriched manure	0.58	1.28	1.74^{bc}	1.83^{bc}
RDF+ IMO enriched manure	0.56	1.30	1.92^c	2.2^c
SEM(±)	0.01	0.03	0.08	0.05
LSD(0.05)	0.88	0.21	0.40	0.33
CV(%)	8.76	9.34	12	9.8
F test	Ns	Ns	*	*

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

There was no significant change in number of leaves in 20 DAS and 40 DAS among the treatments. Maximum leaf number was seen in RDF+ EM enriched manure which was at par with RDF+ IMO enriched manure and RDF. Control and EM enriched treatment had lower number of leaves at 50 DAS. At 60 DAS number of leaves of RDF treatment was at par with control, EM and IMO manure but significantly lower than RDF+ EM enriched manure and RDF+ IMO enriched manure. Detail is shown in table 8.

Table 8: Effect of different fertilizers on leaves number of okra.

	Number of leaves			
	20 DAS	40 DAS	50 DAS	60DAS
Control	5.64	13.80	17.10^a	25.18^a
EM enriched manure	5.85	17.03	18.70^a	29.72^a
IMO enriched manure	5.34	15.40	19.83^{bc}	31.32^b
RDF (Recommended dose of fertilizer)	5.66	15.70	22.05^{cd}	30.71^a
RDF+ EM enriched manure	5.87	17.23	26.83^d	48.60^c
RDF+ IMO enriched manure	5.89	18.10	24.93^d	35.62^{bc}
SEM(±)	0.1	0.82	0.95	1.67
LSD(0.05)	0.92	5.67	5.6	10.8
CV(%)	9.24	18.6	13.8	16.9
F value	Ns	Ns	*	*

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

3.2 Reproductive parameters

The number of buds were not significantly different in the dates of data collection apart from that at 70 DAS. Plot with recommended dose of fertilizers solely and with IMO and EM were at par with each other whereas were significantly higher than that of control, EM enriched manure and IMO enriched manure. Detail is shown in table 9.

Table 9: Effect of different fertilizers on number of buds of okra

	Number of buds			
	40 DAS	50 DAS	60 DAS	70 DAS
Control	4.83	5.67	8.98	9.86[a]
EM enriched manure	5.07	6.60	9.12	10.95 [a]
IMO enriched manure	5.14	7.30	9.42	10.29[a]
RDF (Recommended dose of fertilizer)	6.21	7.41	9.65	13.87[b]
RDF+ EM enriched manure	6.42	6.46	10.2	14.32[b]
RDF+ IMO enriched manure	6.45	7.96	10.46	14.02 [b]
SEM(±)	0.27	0.37	0.62	0.76
LSD(0.05)	2.11	2.45	3.76	3.47
CV(%)	19.98	15.82	20.8	16.5
F value	Ns	Ns	Ns	*

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

Table 10: Effect of different fertilizers on number of flowers of okra

	Number of flowers			
	40 DAS	50 DAS	60 DAS	70 DAS
Control	0.38[a]	0.43 [a]	0.6	1.07
EM enriched manure	0.38 [a]	0.46 [a]	0.6	1.13
IMO enriched manure	0.39 [a]	0.46 [a]	0.6	1.2
RDF (Recommended dose of fertilizer)	0.42 [a]	0.66[ab]	0.8	1.23
RDF+ EM enriched manure	0.64[b]	0.74[b]	0.8	1.6
RDF+ IMO enriched manure	0.61 [b]	0.76 [b]	0.8	1.6
SEM(±)	0.24	0.34	0.04	0.73
LSD(0.05)	2.09	2.19	0.26	3.45
CV(%)	20.87	16.8	22.7	16.3
F value	*	*	Ns	Ns

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

The number of flowers were significantly different at 40 DAS and 50 DAS but were insignificant at later dates. The number of flowers at 40DAS was maximum with RDF+ EM enriched manure and was at par with RDF+ IMO enriched manure but significantly higher than other treatments. In both the case, EM enriched manure and IMO enriched manure was at par with control. At 50 DAS, the number was maximum at RDF+ IMO enriched manure, which was at par with RDF and RDF+ EM enriched manure. Detail is shown in table 10.

Table 11: Effect of different fertilizers on number of fruits of okra

	Number of fruits			
	40 DAS	50 DAS	60 DAS	70 DAS
Control	0.40[a]	1.47	2.34[a]	2.27
EM enriched manure	0.60[ab]	1.47	2.40 [a]	2.34
IMO enriched manure	0.66 [ab]	1.67	2.90 [a]	2.47
RDF (Recommended dose of fertilizer)	0.86[b]	1.69	3.10 [a]	2.54
RDF+ EM enriched manure	0.93 [b]	1.73	3.67 [ab]	2.62
RDF+ IMO enriched manure	0.96 [b]	2.06	4.10 [b]	2.94
SEM(±)	0.06	0.11	0.2	0.12
LSD(0.05)	0.38	0.75	1.1	1.1
CV(%)	27.8	26.2	20.3	24.7
F value	*	Ns	*	Ns

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

The type of fertilizer used significantly affected the number of fruits obtained at 40 DAS and 60 DAS only. RDF+ IMO enriched manure was the best performer in both the case followed by RDF+ EM enriched manure and sole application of RDF. Detail is shown in table 11.

Table 12: Effect of different fertilizers on plant diameter of okra

	Average yield (t/ha)
Control	9.62a
EM enriched manure	12.51[ab]
IMO enriched manure	14.65[b]
RDF (Recommended dose of fertilizer)	15.63[b]
RDF+ EM enriched manure	16.74[b]
RDF+ IMO enriched manure	18.01[c]
SEM (±)	0.84
LSD (0.05)	3.88
CV (%)	14.3
F value	**

Note: Means with the same letter are non-significant at p=0.05 by DMRT, SEM= Standard error of mean, LSD=Least significant difference, CV=Coefficient of variation, NS=Non-significant, *: 5% level of significance.

The average yield was significantly different among treatments. The maximum yield was obtained with RDF+ IMO enriched manure, which was significantly higher than others. Detail is shown in the table 12.

Some researchers found that EM application in FYM, TCR, and NPK amendments increased the yield of 24%, 15%, and 84% respectively in *Vigna radiata* (L.) (Javaid and Bajwa, 2011). Other researcher also obtained similar result of cabbage while assessing the effectivess of effective micororganisms (Chantal, et al., 2010). Similarly, stated that indigenous microorganisms enhace growth though nitrogen fixation, solubilizing insoluble organic phosphate compounds or hydrolyzing organic phosphate into inorganic and stimulating IAA production (Phua et al., 2012). The finding showed that the integration of EM and IMO enriched manure can be a tool for increasing yield and other growth parameters of vegetables rather than sole application of these fertilizers.

3.3 Economic parameter

Based on the rates available for the inputs used the total common cost was calculated to be NRs. 253,500 (Table 13). The total cost on each treatment is shown in table 14. RDF+IMO showed maximum B:C ratio of 1.87, followed by RDF and RDF+EM with 1.79 and 1.75 respectively as shown in table 15.

Table 13: Estimation of common cost incurred in okra cultivation

S.N.	Particulars	Amount (Rs/ha)
1	Land rentals	120,000
2	Field preparation	6,500
3	Cost of seed	23,000
4	Irrigation	62,000
5	Manuring cost of labor	1,500
6	Weeding	16,000
7	Harvesting	24,500
	Total	253,500

Table 14: Estimation of total cost incurred in okra cultivation

S.N.	Particulars	Amount	Common cost	Total
1	EM enriched manure	25,465	253,500	278,965
2	IMO enriched manure	26,674	253,500	280,174
3	Control	-	253,500	253,500
4	RDF	7,632	253,500	261,132
5	RDF+EM	33,097	253,500	286,597
6	RDF+IMO	33,306	253,500	286,806

Table 15: Estimation of B:C ratio in okra cultivation

S.N.	Particulars	Total cost	Revenue (Rs./ha)	B:C
1	EM enriched manure	278,965	375,300	1.34:1
2	IMO enriched manure	280,174	439500	1.56:1
3	Control	253,500	288,600	1.13:1
4	RDF	261,132	468,900	1.79:1
5	RDF+EM	286,597	502,200	1.75:1
6	RDF+IMO	287,806	540,300	1.87:1

4. Conclusion

This study concluded that the highest benefit cost ratio of 1.87 was found in case of integrated application of recommended dose of NPK fertilizer along with enriched IMO manure with the productivity of 18.01 T/ha. The combination was found to be superior in most of the growth parameters of plant. It has shown that the waste food materials can be also a viable manure option. Hence, incoprporating indigenous microorganisms in nutrient management plan of crops was observed to be beneficial in terms of yield and economic perspectives. Further expansion of trails in multi location should be carried out to suggest more concrete way of management and application of the manure and reduction and management of household wastes.

References

Abu-Bakar, N., Ibrahim, N., 2013. Indigenous microorganisms' production and the effect on composting process. AIP Conference Proceedings. doi:10.1063/1.4858669

Acharya, H., 2017. Muncipal solid waste management; problem and opportunity. Retrieved from http://naturekhabar.com/en/archives/3169

ADB. 2008. NEPAL: Preparing the Secondary Towns Integrated Urban Environmental Improvement Project. Asian Development Bank. Retrieved 02 08, 2020, from https://www.adb.org/sites/default/files/project-document/75215/36188-01-nep-tacr-17.pdf

ADB. 2013. Solid waste management in Nepal: Current status and policy recommendations. Mandaluyong, Philippines: Asian Development Bank. Retrieved 4 12, 2020, from https://www.adb.org/sites/default/files/publication/30366/solid-waste-management-nepal.pdf

Agamuthu, P., 2009. Challenges and opportunities in Agro-waste management: An Asian perspective. Inaugural meeting of First Regional 3R Forum in Asia 11 -12 Nov., Tokyo, Japan. 2009.

Amritha, P., Kumar, P., 2017. Productive landscapes as a sustainable organic waste management option in urban areas. Environ Dev. doi: https ://doi.org/10.1007/s1066 8-017-0056-0

Biratnagar Metropolitan. 2020. Introduction to Biratnagar metropolitan city. Retrieved from http://biratnagarmun.gov.np/ne

Chantal, K., Xiaohou, S., Weimu, W., Iro Ong'or, B., 2010. Effect of effective microorganisms on yield and quality of vegetable cabbage comparatively to nitrogen and phosphorus fertilizers. Pakistan Journal of Nutrition, 9 (11), Pp. 1039-1042.

Condor, A., Gonzalez, P., Lakre, C., 2007. Effective microorganisms: Myth or reality? The Peruvian Journal of Biology, 14, Pp. 315-319.

Hait, S., Tare, V., 2012. Transformation and availability of nutrients and heavy metals duringintegrated composting–vermicomposting of sewage sludge. Ecotox Environ Saf, 79, Pp. 214-224.

Javaid, A., Bajwa, R., 2011. Effect of Effective Microorganism Application on Crop Growth, Yield, and Nutrition in Vigna radiata (L.) Wilczek in Different Soil Amendment Systems. Communications in Soil Science and Plant Analysis, 42 (17), Pp. 2112-2121. doi:10.1080/00103624.2011.596240

Kale, A., Yehuda, R., 2018. Solid Waste Management Model for Tuljapur Pilgrimage City, Maharashtra, India. Global Journal for Research Analysis, 6 (11).

Khaliq, A., Abbasi, Hussain, M., 2006. Effects of integrated use of organic and inorganic nutrient sources with Effective Microorganisms (EM) on seed cotton yield in Pakistan. Bioresource Technology, 97, Pp. 967-972.

Li, Z., Lu, H., Ren, L., He, L., 2013. Experimental and mod-eling approaches for food waste composting: A review. Chemosphere, 93 (7), Pp. 1247-1257.

Mbouobda, H., Fotso, F., Djeuani, C., Baliga, M., Omokolo, D., 2014. Comparative evaluation of enzyme activities and phenol content of Irish potato (Solanum tuberosum) grown under EM and IMO manures Bokashi. International Journal of Biological and Chemical Sciences., 8 (1), Pp. 157-166.

Ngoc, U., Schnitzer, H., 2009. Sustainable solutions for solid waste management in Southeast Asian countries. Waste management, 29 (6), Pp. 1982-1995.

Phua, C., Wahid, A., Rahim, A., 2012. Development of multifunctional bio fertilizer formulation from indigenous microorganisms and evaluation of Their N2-fixing capabilities on chinese cabbage using 15 N tracer technique. Pertanika Journal of Tropical Agricultural Science, 35, Pp. 673–679.

Saravanan, P., Kumar, S., Ignesh, A., Ajithan, C., 2013. Eco-friendly practice of utilization of food wastes. International Journal of Pharmaceutical Science Invention, 2 (1), Pp. 14-17. Retrieved 5 1, 2020, from http://www.ijpsi.org/VOl(2)1/Version_1/E211417.pdf

Schulz, R., Römheld, V., 2017. Recycling of municipal and industrial organic wastes in agriculture: benefits, limitations, and means of improvement. In Plant nutrition for sustainable food production and environment, Pp. 581-586.

Sharma, B., Vaish, B., Srivastava, V., Singh, S., Singh, P., Singh, R., 2018. An insight to atmospheric pollution-improper waste management and climate change nexus. In Modern age environmental problems and their remediation, Pp. 23-47.

Singh, R., Singh, P., Araujo, A., Ibrahim, M., Sulaiman, O., 2011. Management of urban solid waste: vermicomposting a sustainable option. Resource Conservation & Recycling., 55 (7), Pp. 719-729.

Tian, H., Gao, J., Hao, J., Lu, L., Zhu, C., Qiu, P., 2013. Anthropogenic pollution problems and control proposals associated with solid waste management in China: A review. Hazard Mater, 252, Pp. 142–154.

Zavaid, A., 2010. Beneficial microorganisms for sustainable agriculture. Sustainable Agriculture Reviews, 4, Pp. 357-369.