STATUS OF COMPOST USAGE AND ITS PERFORMANCE ON VEGETABLE PRODUCTION IN MONGA AREAS OF BANGLADESH

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Abstract

The present study was carried out to assess the existing status of compost usage on vegetable production and determine the overall effect of household waste compost (HWC) on growth and yield of vegetables and enhancement of soil fertility in the monga areas of Bangladesh. A field survey was conducted on 152 sampled farmers during 2010 to 2011. Questionnaire containing both closed and open-ended questions were used to assess existing production practices of vegetables using compost in both homestead and field conditions. Three field trials at Badargonj and Kawnia upazilas of Rangpur district were conducted taking four treatments i.e. control, recommended doses (RD) of fertilizers, HWC at the rate of 10 tha^{-1}, and HWC 10 t ha^{-1} plus RD as IPNS based with Lal shak, Palong shak, Pui shak and Tomato. Base line survey results indicated inadequate knowledge of the farmers on use and preparation of the household waste compost. Yield data of all vegetables i.e. Tomato, Lal shak, Palong shak and Pui shak indicated that the combined application of nutrients using organic and inorganic sources were significantly better than that of solitary application of inorganic fertilizers. The potential of household waste compost applied @ 10 t ha^{-1} along with inorganic fertilizers applied was found highly satisfactory in producing Tomato, where yield was recorded 75 t ha^{-1} in the study area. The fresh yield of Palong shak was found 16 t ha^{-1} when recommended doses of inorganic fertilizers were applied, but it was about 19 t ha^{-1} under combined application of HWC @ 10 t ha^{-1} and inorganic fertilizers following IPNS concept. The fresh yield of Pui shak was found about 49 t ha^{-1} under combined application of organic and inorganic nutrients. Considering the availability and costs of different composts, it is evinced that HWC contained good amount of NPK which indicates its potentiality to be used as a soil amendment, improving soil fertility and crop productivity. It can be an alternative to chemical fertilizer to increase soil microbial populations and enzyme activities and to promote the soil nutrient for horticultural crops in the unfertile areas especially in the monga areas of Bangladesh.

Keywords: Compost, Monga, Vegetable, Soil Fertility

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Introduction

It is a great challenge to keep the agricultural production system sustainable under changing climate. Agriculture in Bangladesh faces the challenge of producing crops from its limited land resource to meet up the huge demand of foods for its ever-growing population. The scope is limited to bring new land under cultivation. Therefore, intensification of land with modern crop varieties for increased production is a necessary (Rahman and Azam, 2005). Heavy pressure on agricultural land through intensive cultivation of high yielding crop varieties using inorganic fertilizers solely and almost no recycling from organic residues has led to decline organic matter and mining out the inherent plant nutrients from soils (Karim *et al.*, 1994). Soil organic matter is an indicator of its

fertility and thereby crop productivity. According to BARC (2005), a good soil should have at least 2.5% organic matter, but most of the soils in Bangladesh have less than 1.5%, and some soils even less than 1% organic matter. The soils of the Monga area of Bangladesh are seriously depleted and organic matter content is very low. Monga is a local term, which means seasonal food scarcity occurring in September – November and March – April in the northern part of Bangladesh. During the period people become jobless leading to poverty. Production of short duration vegetables during this crisis period using household waste compost can be a better option for increasing income, available of domestic foodstuff towards reduction of monga. The use of household waste,

poultry manure and cow dung contributes to the requirement to maintain the long-term fertility of soils by improving physical and chemical properties of soils (Rahman, 2010). Cow dung and crop residues are used as fuel for cooking in many rural areas of Bangladesh and thereby are not available for using in the crop fields. However, household waste is available in everywhere and its composting is very easy. Household waste contains valuable plant nutrients especially N, P, S, K and many other macro and micronutrients, which may pollute the environment if not properly managed and utilized for crop production. Agricultural use of household waste may substantially cut down the cost of production reducing application of inorganic fertilizers especially for short duration vegetable production in the homestead and thus ensure an eco-friendly environment. Therefore, household waste compost could be a good alternative for replenishment of organic matter in soils. Therefore, the project was designed to (a) assess the existing status of using organic manures in vegetable production, (b) motivate the farmers for preparing household wastes compost for vegetable production, and (c) improve soil health in the project area.

Methodologies

Social survey

Interview schedule containing both closed and open-ended questions were prepared as per project objectives. A total of 152-farmers (68 from Kawnia and 84 from Badarganj upazilas of Rangpur district of Bangladesh) were selected based on some criteria viz., home near to well-communicated road; possess at least two decimal spare and sunny homestead area and willing to cultivate vegetables following guidelines provided by the project authority. Trained enumerators were engaged to collect primary data from the selected respondents. The field survey was conducted to delve into their livelihood activities including vegetables production practices, income and expenditure, education and health care, and other related aspects of food quality and production. Selected respondents were trained on preparation of household waste compost and its application for vegetable production in homestead areas. Of them twenty were chosen for conducting trial. As per project objectives, selected farmers prepared household wastes

compost in their own homestead and used for vegetable production in the same areas.

Field trials

A series of trials were laid out in a factorial (nutrients x locations) randomized complete block design with four replications during 2010-2011. The four levels of nutrient treatments were: (1) control, (2) recommended doses (RD) of fertilizers, (3) household waste compost (HWC) at the rate of 10 t ha⁻¹, and (4) HWC 10 t ha⁻¹ plus RD as IPNS based. During the 2010-11 two trials (first one as per nutrient treatments mentioned and the second one using residual nutrients i.e. without applying either compost or inorganic fertilizers) with Palong shak (Spinach) were conducted in 17 locations/villages (Kawnia 7 and Badarganj 10). The dates of sowing of Palong shak seeds were November 3 to December 14, 2010 for the first trial, while for the second one were December 11, 2010 to January 20, 2011. The crop was harvested after 30-35 days of sowing. During the 2010-11, among 17 villages ten were selected (Kawnia 5 and Badarganj 5) to grow Lal shak (Red Amaranth) as first crop using nutrients as per treatments, while second crop Pui shak (Indian spinach) without applying nutrients. The seeds of Lal shak was sown on February 10, 2011 and harvested on March 18, 2011. The Pui shak was sown on April 10, 2011 and harvested on June 8, 2011. During 2010-11, one farmer from Kawnia grew Lal shak, Pui shak and Tomato as first, second and third crops, respectively in the same piece of land using above mentioned four treatments. The Lal shak was sown on July 1, 2010 and harvested on August 4, 2010, while Pui shak was sown on August 19, 2010 and harvested on September 25, 2010. Tomato seedlings were transplanted on November 23, 2010 and final harvest was done on March 25, 2011. In the treatment 4, where household waste compost was applied at the rate of 10 t ha⁻¹ plus recommended doses of N, P and K as IPNS based before sowing Lal shak and after that Pui shak was grown without applying nutrients and Tomato was grown using only nitrogen (N) at the rate of 117 kg ha⁻¹. Before applying to soils house hold waste compost, and initial soil were analyzed for quantifying the nutrients (Table 1) and then rates of chemical fertilizers were calculated following IPNS concept.

Table 1. N, P and K content of household waste compost and initial soil in the study area

Waste material	Total N (%)	Available N (%)	Total P (mg kg⁻¹)	Available P (mg kg⁻¹ soil)	Exchangeable K (mg kg⁻¹ soil)
Household waste compost	1.36	0.089	1650	450	1410
Plot soil	0.090	0.030	-	12.84	0.14 *

* unit of K for plot soil was meq 100 g⁻¹ soil that was for fertilizer recommendation of crops

After harvesting of the Lal shak and Tomato soil samples were collected from each plot at 0-15 cm depth and were analyzed for pH, OM and residual nutrients. Soil pH was determined by Glass Electrode pH Meter method with soil water ratio 1:2.5 (McLean, 1982), OM by Walkley-Black method (Nelson and Sommers, 1982), total N was determined by Kjeldhal systems (Bremner and Mulvaney, 1982), total P was determined by the Acid Digestion method (Jones and Case, 1990; Watson and Issac, 1990), available P by Olsen's method (Olsen and Sommers, 1982), and K by Ammonium acetate extraction method (Barker and Surh, 1982). Available N (NO_3^--N plus NH_4^+-N) was determined using Steam Distillation method (Keeney and Nelson, 1982). The analyses of variance for different parameters were done following the principle of F-statistics and the mean results was compared using Duncan's Multiple Range Test (DMRT).

Results and Discussion

Social survey

Base line survey was conducted on selected 152 farmers (68 from Kawnia and 84 from Badargonj, Rangpur). The main emphasis of the base line survey was on the knowledge of the respondents on preparation and use of household wastes compost and benefits of cultivating vegetables. The findings obtained have been presented in the following headings:

Preparation of household wastes compost with cow dung

Village people usually do not prepare and use scientifically household wastes compost. Rural women throw these here and there around their homestead. Household wastes composts can be prepared in many ways. Information displayed in Table 2 indicate that about four-fifths of the respondents (79%) are using cow dung compost including household wastes and interestingly about one-fifth (21%) used it in other ways.

Table 2. Distribution of the respondents according to types of preparation of household wastes compost with cow dung

Preparation of household wastes compost with cow dung	Respondents	
	Number	Per cent
Direct application in the field	0	0
Composting in separate pit	0	0
Composting with cow dung	120	79
Other ways (if any)	32	21

Time of preparation of cow dung compost

Findings available in Table 3 show that almost all of the respondents (91%) are found using cow dung compost during final land preparation. Though the next negligible portion of them (9%) are found using cow dung compost in other ways i.e. throw in the field whenever available, use during intercultural operations.

Table 3. Distribution of the respondents according to the time of preparation of cow dung compost

Time of using cow dung compost	Respondents	
	Number	Per cent
During final land preparation	138	91
After 15 days of planting	0	0
After 30 days of planting	0	0
Other ways (if any)	14	20

Doses of cow dung compost

Fertilizers and manures are applied in the field based on the demand of the crops grown. The respondents do not care for required doses of the cow dung compost. Information displayed in the Table 4 point out that more than half of the respondents (51%) use cow dung compost @ 10 t ha^{-1} followed by near about half (45%) use @10 t ha^{-1}.

Table 4. Distribution of the respondents according to the using doses of cow dung compost

Doses of cow dung compost	Respondents	
	Number	Per cent
5 t ha^{-1}	6	4
10 t ha^{-1}	77	51
15 t ha^{-1}	69	45
20 t ha^{-1}	2	1

Benefits of using household wastes compost

There are lot of benefits can be harvested by using cow dung compost like increased soil fertility, sound environment, low production cost, higher yield of vegetables, better quality of products etc. Respondents were asked for demonstrating their opinions regarding the benefits of using cow dung compost. Results demonstrated in Table 5 specify that more than four-fifths of the respondents (84%) indicate low production cost, followed by 18 per cent higher yield of vegetables and 13 percent increased soil fertility as the benefits of using cow dung compost.

Table 5. Distribution of the respondents according to their responses on the benefits of using cow dung compost

Benefits of using cow dung compost	Respondents	
	Number	Per cent
Increase soil fertility	19	13
Low production cost	128	84
Higher yield of vegetables	28	18
Sound environment	2	1
Others	0	0

Usefulness of vegetables cultivation

Vegetable cultivation may harvest varieties of advantages like high nutritional value, short durational, prevent disease, higher income etc. However, almost all of the respondents (91%) under study point out higher income as one of the most benefit of vegetable cultivation. A tiny portion of them (8%) indicates prevention of diseases, followed by high nutritional value (5%) and short duration (3%) as the advantages of vegetable cultivation (Table 6).

Table 6. Distribution of the respondents according to their knowledge on the usefulness of vegetables cultivation

Benefits of cultivating vegetables	Respondents	
	Number	Percent
High nutritional value	8	5
Short durational	5	3
Prevent disease	12	8
Higher income	139	91
Others	0	0

Results of field trials in the study area

Fresh yields of Palong shak

Fresh yields of Palong shak were significantly affected by different nutrient levels over the control (Table 7), but location did not show any significant effect on its yield (Table 8).

Table 7. Fresh yield of Palong shak under different nutrient levels in Kawnia and Badarganj, Rangpur

Nutrient levels	Fresh yield of Palong shak (t ha^{-1})	
	First harvest	Second harvest
Control	3.62c	4.91b
Recommended doses of NPK	15.79b	16.09a
Household waste 10 t ha^{-1}	15.67b	17.99a
Household waste 10 t ha^{-1} + RD* of N (IPNS concept)	18.55a	18.86a
S.E. (±)	0.36	0.27
%CV	22.16	22.49

*RD = Recommended dose

Table 8. Fresh yield of Palong shak under different locations in Kawnia and Badarganj, Rangpur

Locations		Fresh yield of palong shak (t ha^{-1})	
Upazila	Village	First harvest	Second harvest
Kawnia	Kachu	10.86	11.17
	Shingerkura	13.21	10.53
	Nazirdah	13.14	14.46
	Shabdi	13.04	15.36
	Madhupur	13.99	14.30
	Shahabaz	13.24	16.56
	Haragach	14.57	14.89
Badarganj	Shonkorpur	13.31	17.63
	Amrulbari	12.84	13.11
	Kachabari	12.99	13.31
	Nataram	13.67	14.98
	Rajarampur	14.36	14.68
	Gopalpur	14.14	13.41
	Khiarpara	14.27	16.51
	Radanagar	14.11	12.42
	Osmanpur	13.62	15.94
	Ramnathpur	12.56	16.87
S.E. (±)		0.74	0.77
%CV		22.16	22.49

It should be noted that crops grown using combined nutrients i.e. household waste and recommended N following IPNS concept were found somewhat better over solitary application of either organic or inorganic nutrients. The fresh yield of Palong shak was found 16 t ha^{-1} when recommended doses of inorganic fertilizers were applied, but it was about 19 t ha^{-1} under combined application of organic and inorganic nutrients in both years.

Fresh yields of Lal shak and Pui shak were significantly influenced by different nutrient levels over the control, but location did not show any significant effect on its yield in Kawnia and Badarganj (Table 9 and 10). Yields of Lal shak grown using combined nutrients i.e. household waste and recommended N following IPNS concept were found significantly higher over recommended doses of fertilizers and only household waste. In case of Pui shak, application of recommended fertilizers and only household waste provided same amount of yield i.e. 45 t ha^{-1}, however combined applications of inorganic fertilizers and household waste gave significantly higher yield over solitary application of either organic or inorganic fertilizer. The fresh yield of Pui shak was found about 49 t ha^{-1} under combined application of organic and inorganic nutriments.

Table 9. Fresh yield of Lal shak and Pui shak under different nutrient levels in Kawnia and Badarganj, Rangpur

Nutrient levels	Fresh yield of Lal shak and Pui shak (t ha^{-1})	
	Lal shak	Pui shak
Control	9.91d	16.72c
Recommended doses of NPK	20.61c	45.19b
Household waste 10 t ha^{-1}	29.07b	45.36b
Household waste 10 t ha^{-1} + RD of N (IPNS concept)	34.79a	48.66a
S.E. (±)	0.65	1.13
%CV	17.51	18.41

Table 10. Fresh yield of Lal shak and Pui shak under different locations in Kawnia and Badarganj, Rangpur

Locations		Fresh yield of Lal shak and Pui shak (t ha^{-1})	
Upazila	Village	Lal shak	Pui shak
Kawnia	Kachu	22.75	39.34
	Shingerkura	23.22	37.42
	Nazirdah	25.11	39.80
	Shabdi	24.34	42.52
	Haragach	22.69	37.41
	Amrulbari	21.08	40.40
Badarganj	Nataram	23.59	39.31
	Rajarampur	23.42	35.56
	Gopalpur	24.84	38.78
	Ramnathpur	24.93	39.29
S.E. (±)		1.03	1.79
%CV		17.51	18.41

Treatments containing different levels of nutrients significantly improved soil pH and OM in soils after harvesting of Lal shak in Kawnia and Badargonj, Rangpur (Table 11). Though the treatments did not show any significant effects on N, P and K contents in soils after harvesting of the crop, however these parameters were improved in soils with the application of household waste. The increment of nutrients in soils with the application of household waste compost indicated the improvement of soil fertility. Different locations did not show significant effect on residual nutrients in soils after harvesting of Lal shak (Table 12).

Table 11. Soil properties after harvesting of Lal shak under different nutrient levels in Kawnia and Badarganj, Rangpur

Nutrient levels	Soil properties at crop harvest				
	pH	OM (%)	N (%)	P (mg kg^{-1})	K (meq 100 g^{-1})
Control	5.15b	1.13b	0.10	14.12	0.17
Recommended doses of NPK	5.18b	1.14a	0.13	15.23	0.23
Household waste 10 t ha^{-1}	5.85a	1.30a	0.12	18.54	0.23
Household waste 10 t ha^{-1} + RD of N (IPNS concept)	5.71a	1.35a	0.14	17.09	0.25
S.E. (±)	0.11	0.04	0.004	0.44	0.01
%CV	12.61	19.20	30.40	17.23	14.37

Table 12. Soil properties after harvesting of Lal shak under different locations in Kawnia and Badarganj, Rangpur

Locations		Soil properties at crop harvest				
Upazila	Village	pH	OM (%)	N (%)	P (mg kg^{-1})	K (meq 100 g^{-1})
	Kachu	5.51	1.19	0.09	15.93	0.25
	Shingerkura	5.75	1.20	0.10	17.07	0.22
Kawnia	Nazirdah	5.29	1.66	0.08	15.85	0.23
	Shabdi	5.61	1.28	0.11	16.20	0.20
	Haragach	5.51	1.37	0.10	14.43	0.21
Badarganj	Amrulbari	5.52	1.50	0.12	16.38	0.23
	Nataram	5.70	1.23	0.11	18.04	0.19
	Rajarampur	5.41	1.19	0.13	14.32	0.22
	Gopalpur	5.67	1.24	0.11	19.93	0.25
	Ramnathpur	5.53	1.18	0.15	16.85	0.20
S.E. (±)		0.17	0.06	0.01	0.69	0.01
%CV		12.61	19.20	30.40	17.23	14.37

Yields of lal shak, pui shak and tomato

Yields of Lal shak, Pui shak and Tomato were significantly affected by different nutrient levels over the control (Table 13). However, yield of Lal shak and Pui shak among recommended doses of chemical fertilizers, household waste compost alone and combined application of household waste and chemical fertilizer was statistically similar. Tomato yield was higher in household waste compost alone and combined application of household waste and chemical fertilizer over recommended doses of chemical fertilizers. From the results, it was observed that combined application of nutrients using organic and inorganic sources performed better.

Table 13. Fresh yield of Lal shak, Pui shak and Tomato under different nutrient levels in Kawnia, Rangpur

Nutrient levels	Yield of lal shak (t ha^{-1})	Yield of pui shak (t ha^{-1})	Tomato fruit yield (t ha^{-1})
Control	7.15b	14.33b	24.10c
Recommended doses of NPK	17.35a	30.80a	63.70b
Household waste 10 t ha^{-1}	20.75a	33.48a	78.67a
Household waste 10 t ha^{-1} + RD of N (IPNS concept)	20.85a	32.98a	75.35a
S.E. (±)	1.90	2.08	3.65
%CV	23.02	14.98	12.09

Treatments containing different levels of nutrients did not show significant effects on soil pH and nutrients except potassium in soils after harvesting of tomato in Kawnia, Rangpur (Table 14). However, soil pH, OM, nitrogen and phosphorous were improved in soils with the application of household waste compost. Application of household waste compost alone and in combination with inorganic fertilizers increased soil K level over the control and recommended doses of chemical fertilizers. The increment of nutrients in soils with the application of household waste compost indicated the improvement of soil fertility.

Table 14. Soil properties after harvesting of Tomato under different nutrient levels in Kawnia, Rangpur

Nutrient levels	Soil properties at crop harvest				
	pH	OM (%)	N (%)	P (mg kg^{-1})	K (meq 100 g^{-1})
Control	5.56	1.22	0.08	10.01	0.12b
Recommended doses of NPK	5.58	1.21	0.09	10.22	0.13b
Household waste 10 t ha^{-1}	5.71	1.29	0.11	11.31	0.20a
Household waste 10 t ha^{-1} + RD of N (IPNS concept)	5.63	1.27	0.11	12.11	0.22a
S.E. (±)	0.15	0.08	0.006	0.52	0.02
%CV	11.55	15.32	27.38	14.89	19.56

Case study

Punil Chandra Roy, a medium farmer of the Rajarampur village of Badarganj upazila was selected as a participatory farmer of the project. Mr. Roy actively participated in the project training, positively motivated and gave consent to work to achieve the project mission. He dug a pit in front of his house and started collecting and piling all his decomposable household wastes therein. As per instruction, he covered the pit with a thin layer of soil when sufficient household wastes were collected in the pit. Mr. Roy observed the decomposition of the household wastes into compost. After three months, the household wastes decomposed into household wastes compost which was 26 kg in weight. Mr. Roy prepared a land of 4 decimal subdivided into 8 plots using household wastes compost at different doses. He grew Palong shak in the plots and got the differences of using household wastes compost within a very short time. He found the plots with only household wastes composts (@ 10 t ha^{-1}) showed better result. Second time he continued it with Pui shak without any chemical fertilizers. Third time he produced Lal shak using only household wastes compost and got the similar result. Neighbors visited his household wastes pit and vegetables plots. They became interested to hear from him and motivated to do the same in their homestead. Mr. Khokon Chandra Roy, one of the sons of Mr. Punil Chandra Roy, took the leadership of convincing people in preparation and use of household wastes compost for vegetable production. Like Mr. Roy, other participating farmers also got benefit from this project and committed to continue it with increasing rate along with their neighboring farmers. The main outcome of the project is successful preparation of household wastes compost and better performance of household wastes compost in vegetable production. Rural household dwellers can have vegetable production without using chemical fertilizers, which is economic for the rural poor. It will also increase the soil health with added organic matter in the soil and will maintain sound environmental condition. The policy makers may include this idea during formulation of environmentally sound and economically viable vegetable production in the homestead.

Conclusion

Most of the farmers under study showed low-level knowledge on household compost preparation as well as benefits of vegetable cultivation. Household waste compost has all the potentials to be used as a soil amendment, improving soil fertility and crop productivity and farmers have been motivated to prepare and use household waste compost for vegetable production in their homestead. Application of household waste compost @ 10t ha^{-1} along with inorganic fertilizers as IPNS based was found the best for short duration vegetables like Lal shak, Palong shak, Pui shak and also Tomato production over the sole application of either household waste compost or recommended doses of inorganic fertilizers. Household waste is available in the rural areas. Its compost is well proved as economic and valued source of plant nutrients to be applied to soils for crop production. Once household waste compost is applied @ 10 t ha^{-1} along with inorganic fertilizers as IPNS based, cultivation of three successive short duration vegetables is recommended for farmers' practice without applying any organic or inorganic fertilizers. Policy makers may take into consideration to circulate the technology to the rural household dwellers through extension organization.

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