




IMPACT OF DHAP RESIDUE ON THE PERFORMANCE OF SOME SELECTED WINTER VEGETABLES

 **Asit Baran Mondal¹⁺**
Mohammad Bashir Ahmed²
Md. Abdul Mannan³

¹Rural Reconstruction Foundation, Jashore, Bangladesh.

¹Email: mondalasi90@gmail.com Tel: +8801712577750

²Khulna University, Khulna, Bangladesh.

²Email: mbaatku@gmail.com

³Email: mannanku@gmail.com



(+ Corresponding author)

ABSTRACT

Article History

Received: 25 October 2021

Revised: 2 December 2021

Accepted: 20 December 2021

Published: 17 January 2022

Keywords

Floating garden
Dhap residue
Nutrient sources
Vegetables production
Economic consideration.

The experiment was conducted to evaluate the performance of dhap residue and nutrient sources on the growth and yield of red amaranth, radish and garlic during the period from October, 2013 to February 2014 and October, 2014 to February 2015 at Gopalganj district in Bangladesh. The single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were eight treatments viz. control (without organic and inorganic fertilizer), cowdung, recommended dose of NPK, 50% cowdung + 50% recommended dose of NPK, dhap residue, dhap residue + cowdung, dhap residue + recommended dose of NPK, dhap residue + 50% cowdung + 50% recommended dose of NPK. Dhap residue significantly influences the growth and yield of all three crops i.e red amaranth, radish and garlic. In respect of red amaranth, the tallest plant (43.70 cm and 42.37 cm, respectively) and maximum number of leaves (33.00 and 33.33, respectively) per plant as well as yield (20.88 and 21.32 t ha⁻¹, respectively) were observed from dhap residue + 50% cowdung + 50% recommended dose of NPK which was significantly similar to dhap residue + recommended dose of NPK in both the years. Similar results were also observed in radish for root growth and in bulb production of garlic. From economic consideration, the application of dhap residue + 50% cowdung + 50% recommended dose of NPK fertilizers were suitable for growth and yield as well as cost effective for red amaranth, radish and garlic production under the climatic conditions in Gopalganj district of Bangladesh.

Contribution/Originality: This study is one of very few studies which have investigated the impact of dhap residue and cowdung along with NPK fertilizers for growth and yield as well as cost effective of some selected winter vegetables in Bangladesh. As a new concept, the study is original.

1. INTRODUCTION

Floating garden agricultural practices (locally known as *Dhap*) to grow vegetables and spices is prevailing in the wetlands of the south central coastal districts of Bangladesh from time immemorial, utilizing locally available water hyacinth (*Eichhornia crassipes*) and other aquatic weeds. The unique production system was developed in the hands of the locals by using their traditional knowledge for livelihood. The land with the water is used for production of fish in the open water and crops on the floating beds. Thus, ensures a sustainable utilization of agro biodiversity, natural resources and multiple use of the land. The bed materials are available locally free of cost. With the recession of water the beds touch the ground and winter crops are grown on the organic matter of the beds. The

production system is almost organic. This is a low input and low cost resilient family farming production system. The system is sustainable and easily adaptable in similar flooded condition.

The floating platforms or rafts or floating beds were provides a base on the surface of water as the foundation of growing seedlings, vegetables and spices on it without soil. The plants grown on floating bed get nutrition and food either from composted organics or from the water. Decomposed water hyacinths are rich in a variety of organic debris and decomposing materials that release large amount of essential nutrients.

The floating beds that prepared during monsoon season there crops were grown. After harvesting the crops, in winter when the water recede and land exposed, the residual part of Dhaps were shifted and mixes the Dhap with the soil to enrich the soil fertility. The dried and rotten water hyacinths and other aquatic plants that act as composed manure or organic manure. This compost is very useful to both the plants and the soil. The land in which decomposed water hyacinth added need not use any other chemical fertilizers for sustains level of fertility of the soil. In this way, floating garden agricultural practice enhances eco-friendly agriculture practice in winter season to cultivate winter crops. Floating beds can be recycled as organic fertilizer in the newly prepared floating bed and also in the agricultural fields, which is economical as well as environmentally friendly (Saha, 2010).

The Dhap residue or decomposed water hyacinth can be applied directly to the soil. The compost increases soil fertility and crop yield and generally improves the quality of the soil. In developing countries where mineral fertilizer is expensive, it is an elegant solution to the problem of water hyacinth proliferation and also poor soil quality. It contains many trace elements, seldom found in synthetic fertilizers, so it helps plants to be more disease resistant. The nutrients are in the compost are not leached out by rainwater and all available to the plants (Vidya & Girish, 2014).

Farmers cultivate in Dhap method traditionally and do not follow any Scientific method. So, it is necessary to find out a Scientific method or model for this purpose.

Considering the points in view, a study entitled as "Impact of Dhap Residue on the Performance of some Selected Winter Vegetables" was conducted with following objectives kept in mind.

1.1. Objectives of the Research

In view of the above cited facts, the present study was undertaken with the following objective:

1. To find out the impact of Dhap residue on the performance of some selected winter vegetables.

2. MATERIALS AND METHODS

2.1. Experimental Design and Planting Materials

The single factor experiment was conducted in Randomized Complete Block Design (RCBD) with three replications and with eight treatments viz. control (without organic and inorganic fertilizer), cowdung, recommended dose of NPK, 50% cowdung + 50% recommended dose of NPK, dhap residue, dhap residue + cowdung, dhap residue + recommended dose of NPK, dhap residue +50% cowdung +50% recommended dose of NPK and three crops viz. Red amaranth (*Amaranthus gangaticus* L.), Radish (*Raphanus sativas*. L) and Garlic (*Allium sativum* L.), seeds/bulbs were used as the planting materials in the experiment. The medium high land was prepared and the eight treatments were then distributed randomly among the each block so as to all treatments were placed once in each block. Afterwards 20 kg dhap residual spread (well decomposed water hyacinth that was used for vegetables production on floating condition in summer season) per plot and were mixed with soil with the help of a spade. The size of each unit plot was 2m x 1m = 2 m².

2.2. Seed Sowing and Planting

Treated seeds of red amaranth, radish were sown and cloves of garlic were planted on first week of November 2013 and 2014 by maintaining spacing for specific crop.

2.3. Application of Manure and Fertilizers and Other Intercultural Operations

Manure and fertilizers were applied according to the treatments considering by the FRG (2012). Irrigation, weeding, drainage, plant protection measures and other intercultural operations were done as and when necessary.

2.4. Data Collection

Five plants were selected randomly from each unit plot and the parameters were recorded at 15 days intervals including plant height (cm), number of leaves plant⁻¹, fresh weight of 5 plants (g) and yield (t ha⁻¹) in case of red amaranth, in respect of radish, number of leaves plant⁻¹, length and diameter of root (cm), root fresh weight (g plant⁻¹) and yield of root (t ha⁻¹), in case of garlic, plant height (cm), number of leaves plant⁻¹, length and diameter of bulb (cm), individual bulb weight (g), number of cloves bulb⁻¹ and yield of bulb (t ha⁻¹).

Recorded data were analyzed statistically with the help of computer package program MSTAT-C and the mean differences were adjudged by DUNCAN'S NEW MULTIPLE RANGE TEST (DMRT) at 5% level of probability for interpretation of the results (Gomez & Gomez, 1984).

3. RESULTS & DISCUSSION

Eight treatments viz. (T₁) control (without organic and inorganic fertilizer), (T₂) cowdung, (T₃) recommended dose of NPK, (T₄) 50% cowdung + 50% recommended dose of NPK, (T₅) dhap residue, (T₆) dhap residue + cowdung, (T₇) dhap residue + recommended dose of NPK, (T₈) dhap residue +50% cowdung +50% recommended dose of NPK and crops of red amaranth, radish, and garlic were used for this study.

3.1. Effects on Growth Parameters, Yield Components and Economic Consideration of Red Amaranth

The impact of dhap residue and nutrient sources significantly influenced (P≤0.05) the growth parameters and yield of red amaranth Table 1. The tallest plant (43.70 and 42.37 cm, respectively) and maximum number of leaves per plant (33.00 and 33.33, respectively) in 2013 and 2014 were recorded from (T₈) dhap residue + 50% cow dung + 50% recommended dose of NPK treatment while the shortest plant (16.03 and 16.87 cm, respectively) and minimum number of leaves per plant (12.00 and 10.67, respectively) were found in (T₁) control in 2013 and 2014. The highest yield (20.88 and 21.32 t ha⁻¹, respectively) was obtained from (T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK followed by (T₇) dhap residue + recommended dose of NPK (17.47 and 17.62 t ha⁻¹, respectively) and (T₃) recommended dose of NPK (12.96 and 12.77 t ha⁻¹, respectively) where the lowest yield (5.03 and 5.04 t ha⁻¹, respectively) was obtained from the (T₁) control in 2013 and 2014. Fresh weight of 5 plants also followed the similar trend of results. Although fresh weight of 5 plants did not vary significantly in (T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK and (T₇) dhap residue + recommended dose of NPK.

Table 1. Growth and yield contributing characters and yield of red amaranth as influenced by dhap residue and nutrient sources.

Treatment	Plant height (cm)		Leaves plant ⁻¹ (No.)		Fresh wt. of 5 plants (g)		Yield (t ha ⁻¹)	
	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr
T ₁	16.03f	16.87e	12.00d	10.67e	5.47f	5.27e	5.03f	5.04f
T ₂	19.73e	23.97de	17.67c	18.00d	12.67e	13.07cd	7.67e	7.55e
T ₃	35.57b	34.73b	31.33a	29.33ab	23.27b	23.00ab	12.96c	12.77c
T ₄	30.90c	30.97c	30.67ab	28.33b	20.87c	20.27abc	11.15d	10.96cd
T ₅	17.97ef	21.13e	12.67d	11.33e	7.73df	8.27de	7.56e	7.14e
T ₆	26.20d	25.00d	20.33c	21.67c	15.33d	16.53bc	10.33d	10.70d
T ₇	40.40a	37.07b	32.67a	30.67ab	25.80a	24.27a	17.47b	17.62b
T ₈	43.70a	42.37a	33.00a	33.33a	28.00a	26.33a	20.88a	21.32a
CV (%)	6.61	5.95	7.14	5.65	7.82	6.43	6.93	8.90

Note: Figures in a column having common letter (s) do not differ significantly (P≤0.05). Here, T₁=Control, T₂=Cowdung, T₃= Recommended dose of NPK, T₄= 50% cowdung + 50% Recommended dose of NPK, T₅= Dhap residue, T₆= Dhap residue + cowdung, T₇= Dhap residue + recommended dose of NPK, T₈= dhap residue + 50% cowdung + 50% recommended dose of NPK.

Plant height and number of leaves significantly increased by application of dhap residue and nutrient sources might be due to deeper root penetration and increased availability of nutrients. Dhap is supposed to be a good source of organic matter and when cowdung and fertilizers were applied especially nitrogenous fertilizer, the plant height and number of leaves increased significantly because nitrogen increases photosynthetic ability of the plant. Due to application of organic and inorganic fertilizers higher plant height in okra has been reported by [Chattoo et al. \(2011\)](#) and [Malik, Chattoo, Sheemar, and Rashid \(2011\)](#). [Gayathri and Reddy \(2013\)](#) also got the similar result.

In this study it was also revealed that dhap residue + 50% cowdung + 50% recommended dose of NPK produced the highest yield and it was probably due to the fact that combination of organic and inorganic fertilizers improved physical condition of the soil for better growth as well as supplied sufficient plant nutrients in all stages of plant growth. This result is in agreement with the findings of [Mallanagouda, Sulikeri, Hulamari, Murthy, and Madalgeri \(1995\)](#); [Kropisz \(1992\)](#); [Vinay and Singh \(1995\)](#).

3.2. Economic Consideration

Significant variations were found among the treatments in respect of the benefit cost ratio (BCR) [Table 2](#). From the treatment (T₈) of dhap residue + 50% cowdung + 50% recommended dose of NPK showed the highest BCR (1.64) where the lowest BCR (0.57) value was found in the control(T₁). The results revealed that dhap residue + 50% cowdung + 50% recommended dose of NPK was found to be suitable for higher economic return from red amaranth under the climatic conditions of Gopalganj.

Table 2. Cost and return analysis of red amaranth production due to impact of dhap residue in 2013 and 2014.

Treatment	Mean marketable yield of two years (t ha ⁻¹)	Mean total variable cost of two years (t ha ⁻¹)	Mean gross return of two years (t ha ⁻¹)	Mean net return of two years (t ha ⁻¹)	Mean benefit cost ratio of two years (BCR)
T ₁	5.04 f	307400.00 e	176400.00 f	-131000 f	0.57 g
T ₂	7.61 e	352216.67 d	266350.00 e	-85866.67 e	0.76 f
T ₃	12.87 c	390266.67 c	450450.00 c	60183.33 c	1.15 c
T ₄	11.06 d	367583.33 cd	387100.00 d	19516.67 d	1.05 d
T ₅	7.35 e	394416.67 c	257250.00 e	-137166.67 f	0.65 g
T ₆	10.52 d	435683.33 b	368200.00 d	-67483.33 e	0.85 e
T ₇	17.55 b	473366.67 a	614250.00 b	140883.33 b	1.3 b
T ₈	21.1 a	451633.33 ab	738500.00 a	286866.67 a	1.64 a
CV (%)	3.4	2.74	4.60	9.40	2.2
Level of significance	*	*	*	*	*

Note: *= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT. Here, T₁ =Control, T₂ =Cowdung, T₃ = Recommended dose of NPK, T₄= 50% cowdung + 50% Recommended dose of NPK, T₅ = Dhap residue, T₆ = Dhap residue + cowdung, T₇ = Dhap residue + recommended dose of NPK, T₈ = dhap residue + 50% cowdung + 50% recommended dose of NPK.

Sale of marketable red amaranth @ Tk.35000 per ton, Net return=Gross return – Total variable cost, Benefit cost ratio (BCR) = Gross return ÷ Total variable cost.

3.3. Effects on Growth Parameters, Yield Components and Economic Consideration of Radish

The impact of dhap residue, cowdung and fertilizers applications were significantly influenced ($P \leq 0.05$) the growth parameters and yield of radish [Table 3](#). The maximum number of leaves per plant (23.67 and 23.00, respectively) was obtained from(T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK followed by (T₇) dhap residue + recommended dose of NPK (21.67 and 21.33, respectively) and the minimum number of leaves per plant (10.67 and 10.67, respectively) was obtained from the control(T₁) in 2013 and 2014. The longest root (31.70 and 33.13 cm, respectively) and the maximum root diameter (22.83 and 23.40 cm, respectively) were obtained from(T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK followed by(T₇) dhap residue + recommended dose of NPK (29.57 and 30.77 cm, respectively) and (21.90 and 21.20 cm, respectively) whereas the

shortest root length (15.77 and 16.73 cm, respectively) and the minimum root diameter (13.33 and 12.70 cm, respectively) were obtained from the control (T₁) in 2013 and 2014. Dhap residue and nutrient sources influenced the yield of radish significantly. The maximum fresh weight of root (666.08 and 638.51 g, respectively) and the highest root yield (91.67 and 90.48 t ha⁻¹, respectively) were obtained from (T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK followed by (T₇) dhap residue + recommended dose of NPK (621.24 and 623.06 g, respectively) and (87.91 and 87.55 t ha⁻¹, respectively) in 2013 and 2014. In contrast, the minimum fresh weight of root per plant (115.44 and 105.29 g, respectively) and the lowest root yield (28.78 and 27.62 t ha⁻¹, respectively) were obtained from the control (T₁) in 2013 and 2014.

Table 3. Growth and yield contributing characters and yield of radish as influenced by dhap residue and nutrient sources.

Treat.	Leaves plant ⁻¹ (No.)		Root length (cm)		Diameter of root (cm)		Root fresh weight (g plant ⁻¹)		Yield (t ha ⁻¹)	
	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr
T ₁	10.67f	10.67f	15.77e	16.73f	13.33e	12.70g	115.44e	105.29d	28.78f	27.62e
T ₂	15.00e	15.33e	19.60d	20.47e	17.37d	15.13f	245.22d	211.32c	39.38e	43.17d
T ₃	20.00c	20.33bc	28.53b	29.33b	20.70b	20.20bc	496.17b	509.87b	69.21b	69.65b
T ₄	19.33c	18.00d	26.70c	27.43c	19.10c	18.57d	421.38c	446.55b	64.87b	64.23b
T ₅	14.67e	15.67e	18.37d	20.67e	16.50d	16.90e	264.05d	219.12c	46.19d	47.34d
T ₆	17.33d	18.67cd	24.90c	25.23d	19.90bc	19.43cd	432.62c	489.10b	54.25c	54.72c
T ₇	21.67b	21.33ab	29.57b	30.77b	21.90a	21.20b	621.24a	623.06a	87.91a	87.55a
T ₈	23.67a	23.00a	31.70a	33.13a	22.83a	23.40a	666.08a	638.51a	91.67a	90.48a
CV (%)	7.73	7.39	6.10	5.32	7.11	7.60	9.44	10.10	8.25	8.69

Note: Figures in a column having common letter (s) do not differ significantly ($P \leq 0.05$). Here, T₁ = Control, T₂ = Cowdung, T₃ = Recommended dose of NPK, T₄ = 50% cowdung + 50% Recommended dose of NPK, T₅ = Dhap residue, T₆ = Dhap residue + cowdung, T₇ = Dhap residue + recommended dose of NPK, T₈ = dhap residue + 50% cowdung + 50% recommended dose of NPK.

The maximum number of leaves per plant, root length, root diameter and yield of radish were produced to dhap residue + 50% cowdung + 50% recommended dose of NPK fertilizers due to dhap residue comparatively loose and supply adequate moisture and nutrients for higher vegetative growth and root easily penetrate in to the growing media and uptake required amount of nutrients. That might be reason for better results in dhap residue and combination of manure and fertilizers. The result was in conformity with the results of Pathak, Tripathi, Das, Sahu, and Pattanayak (2018) who reported that all the yield contributing characters and yield of radish was higher when organic and inorganic fertilizers were applied in combination than single. Similar results were obtained by Buckerfield, Flavel, Lee, and Webster (1999) in radish, Sood and Lal (2004) in potato, Singh, Pathak, Boopathi, and Deka (2010) and Bandani, Mobasser, and Sirusmehr (2014) in tomato and mung bean.

Table 4. Cost and return analysis of radish production due to impact of dhap residue in 2013 and 2014.

Treatment	Mean marketable yield of two years (t ha ⁻¹)	Mean total variable cost of two years (t ha ⁻¹)	Mean gross return of two years (t ha ⁻¹)	Mean net return of two years (t ha ⁻¹)	Mean benefit cost ratio of two years (BCR)
T ₁	28.2 f	316183.33 f	282000.00 g	-34183.33 f	0.89 e
T ₂	41.28 d	361200.00 e	412800.00 f	51600.00 e	1.14 d
T ₃	69.43 b	407350.00 cd	694300.00 b	286950.00 c	1.70 c
T ₄	64.55 b	376550.00 de	645500.00 c	268950.00 c	1.71 c
T ₅	46.77 e	400350.00 d	467700.00 e	67350.00 e	1.17 cd
T ₆	54.49 c	443833.33 bc	544900.00 d	101066.67 d	1.23 d
T ₇	87.73ab	487733.33 a	877300.00 a	389566.67 b	1.80 b
T ₈	91.08 a	479200.00 ab	910800.00 a	431600.00 a	1.90 a
CV (%)	4.2	3.32	2.64	4.44	2.98
Level of significance	*	*	*	*	*

Note: *= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT. Here, T₁ = Control, T₂ = Cowdung, T₃ = Recommended dose of NPK, T₄ = 50% cowdung + 50% Recommended dose of NPK, T₅ = Dhap residue, T₆ = Dhap residue + cowdung, T₇ = Dhap residue + recommended dose of NPK, T₈ = dhap residue + 50% cowdung + 50% recommended dose of NPK.

Sale of marketable radish @ Tk.10000 per ton, Net return=Gross return – Total variable cost, Benefit cost ratio (BCR) = Gross return ÷ Total variable cost.

3.4. Economic Consideration

Significant variations were found among the treatments in respect of the benefit cost ratio (BCR) Table 4. From the treatment (T₈) of dhap residue + 50% cowdung + 50% recommended dose of NPK showed the highest BCR (1.9) whereas the lowest BCR (0.89) value was found in the control(T₁). The results revealed that dhap residue + 50% cowdung + 50% recommended dose of NPK was found to be suitable for higher economic return from radish under the climatic conditions of Gopalganj.

3.5. Effects on Growth Parameters, Yield Components, Yield and Economic Consideration of Garlic

The impact of dhap residue and nutrient sources were significantly influenced ($P \leq 0.05$) the growth parameters, yield components and yield of garlic Table 5. The tallest plant (72.37 and 74.17 cm, respectively) and maximum number of leaves per plant (12.33 and 12.00, respectively) in 2013-14 and 2014-15 were achieved from (T₈) dhap residue + 50% cow dung + 50% recommended dose of NPK treatment whereas the shortest plant (45.07 and 49.80 cm, respectively) and the minimum number of leaves per plant (6.00 and 5.67, respectively) were found in the control (T₁) in 2013-14 and 2014-15. The longest bulb length (6.33 and 6.33 cm, respectively) and the maximum bulb diameter (17.83 and 17.40 cm, respectively) were obtained from (T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK whereas the shortest bulb length (3.53 and 4.27 cm, respectively) and the minimum bulb diameter (9.23 and 11.90 cm, respectively) were obtained from the control (T₁) in 2013-14 and 2014-15. The maximum bulb weight (61.33 and 59.80 g, respectively) and maximum number of cloves per bulb (35.03 and 37.97, respectively) were obtained from (T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK whereas, the minimum bulb weight (15.20 and 21.63 g, respectively) and the minimum number of cloves per bulb (14.53 and 14.90, respectively) was obtained from the control (T₁) in 2013-14 and 2014-15. The maximum yield (11.59 and 11.72 t ha⁻¹, respectively) was obtained from (T₈) dhap residue + 50% cowdung + 50% recommended dose of NPK followed by (T₇) dhap residue + recommended dose of NPK (10.85 and 10.93 t ha⁻¹, respectively) and (T₆) dhap residue + cowdung (8.78 and 8.94 t ha⁻¹, respectively) and the minimum yield (3.16 and 3.56 t ha⁻¹, respectively) was obtained from the control (T₁) in 2013-14 and 2014-15.

This might be due to the fact that dhap residue + 50% cowdung + 50% recommended dose of NPK kept the soil loose and both manure and fertilizers supplied adequate plant nutrients for better vegetative growth of garlic plants and ultimately increased bulb length and diameter as well as yield of garlic. The result was in conformity with the results of Chattoo et al. (2011) who obtained a higher plant height and leaf number per plant from organic + inorganic fertilizers in okra. Gayathri and Reddy (2013) and Malik et al. (2011) got the similar result in okra. Varu, Vhora, and Kikani (1997) obtained the highest bulb diameter from organic + inorganic fertilizers in onion. The plants received more nutrients when raised with the combination of organic and inorganic fertilizers.

3.6. Economic Consideration

Significant variations were found among the treatments in respect of the benefit cost ratio (BCR) Table 6. From the treatment (T₈) of dhap residue + 50% cowdung + 50% recommended dose of NPK showed the highest BCR (1.79) whereas the lowest BCR (0.75) value was found in the control (T₁). The results revealed that dhap residue + 50% cowdung + 50% recommended dose of NPK was found to be suitable for higher economic return from garlic under the climatic conditions of Gopalganj.

Table 5. Growth and yield contributing characters and yield of garlic as influenced by dhap residue and nutrient sources.

Treat.	Plant height (cm)		Leaves plant ⁻¹ (No.)		Bulb length (cm)		Diameter of bulb (cm)		Individual bulb weight (g)		No. of cloves bulb ⁻¹		Yield of bulb (t ha ⁻¹)	
	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr	1 st yr	2 nd yr
T ₁	45.07f	49.80 d	6.00e	5.67 f	3.53 g	4.27 e	9.23 f	11.90 f	15.20 e	21.63 e	14.53 f	14.90 f	3.16 f	3.56 g
T ₂	56.30d	56.53c	8.00d	8.00d	5.17 e	5.07 d	13.50 d	14.07 d	35.47 c	34.63 d	20.03 e	20.93 e	5.14 e	5.38 f
T ₃	66.60b	65.47b	10.67b	10.67b	5.80 bc	5.87 bc	16.50 b	16.17 b	53.17 b	52.83 b	31.40 b	30.43 c	7.72 c	7.87 d
T ₄	61.53c	63.57b	9.33c	9.67c	5.60 cd	5.87 bc	15.47 bc	15.93 b	52.13 b	48.93 c	27.53 c	27.33 cd	6.80 d	7.15 de
T ₅	53.40e	52.20cd	7.33d	7.00e	4.33 f	5.23 d	12.00 e	13.10 e	23.77 d	32.90 d	19.97 e	20.10 e	6.71 d	6.58 e
T ₆	61.77c	56.73c	9.00c	8.67d	5.30 de	5.67 c	14.47 cd	15.13 c	40.47 c	48.70 c	25.50 d	26.63 d	8.78 b	8.94 c
T ₇	68.80b	71.37a	11.33b	11.33ab	6.03 ab	5.97 b	17.27 a	17.07 a	56.90 ab	55.07 b	32.67 b	33.97 b	10.85 a	10.93 b
T ₈	72.37a	74.17a	12.33a	12.00a	6.33 a	6.33 a	17.83 a	17.40 a	61.33 a	59.80 a	35.03 a	37.97 a	11.59 a	11.72 a
CV (%)	2.40	4.41	6.01	4.23	8.15	6.78	7.46	8.37	8.21	7.54	8.26	6.96	8.06	9.67

Note: Figures in a column having common letter (s) do not differ significantly ($P \leq 0.05$). Here, T₁ = Control, T₂ = Cowdung, T₃ = Recommended dose of NPK, T₄ = 50% cowdung + 50% Recommended dose of NPK, T₅ = Dhap residue, T₆ = Dhap residue + cowdung, T₇ = Dhap residue + recommended dose of NPK, T₈ = dhap residue + 50% cowdung + 50% recommended dose of NPK.

Table 6. Cost and return analysis of garlic production due to impact of dhap residue in 2013-14 and 2014-15.

Treatment	Mean marketable yield of two years (t ha ⁻¹)	Mean total variable cost of two years (t ha ⁻¹)	Mean gross return of two years (t ha ⁻¹)	Mean net return of two years (t ha ⁻¹)	Mean benefit cost ratio of two years (BCR)
T ₁	3.36 f	358816.67 d	268800.00 g	-90016.67 h	0.75 g
T ₂	5.26 e	402466.67 cd	420800.00 f	18333.33 g	1.05 f
T ₃	7.8 c	447666.67 bc	624000.00 d	176333.33 d	1.39 cd
T ₄	6.98 d	420066.67 cd	558400.00 e	138333.33 e	1.33 d
T ₅	6.65 d	445000.00 bc	532000.00 e	87000.00 f	1.20 e
T ₆	8.86 b	486100.00 ab	708800.00 c	222700.00 c	1.46 c
T ₇	10.89 a	530833.33 a	871200.00 b	340366.67 b	1.64 b
T ₈	11.66 a	521225.00 a	932800.00 a	411575.00 a	1.79 a
CV (%)	2.03	4.94	3.71	6.33	3.1
Level of significance	*	*	*	*	*

Note: *= Significant at 5% level. Means followed by common letter(s) in a column do not differ significantly by DMRT. Here, T₁ =Control, T₂ =Cowdung, T₃ = Recommended dose of NPK, T₄ = 50% cowdung + 50% Recommended dose of NPK, T₅ = Dhap residue, T₆ = Dhap residue + cowdung, T₇ = Dhap residue + recommended dose of NPK, T₈ = dhap residue + 50% cowdung + 50% recommended dose of NPK.

Sale of marketable garlic @ Tk.80000 per ton, Net return=Gross return – Total variable cost, Benefit cost ratio (BCR) = Gross return ÷ Total variable cost.

From the results of the experiment it was found that almost all the parameters studied were significantly influenced by dhap residue and nutrient sources. Almost all the characters attained the highest values when dhap residue +50% cowdung +50% recommended dose of NPK were applied. The control treatment gave the lowest values in all the characters in both the years (2013-14 and 2014-15, respectively). Dhap residue is supposed to be a good source of organic matter and when cowdung and fertilizers along with dhap residue were applied the studied parameters increased significantly and to be suitable for higher economic return from garlic under the climatic conditions of Gopalganj.

4. CONCLUSION AND RECOMMENDATIONS

Application of dhap residue + 50% cow dung + 50% recommended dose of NPK fertilizers were suitable for growth and yield as well as cost effective for red amaranth, radish and garlic production under the climatic conditions in Gopalganj district of Bangladesh.

Funding: This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

Authors' Contributions: All authors contributed equally to the conception and design of the study.

REFERENCES

- Bandani, M., Mobasser, H. R., & Sirusmehr, A. (2014). Effect of organic fertilizer on length of pod, biological yield and number of seeds per pod in mung bean (*Vigna radiata* L.). *International Research Journal of Applied and Basic Sciences*, 8(7), 763-766.
- Buckerfield, J., Flavel, T., Lee, K., & Webster, K. (1999). V earthworms and waste management-Vermicompost in solid and liquid forms as a plant-growth promoter. *Pedobiologia*, 43(6), 753-759.
- Chattoo, M., Ahmed, N., Wani, M., Mir, S., Khan, S., & Jabeen, N. (2011). Effect of organic manures and inorganic fertilizers on growth, yield and quality of Okra [*Abelmoschus esculentus* (L.) Moench]. *Vegetable Science*, 38(2), 135-139.
- FRG. (2012). Fertilizer recommendation guide (pp. 119-131). Farmgate, Dhaka, Bangladesh: Bangladesh Agricultural Research Council (BARC).
- Gayathri, K., & Reddy, P. (2013). Effect of integrated nutrient management growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) cv. Arka Anamika. *Vegetable Science*, 40(2), 246-248.
- Gomez, K. A., & Gomez, A. A. (1984). Statistical procedure for agricultural research (2nd ed., pp. 28-192). New York: John Wiley and Sons.

- Kropisz, A. (1992). Influence of fertilization with compost on yield of vegetables and their content of mineral elements (Vol. 16, pp. 9-13). Horticulture: Annals of Warsaw Agricultural University.
- Malik, A., Chattoo, M., Sheemar, G., & Rashid, R. (2011). Growth, yield and fruit quality of sweet pepper hybrid SH-SP-5 (*Capsicum annuum* L.) as affected by integration of inorganic fertilizers and organic manures (FYM). *Journal of Agricultural Technology*, 7(4), 1037-1048.
- Mallanagouda, B., Sulikeri, G. S., Hulamari, N. C., Murthy, B. G., & Madalgeri, B. B. (1995). Effect of NPK and FYM on growth parameters of onion, garlic and coriander. *Current Research University of Agricultural Sciences, India*, 24(11), 212-213.
- Pathak, M., Tripathi, P., Das, S. K., Sahu, G. S., & Pattanayak, S. K. (2018). Efficacy of biofertilizer, organic and inorganic fertilizer on yield and quality of radish (*Raphanus sativus* L.). *International Journal of Chemical Studies*, 6(4), 1671-1673.
- Saha, S. K. (2010). *Soil less cultivation for landless people: An alternative livelihood practice through indigenous hydroponic agriculture in flood-prone Bangladesh*. Beppu: Ritsumeikan Asia Pacific University.
- Singh, B., Pathak, K., Boopathi, T., & Deka, B. (2010). Vermicompost and NPK fertilizer effects on morpho-physiological traits of plants, yield and quality of tomato fruits: (*Solanum lycopersicum* L.). *Vegetable Crops Research Bulletin*, 73(1), 77-86. Available at: <https://doi.org/10.2478/v10032-010-0020-0>.
- Sood, M. C., & Lal, S. S. (2004). Evaluation of vermicompost as an organic source of plant nutrients in potato (*Solanum tuberosum* L.) (pp. 212-214). Lucknow, India: Organic Farming in Horticulture, CISH.
- Varu, D., Vhora, P., & Kikani, K. (1997). Effect of organic and inorganic fertilizers on onion. *Gujarat Agricultural University Research Journal*, 22(2), 116-118.
- Vidya, S., & Girish, L. (2014). Water hyacinth as a green manure for organic farming. *International Journal of Research in Applied, Natural and Social Sciences*, 2(6), 65-72.
- Vinay, S., & Singh, R. K. (1995). Response of onion (*Allium cepa* L) to N, P, Zn and FYM. *Annals of Agricultural Research*, 6(1), 79-81.

Views and opinions expressed in this article are the views and opinions of the author(s), International Journal of Sustainable Agricultural Research shall not be responsible or answerable for any loss, damage or liability etc. caused in relation to/arising out of the use of the content.