



Effect of Different Levels of Vermicompost and Macro Nutrients on the Growth and Yield of Garlic (*Allium sativum* L.)

Md. Murshedul Alam ^a, Khaleda Khatun ^a, Tahmina Mostarin ^a,
Md. Imran Sarkar ^a, Most. Jakia Siddika ^a, Aysha Jannatul Ferdousi ^{a*},
Mst. Umme Habiba ^a and Md. Ali Reza ^b

^a Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

^b Department of Institute of Seed Technology, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

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/AJAAR/2022/v18i430228

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/88762>

Original Research Article

Received 24 April 2022

Accepted 28 June 2022

Published 09 July 2022

ABSTRACT

A field experiment was conducted at the horticulture farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during October 2019 to July 2020 to study the effect of different levels of vermicompost and macro nutrients on the growth and yield of garlic. Garlic variety 'BARI Rashun-3' was used as planting material in this study. The experiment consists of single factor. Twelve treatment combinations were tested in this experiment: T₀ = Control, T₁ = 2 t ha⁻¹ vermicompost, T₂ = 4 t ha⁻¹ vermicompost, T₃ = 6 t ha⁻¹ vermicompost, T₄ = 50% NPKS (RDF), T₅ = 100% NPKS (RDF), T₆ = 2 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₇ = 4 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₈ = 6 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₉ = 2 t ha⁻¹ vermicompost + 100% NPKS (RDF), T₁₀ = 4 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T₁₁ = 6 t ha⁻¹ vermicompost + 100% NPKS (RDF). The experiment was laid out in Randomized Complete Block Design (RCBD) with 12 treatment combinations having three replications. Data on different growth and yield parameter of garlic were recorded and significant variation was recorded for different treatments. Plant height and number of leaves plant-1 value of garlic was recorded to be the maximum from treatment T₁₀ (4.00 t ha⁻¹ vermicompost + 100% NPKS (RDF)) at different days after sowing (DAS). But, the highest bulb diameter (3.32 cm), the longest clove (3.44 cm), the

*Corresponding author: Email: aysha.farabi@gmail.com;

highest bulb length (2.43 cm), the maximum number of cloves bulb⁻¹ (21.25), the maximum fresh weight of bulb (35.11 g), the maximum dry weight of bulb (4.95 g), the highest fresh clove weight (6.93 g), the maximum dry clove weight (1.89 g), the maximum fresh weight of leaves plant-1 (25.31 g), the maximum dry weight of leaves (3.31 g), the highest bulb yield plot-1 (1.45 kg) and the maximum yield of garlic (14.53 t ha⁻¹) was recorded from T₁₁ (6.00 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment).

Keywords: Vermicompost; macro nutrients; growth; yield; garlic.

1. INTRODUCTION

Garlic (*Allium sativum* L.) belonging to the family alliaceae is the second most widely used cultivated vegetable bulb crops after onion in the world. It has a wide area of adaptation and cultivation throughout the world [1]. The world production is about three million metric tonnes per annum, with major producers being China, United States of America, Egypt, Korea, Russia and India [2]. The average yield of garlic in Bangladesh is only 8.41 t ha⁻¹ [3]. In Bangladesh about 263000 metric tons of garlic was produced from approximately 31260 hectares of land in 2019-2020 [3]. Garlic has been considered as a rich source of carbohydrates, proteins and phosphorus. It is popular all over the world as a valuable spice for different dishes. Aqueous extracts of garlic cloves (allicin and related disulphides) significantly reduce cholesterol level in men [4]. The growth and yield of garlic crop is greatly influenced by both inorganic and organic nutrients [5]. Studies have indicated application of inorganic fertilizers by small holder farmers have led to increased yield at the expense of product quality and environmental degradation [6]. Vermicompost has emerged as an alternative to conventional organic fertilizers due to its additional benefits to the soil. Also, some problems, such as nutrient loss, nutrient toxicity, and salinity that may be associated with organic amendments under certain conditions could also be avoided by vermicompost application especially due to its slow and more release of nutrients to the soil environment [7]. Vermicompost and compost can meet the nutrient demand of greenhouse and field crops and significantly reduce the use of fertilizers [8]. Growth and yield of garlic is influenced by different nutrients management and other factors during their production in field. Garlic productivity, in many countries, is low due to low yielding varieties and environmental factors [9]. In many garlic producing areas lack of available nutrients is frequently the limiting factor next to the soil water as their uptake and liberation of N, P and S from soil organic matter depends upon availability of water [10]. For increase garlic

production different fertilizers application (type, time and rate) is one of the limiting factors of garlic production that should be considered [11,12]. Nutrients needs of a crop is depend on its physiological requirements and yield potentials, thus, balance fertilizer is the basis of more production [13]. The existing practice of fertilizer application is below the recommended level and farmer use only N containing fertilizer mostly Urea. However, the use of balance fertilizer in sufficient quantity is essential for high yield and good quality garlic production. [14] stated that the vermicompost also has significant influence on days to maturity, leaf number, leaf area index, mean clove weight, mean bulb weight, fresh biomass yield, total bulb yield, dry matter percent and total soluble solid of garlic.

Garlic growers in the central high lands of Ethiopia tend to rely on fertilizer sources that contain only nitrogen (N) and phosphorus (P), resulting in steady decline in other nutrients in the soil. Smaller potassium (K) and sulfur (S) uptake relative to N uptake can predispose the crop to serious disease and insect damage [15]. All the plants are characterized by a shallow root system which explains why fertilizers should be banded at 8-10 cm below the seed row [16]. Due to the shallow root system, it is preferable to split fertilizer application (before sowing or planting, at the fully expanded leaf stage, and just before bulb formation). Availability of Nitrogen and Phosphorous is of prime importance for growing plants as it is a major and indispensable source of protein and nucleic acid molecules. The aim of this study was to assess the effect of vermicompost and NPKS on the growth and yield of garlic.

2. METHODS AND MATERIALS

2.1 Description of the Experimental Site

The present research work was conducted at the Horticulture Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during September 2019 to August 2020 to study the effect of seed sowing time and nutrients on the growth and yield of fennel. The location of the

site 90°33' E longitude and 23°77' N latitude with an elevation of 8.2 m from sea level [17]. Location of the experimental site presented in. Soil of the study site was salty clay loam in texture belonging to series. The area represents the Agro-Ecological Zone of Madhupur tract (AEZ-28). The experiment consists of single factor. Twelve treatment combinations will be tested in this experiment: T_0 = Control, T_1 = 2 t ha⁻¹ vermicompost, T_2 = 4 t ha⁻¹ vermicompost, T_3 = 6 t ha⁻¹ vermicompost, T_4 = 50% NPKS (RDF), T_5 = 100% NPKS (RDF), T_6 = 2 t ha⁻¹ vermicompost + 50% NPKS (RDF), T_7 = 4 t ha⁻¹ vermicompost + 50% NPKS (RDF), T_8 = 6 t ha⁻¹ vermicompost + 50% NPKS (RDF), T_9 = 2 t ha⁻¹ vermicompost + 100% NPKS (RDF), T_{10} = 4 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T_{11} = 6 t ha⁻¹ vermicompost + 100% NPKS (RDF).

The single factorial experiment was laid out in Randomized Complete Block Design (RCBD) with three replications to minimize the soil heterogeneous effects. The experiment was divided into three blocks and consisted of 36 plots. Each unit plot in from of raised bed was 1.0 m² (1.0m x 1.0m) in size. Altogether there were 36 unit plots in experiment and required 36.0 m² land. Row to row and plant to plant distance were 20cm and 25 cm respectively. The treatments were randomly assigned to each of the block. Each unit plot had 5rows and each with 4 plants. So there were 20 plants per unit plot.

2.2 Planting Materials

The seeds of garlic cv. BARI Rashun-3 variety was collected from Bangladesh Agricultural Research Institute (BARI), Gazipur.

2.3 Manuring and Fertilization

Urea, Triple Super Phosphate (TSP) and Murate of Potash (MoP), Zypsum were used as the fertilizer source of the nutrient elements N, P, K and S, respectively. A standard dose of Boric acid @ 24 kg ha⁻¹ and Zinc Sulphate @ 29 kg ha⁻¹ was used in all treatments. The vermicompost was applied after opening the land as per treatment. The total amount of TSP, MoP, Zypsum, Boric acid and Zinc sulphate were applied at the final land preparation as per treatment. Total urea was applied in two installments. The 1st instalments were applied at final land preparation and 2nd installments were applied 25 days after planting as top dressing as per treatment as per treatment. The fertilizer was thoroughly mixed with the soil.

List 1. The following doses of manure and fertilizer were used for the present study

Fertilizer	Doses ha ⁻¹
Vermicompost	2 t 4 t 6 t
Urea	217 kg
TSP	265 kg
MoP	333 kg
Zypsum	110 kg
Boric acid	24 kg

The above doses of fertilizers were converted into manure and fertilizer mixed per treatment of the experiment and supplied by each type of manure and fertilizer except control. After conversion the dose of each manure used in the experiment was as bellow.

List 2. After conversion the dose of each manure used in the experiment

	Vermi- compost (kg/ha)	Urea (g/ha)	TSP (g/ha)	MoP (g/ha)	Gypsum (g/ha)	Boron (g/ha)
T_0	-	-	-	-	11.0	2.4
T_1	0.2	-	-	-	11.0	2.4
T_2	0.4	-	-	-	11.0	2.4
T_3	0.6	-	-	-	11.0	2.4
T_4	-	10.85	13.25	16.65	11.0	2.4
T_5	-	21.7	26.5	33.3	11.0	2.4
T_6	0.2	10.85	13.25	16.65	11.0	2.4
T_7	0.4	10.85	13.25	16.65	11.0	2.4
T_8	0.6	10.85	13.25	16.65	11.0	2.4
T_9	0.2	21.7	26.5	33.3	11.0	2.4
T_{10}	0.4	21.7	26.5	33.3	11.0	2.4
T_{11}	0.6	21.7	26.5	33.3	11.0	2.4

Note: T_0 = Control, T_1 = 2 t ha⁻¹ vermicompost, T_2 = 4 t ha⁻¹ vermicompost, T_3 = 6 t ha⁻¹ vermicompost, T_4 = 50% NPKS (RDF), T_5 = 100% NPKS (RDF), T_6 = 2 t ha⁻¹ vermicompost + 50% NPKS (RDF), T_7 = 4 t ha⁻¹ vermicompost + 50% NPKS (RDF), T_8 = 6 t ha⁻¹ vermicompost + 50% NPKS (RDF), T_9 = 2 t ha⁻¹ vermicompost + 100% NPKS (RDF), T_{10} = 4 t ha⁻¹ vermicompost + 100% NPKS (RDF), T_{11} = 6 t ha⁻¹ vermicompost + 100% NPKS (RDF)

2.4 Statistical Analysis

The recorded data on different parameters were statistically analyzed using Statistic 10 software. The significance of the difference among the treatments means was estimated by the least significant difference test (LSD) at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Plant height was significantly influenced by different nutrients application at different days after sowing (DAS) of garlic (Table 1). It was observed that at 30, 60, 90 DAS and at harvest plant height was significantly influenced by different levels of plant nutrient. Plant height was increased within 30 DAS to 90 DAS. At 30 and 60 DAS, the longest plant (22.60 cm and 36.30 cm) was achieved from T₁₀ (4.00 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment, which was statistically similar to T₁₁ (22.07 cm and 35.60 cm) treatment whereas, the shortest plant (19.53 cm and 28.53 cm) was observed from T₀ (control) treatment which was statistically identical to T₁ (19.87 cm) at 30 DAS and similar to T₂ (20.20 cm) at 30 DAS treatment. At 90 DAS and harvest, the longest plant (49.90 cm and 37.10 cm) was achieved from T₁₁ (6.00 t ha⁻¹

vermicompost + 100% NPKS (RDF) treatment, which was statistically similar to T₁₀ (36.20 cm) at harvest treatment and the shortest plant (39.33 and 32.30 cm, respectively) was observed from T₀ (control) treatment which was statistically similar to T₁ (40.80 cm at 90 DAS) treatment. This promoted increased nutrient uptake by the garlic crop in goat manure-based vermicompost treated soils which facilitated increased plant growth hence taller garlic plants. Similar results were found from the findings of [18]. Hence it may be inferred that the increase in plant height may be due to the favorable influence and balanced absorption of nutrients, increased role of photosynthesis, reduced transpiration and stimulation of root system. [19] also reported that plant height increased from 53.98 cm to 69.14 cm with increasing level of nitrogen from 50 kg ha⁻¹ to 200 kg ha⁻¹ and thereby decreased. [12] also found similar results that application of different compound fertilizers significantly influenced garlic plant height at all successive growth stages of 30, 60, 90 and 120 days after planting.

3.2 Number of Leaves Plant⁻¹

There was significant difference in the number of leaves plant⁻¹ of garlic due to different plant nutrient application at different days after sowing (DAS) (Table 2). It was observed that at 30, 60,

Table 1. Effect of different nutrient on plant height of garlic at different data recording intervals

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At Harvest
T ₀	19.53 g	28.53 g	39.33 h	32.30 e
T ₁	19.87 g	31.73 f	40.80 gh	33.63 d
T ₂	20.20 fg	32.80 e	41.23 g	34.47 cd
T ₃	20.93 d-f	33.27 de	44.10 ef	35.43 bc
T ₄	20.73 ef	34.03 cd	44.07 ef	35.17 bc
T ₅	21.20 c-e	34.03 cd	43.30 f	34.83 cd
T ₆	21.67 b-d	34.73 bc	45.30 de	35.03 bc
T ₇	21.77 bc	34.90 bc	47.27 bc	35.50 bc
T ₈	21.80 bc	35.23 b	47.23 bc	35.43 bc
T ₉	21.73 bc	34.20 cd	46.10 cd	34.90 c
T ₁₀	22.60 a	36.30 a	48.17 b	36.20 ab
T ₁₁	22.07 ab	35.60 ab	49.90 a	37.10 a
LSD (0.05)	0.3700	0.9760	0.8552	0.6019
CV (%)	2.06	1.71	2.26	2.03

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 levels of probability

Here, T₀ = Control, T₁ = 2.0 t ha⁻¹ vermicompost, T₂ = 4.0 t ha⁻¹ vermicompost, T₃ = 6.0 t ha⁻¹ vermicompost, T₄ = 50% NPKS (RDF), T₅ = 100% NPKS (RDF), T₆ = 2.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₇ = 4.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₈ = 6.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₉ = 2.0 t ha⁻¹ vermicompost + 100% NPKS (RDF), T₁₀ = 4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T₁₁ = 6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF)

90 DAS and at harvest, number of leaves plant⁻¹ was significantly influenced by different levels of plant nutrient application. At 30 and 60 DAS, the highest number of leaves plant⁻¹ (4.53) and (5.93) was achieved from T₁₀ (4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment, which was statistically similar to T₁₁ (4.37) and (5.73) treatment whereas, the lowest number of leaves plant⁻¹ (3.17) and (4.23) was observed from T₀ (control) treatment which was statistically similar to T₁ (3.37) and T₂ (3.40) treatment at 30 DAS. At 90 DAS and harvest, the highest number of leaves plant⁻¹ (6.60) and (5.87) was achieved from T₁₁ (6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment and the lowest number of leaves plant⁻¹ (5.05) and (4.02) was observed from T₀ (control) treatment which was statistically similar to T₂ (4.30) and T₁ (4.32) treatment at harvest. From the results of the present study indicated that optimum levels of vermin-compost and NPKS combination might have induced better growing condition, perhaps due to supply of adequate plant nutrients which ultimately led to the production of more leaves plant⁻¹. The result obtained from the present was supported by [18] in respect of number of leaves per plant. [20] reported that significantly higher number of leaves per plant, leaf area per plant and leaf area index over lower levels of vermicompost was recorded in response to application of vermicompost at the rate of 6 t ha⁻¹.

3.3 Bulb Diameter (cm)

Different levels of nutrient application showed significant variation for bulb diameter of garlic (Table 3). It was found that the highest bulb diameter of garlic (3.32 cm) was recorded from T₁₁ (6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment which was statistically similar to T₁₀ (3.15 cm) treatment, where the lowest bulb diameter of garlic (2.11 cm) treatment was recorded from T₀ (control) treatment, which was statistically identical (2.13 cm) with T₁ (vermicompost 2.0 t ha⁻¹) treatment. The probable reason for maximum diameter of bulb is may be due to the application of RDF which enhanced the activity of some microbial population vermin-compost along with NPK nutrient resulting in increase to the diameter of bulb. The results of this study are agreements with [21] in garlic crop. Different levels of plant nutrient application showed significant influence on bulb diameter and it was supported by the findings of [18] that reported the application of both potassium and sulfur either individually or in combined increased bulb diameter, bulb weight and bulb yield. This might be due to the fact that organic manure (MOC) kept the soil loose and both manure and fertilizers supplied adequate plant nutrients for better vegetative growth of garlic plants and ultimately increased bulb diameter.

Table 2. Effect of different nutrient on number of leaves plant⁻¹ of garlic at different data recording intervals

Treatment	Number of leaves plant ⁻¹			
	30 DAS	60 DAS	90 DAS	At Harvest
T ₀	3.17 g	4.23 h	5.05 e	4.02 f
T ₁	3.37 fg	4.53 g	5.47 d	4.32 e
T ₂	3.40 fg	4.80 f	5.67 cd	4.30 ef
T ₃	3.53 ef	5.07 e	5.80 b-d	4.73 cd
T ₄	3.80 de	5.33 d	5.60 cd	4.33 e
T ₅	3.87 cd	5.40 cd	5.80 b-d	4.53 de
T ₆	3.90 cd	5.57 bc	6.00 bc	4.40 e
T ₇	4.13 bc	5.70 b	5.95 bc	5.30 b
T ₈	3.90 cd	5.67 b	5.87 b-d	5.00 c
T ₉	3.73 de	5.60 bc	5.67 cd	4.93 c
T ₁₀	4.53 a	5.93 a	6.13 b	5.33 b
T ₁₁	4.37 ab	5.73 ab	6.60 a	5.87 a
LSD (0.05)	0.1390	0.1028	0.2037	0.1420
CV (%)	4.31	2.29	4.15	3.53

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 levels of probability

Here, T₀ = Control, T₁ = 2.0 t ha⁻¹ vermicompost, T₂ = 4.0 t ha⁻¹ vermicompost, T₃ = 6.0 t ha⁻¹ vermicompost, T₄ = 50% NPKS (RDF), T₅ = 100% NPKS (RDF), T₆ = 2.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₇ = 4.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₈ = 6.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₉ = 2.0 t ha⁻¹ vermicompost + 100% NPKS (RDF), T₁₀ = 4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T₁₁ = 6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF)

3.4 Clove Length (cm)

Effect of different nutrients application showed significant variation on clove length of garlic (Table 3). Increased trend was found with increased nutrient levels. The longest clove of garlic (3.44 cm) was recorded from T₁₁ (6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment which was statistically identical (3.36 cm) with T₁₀ (4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment. On the other hand, the shortest clove of garlic (2.53 cm) was recorded from T₀ (control) treatment.

3.5 Bulb Length (cm)

Effect of different nutrients application showed significant variation on bulb length of garlic (Table 3). Increased trend was found with increased nutrient levels. The highest bulb length of garlic (2.43 cm) was recorded from T₁₁ (6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment whereas, the lowest bulb length of garlic (1.65 cm) was recorded from T₀ (control) treatment. [22] and [23] observed that different nutrients had significant effect on bulb size.

3.6 Fresh Weight of Bulb (g)

Fresh weight bulb plant⁻¹ was significantly influenced due to different levels of nutrients application (Fig. 1). Fresh bulb weight was

increased with increasing plant nutrients. Results showed that the maximum fresh weight of bulb (35.11 g) was recorded from T₁₁ (6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) treatment whereas, the minimum fresh weight of bulb (18.52 g) was recorded from T₀ (control) treatment. From the above results, it was noted that vermicompost and NPKS fertilizers when combinedly used the nutrients become available to plants and much bulb formation was occurred. The available soil nutrients supported proper vegetative growth by producing succulent bulb with more protoplasm in the cells in comparison to less available nutrient in garlic. The results found from the findings of [18,24,23,25], were similar with the present study. Bulb development in garlic depend on an increase in total soluble carbohydrate in photosynthetic activity of the leaves which depend on light and nutrition [26]. [27] reported that increasing nitrogen level upto 100 kg resulted in the maximum single bulb weight (42.60 g) of garlic. The result was in conformity with the findings of [28] that reported the application of both potassium and sulfur either individually or in combined increased fresh bulb weight of gralic. The reason for maximum fresh weight of bulb due to the RDF and Vermicompost application in the soil enhances the biochemical potential of soil and consequently effect plant production. The results of this study are agreements with the [29] in garlic crop.

Table 3. Effect of different nutrients on clove and bulb parameters of garlic

Treatment	Bulb diameter (cm)	Clove length (cm)	Bulb length (cm)
T ₀	2.11 g	2.53 f	1.65 g
T ₁	2.13 g	2.65 e	1.81 f
T ₂	2.35 f	2.72 e	1.88 f
T ₃	2.39 f	2.87 d	1.90 ef
T ₄	2.44 ef	2.95 cd	1.99 de
T ₅	2.63 de	2.93 cd	2.03 cd
T ₆	2.65 d	2.97 cd	2.01 d
T ₇	2.94 c	3.01 c	2.07 cd
T ₈	3.01 bc	3.14 b	2.25 b
T ₉	2.93 c	2.98 c	2.13 c
T ₁₀	3.15 ab	3.36 a	2.28 b
T ₁₁	3.32 a	3.44 a	2.43 a
LSD (0.05)	0.1020	0.0510	0.0508
CV (%)	4.51	2.04	2.95

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 levels of probability

Here, T₀ = Control, T₁ = 2.0 t ha⁻¹ vermicompost, T₂ = 4.0 t ha⁻¹ vermicompost, T₃ = 6.0 t ha⁻¹ vermicompost, T₄ = 50% NPKS (RDF), T₅ = 100% NPKS (RDF), T₆ = 2.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₇ = 4.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₈ = 6.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₉ = 2.0 t ha⁻¹ vermicompost + 100% NPKS (RDF), T₁₀ = 4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T₁₁ = 6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF)

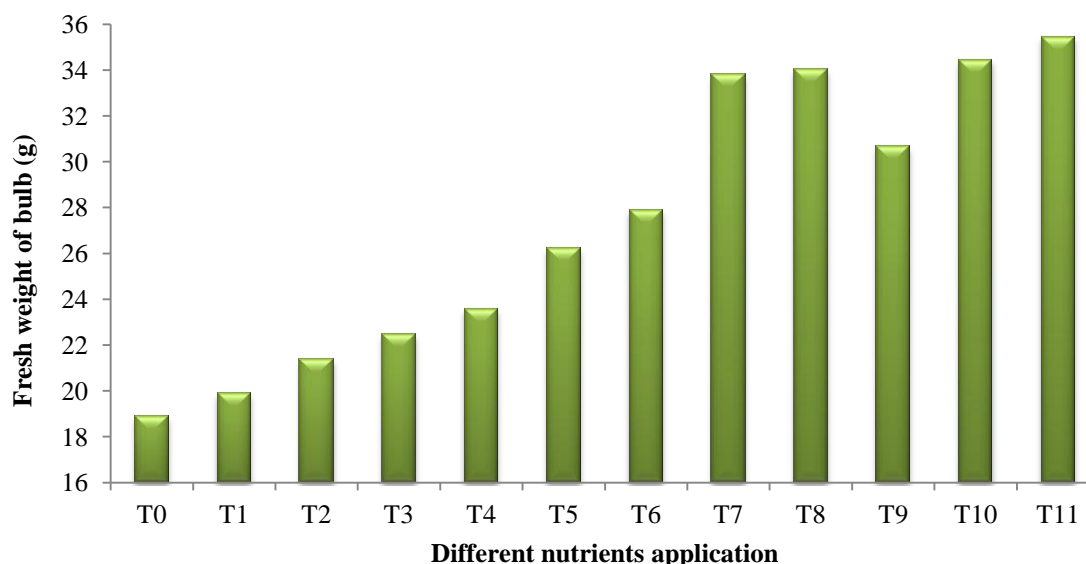


Fig. 1. Effect of different nutrients application on fresh weight of bulb(g) of garlic (LSD value = 0.4632)

Here, T_0 = Control, T_1 = 2.0 t ha^{-1} vermicompost, T_2 = 4.0 t ha^{-1} vermicompost, T_3 = 6.0 t ha^{-1} vermicompost, T_4 = 50% NPKS (RDF), T_5 = 100% NPKS (RDF), T_6 = 2.0 t ha^{-1} vermicompost + 50% NPKS (RDF), T_7 = 4.0 t ha^{-1} vermicompost + 50% NPKS (RDF), T_8 = 6.0 t ha^{-1} vermicompost + 50% NPKS

3.7 Root Length (cm)

Effect of different nutrients application showed significant variation on root length of garlic (Table 4). Increased trend was found with increased nutrient levels. The longest root of garlic (22.70 cm) was recorded from T_{10} (4.0 t ha^{-1} vermicompost + 100% NPKS (RDF) treatment which was statistically similar (21.57 cm) with T_{11} (6.0 t ha^{-1} vermicompost + 100% NPKS (RDF) treatment. On the other hand, the shortest root of garlic (10.40 cm) was recorded from T_0 (control) treatment which was statistically similar (11.47 cm) with T_1 (2.0 t ha^{-1} vermicompost) treatment.

3.8 Yield of Bulb Plot⁻¹ (kg)

Yield per plot of garlic was significantly affected by different levels of nutrients application (Table 4). Higher application of plant nutrients gave higher bulb yield per plot. Results specified that the highest yield per plot of garlic (1.45 kg) was recorded from T_{11} (6.0 t ha^{-1} vermicompost + 100% NPKS (RDF) treatment where, the lowest yield per plot of garlic (0.54 kg) was recorded from T_0 (control) treatment. 6.0 t ha^{-1} vermicompost + 100% NPKS (RDF) gave 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 [30].

3.9 Yield (t ha⁻¹)

Different levels of nutrients application showed significant variation on yield (t ha^{-1}) of garlic (Fig. 2). Results represented that the maximum yield of garlic (14.53 t ha^{-1}) was recorded from T_{11} (6.0 t ha^{-1} vermicompost + 100% NPKS (RDF)) treatment. Again, the minimum yield of garlic (5.43 t ha^{-1}) was recorded from T_0 (control) treatment. The results obtained from the present study was similar with the findings of [18,22]. The plant received more nutrients when raised with the combination of vermicompost and NPKS fertilizers. Balanced fertilizers are the basis for more production and nutrient needs of crops is according to their physiological requirements and expected yields [13]. Bulb crops are a heavy feeder, requiring optimum supplies of nitrogen, phosphorus, potassium and sulphur and other nutrients which can adversely affect the growth, yield and quality of bulbs under sub-optimal levels in the soil [31]. The application of RDF and vermicompost and micro nutrients setting are affected the soil ability and balancing nutrient supply to the plant increase with the bulb yield with the study are agreement with the findings of [21] in garlic crop.

Table 4. Effect of different nutrient on leaf and root parameters of garlic

Treatment	Dry weight of leaf (g)	Root length (cm)	Fresh weight of root (g)	Yield plot ⁻¹ (kg)
T ₀	1.11 i	10.40 h	0.48 g	0.54 j
T ₁	1.15 i	11.47 gh	0.49 g	0.66 i
T ₂	1.41 h	12.74 fg	0.56 f	0.74 h
T ₃	1.63 g	13.84 f	0.58 f	0.87 f
T ₄	1.93 f	15.48 e	0.61 ef	0.77 g
T ₅	2.38 e	16.35 e	0.67 de	0.85 f
T ₆	2.64 d	18.11 d	0.72 d	0.92 e
T ₇	3.05 c	20.16 bc	0.86 bc	1.05 d
T ₈	3.07 bc	21.17 bc	0.88 bc	1.22 c
T ₉	2.99 c	19.97 c	0.84 c	1.06 d
T ₁₀	3.21 ab	22.70 a	0.96 a	1.25 b
T ₁₁	3.31 a	21.57 ab	0.92 ab	1.45 a
LSD (0.05)	0.0779	0.7373	0.0316	0.0170
CV (%)	3.96	5.12	5.23	0.60

In a column means having similar letter (s) are statistically similar and those having dissimilar letter(s) differ significantly by LSD at 0.05 levels of probability

Here, T₀ = Control, T₁ = 2.0 t ha⁻¹ vermicompost, T₂ = 4.0 t ha⁻¹ vermicompost, T₃ = 6.0 t ha⁻¹ vermicompost, T₄ = 50% NPKS (RDF), T₅ = 100% NPKS (RDF), T₆ = 2.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₇ = 4.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₈ = 6.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₉ = 2.0 t ha⁻¹ vermicompost + 100% NPKS (RDF), T₁₀ = 4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T₁₁ = 6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF)

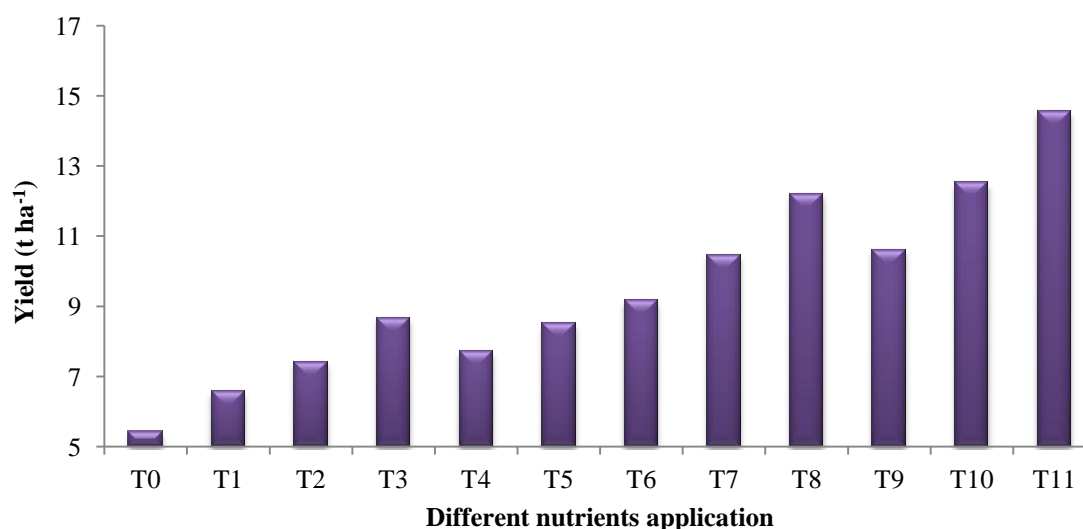


Fig. 2. Effect of different nutrients application on yield (t ha⁻¹) of garlic (LSD value = 0.1696)

Here, T₀ = Control, T₁ = 2.0 t ha⁻¹ vermicompost, T₂ = 4.0 t ha⁻¹ vermicompost, T₃ = 6.0 t ha⁻¹ vermicompost, T₄ = 50% NPKS (RDF), T₅ = 100% NPKS (RDF), T₆ = 2.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₇ = 4.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₈ = 6.0 t ha⁻¹ vermicompost + 50% NPKS (RDF), T₉ = 2.0 t ha⁻¹ vermicompost + 100% NPKS (RDF), T₁₀ = 4.0 t ha⁻¹ vermicompost + 100% NPKS (RDF) and T₁₁ = 6.0 t ha⁻¹ vermicompost + 100% NPKS (RDF)

4. CONCLUSION

Considering the above result of this experiment, the following conclusion can be drawn:

- i. The effect of different levels of vermicompost and essential

macronutrients was found to be significant on growth, yield contributing and yield parameters of garlic.

- ii. Application of 6.00 t ha⁻¹ vermicompost + 100% NPKS (RDF) was recorded to be more suitable practice for getting higher amount and quality of bulb yield of garlic.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Mohd TA, Desal JD, Parmar SB, Parmar BR. Effect of organic and inorganic fertilizers on growth, yield and quality of garlic. The Asian Journal of Horticulture. 2011;6:52-55.
- Kioko JMD, Kamau PA, Mushimiyimana D. Evaluation of the effect of NPK fertilizer and spacing on growth and yield of garlic (*Allium sativum*) In Bomet County. IJRDO- Journal of Educational Research. 2017;2(9):85-108.
- BBS. Monthly Statistical Bulletin in Bangladesh. June. Statistics Division. Ministry' of Planning, Government of People's Republic of Bangladesh; 2020.
- Augusti KT. Hypocholesterolaemic effect of garlic (*Allium sativum* L.). Indian J. Expt. Biol. 1977; 15(6):489-490.
- Degwale A. Effect of vermicompost on growth, yield and quality of garlic. Journal of Natural Sciences Research. 2016;6(3):51-63.
- Mbithi MA, Mwanarusi S, Mwangi M. Effect of different rates of vermicompost on growth and yield of beetroot (*Beta vulgaris* L.). Egerton J. Sci. & Technol. 2015;15(2073 – 8277):30-43.
- Lazcano C, Gomez-Brandon M, Dominguez J. Comparison of the effectiveness of composting and vermicomposting for the biological stabilization of cattle manure. Chemosphere. 2008;72:1013-1019.
- Acharya S, Kumar H. Effect of some organic manure on growth and yield of garlic in greenhouse condition at cold desert high altitude ladakh region. Defence Life Science Journal. 2018;3(2):100-104.
- Nonnecke IL. Vegetable Production, New York. 1989;657.
- Food and Agricultural Organization (FAO). Global review of area and production of garlic. 2003; 135-139.
- Brewster JL, Butler HA. Effects of nitrogen supply on bulb development in onions (*Allium cepa* L.). Journal of Experimental Botany. 1989;40:1155-1162.
- Diriba-Shiferaw G, Nigussie-Dechassa R, Woldetsadik K, Tabor G, Sharma JJ. Growth and nutrients content and uptake of garlic (*Allium sativum* L.) as influenced by different types of fertilizers and soils. Sci. Technol. Arts Res. J. 2013;2(3):35–50.
- Ryan J. A Perspective on balanced fertilization in the Mediterranean Region. The Turkish Journal of Agriculture and Forestry. 2008;32:79-89.
- Alemu D. Effect of vermicompost on growth, yield and quality of garlic (*Allium sativum* L.) in Enebe Sar Midir District, Northwestern Ethiopia. J. N. Sci. Res.; 2016.
- Ethiopian National Agricultural Input Authority (ENAIA). Crop Variety Register. 2003;5:101-102.
- SOPIB. Sulphate of Potash information board and Bulb Crops (Onions, Shallots, Garlic, Leeks); 2001. Available:<http://www.sopib.com>.
- Anonymous. Land resources appraisal of Bangladesh for agricultural development. Report No. 2. Agroecological Regions of Bangladesh, UNDP and FAO. 1989;472-496.
- Farooqui MA, Naruka IS, Rathore SS, Singh PP, Shaktawat RPS. Effect of nitrogen and sulphur levels on growth and yield of garlic (*Allium sativum* L.). As. J. Food Ag-Ind. 2009;Special Issue,S: 18–23.
- Hore JK, Ghanti S, Chanchan M. Influence of nitrogen and sulphur nutrition on growth and yield of garlic (*Allium sativum* L.). Journal of Crop and Weed. 2014;10(2):1418.
- Bagali AN, Patil HB, Chimmad VP, Patil PL, Patil RV. Effect of inorganics and organics on growth and yield of onion (*Allium cepa* L.). Karnataka J. Agric. Sci. 2012;25(1):112-115.
- Yadav PK. Effect of nitrogen and potassium on growth and yield of Garlic (*Allium sativum* L.) in western Rajasthan. Haryana Journal of Horticultural Sciences. 2003;32:290-291.
- Setty BS, Sulikeri GS, Hulamani NC. Effect of N, P and K on growth and yield of garlic (*Allium sativum* L.). Karnataka J. Agril. Sci. 1989;2(3):160–164.
- Pande RC, Mundra RS. Note on response of onion (*Allium cepa* L.) to varying levels of N, P and K. Indian J. Agril. Sci. 1971; 41(2):107-108.
- Gudi N, Swandi A, Hilman Y. The effects of the application of stable manure and different trace to elements on garlic. Buletin Penelitiar Hirtukultura Indonesia. 1988;16(4):5–13. [Cited from Hort. Abst. 1991;54(4):4779.

25. Hilman Y, Noordiyata I. Equilibrium N, P and K fertilization trial on garlic in rice field. Buletin Peneletian Horticulture. 1988;16(1):48–53. [Cited from Hort. Abstr. 1990;60(7):5116.
26. Arguello JA, Nunez SB, Ledesma A. Bulbing physiology in Garlic (*Allium sativum* L.) cv. Rosado Paraguayo III. Nutrient content in garlic plant; its relation to growth dynamics and bulb morphogenesis. Acta. Hort. 2007;433:417-426.
27. Kakar AA, Abdullahzai MK, Saleem M, Shah SAQ. Effect of nitrogenous fertilizer on growth and yield of garlic. Asian J. Pl. Sci. 2002;1(5):544-545.
28. Nasiruddin KM, Farooque AM, Baten MA. Effect of potassium and sulphur on growth and yield of onion. Bangladesh J. Agril. Sci. 1993;20(1):35-40.
29. Suthar S. Impact of vermicompost and composted farmyard manure on growth and yield of garlic (*Allium sativum* L.) field crop. International J. Plant Production. 2009;3(1):27–38.
30. Mallanagouda B, Sulikeri GS, Hulamari NC, Murthy BG, Masalgeri BB. Effect of NPK and FYM on growth parameters of onion, garlic and coriander. Current Research University of Agricultural Sciences, India. 1995;24(11):212-213.
31. Gubb IR, Tavis MSH. Onion preharvest and postharvest considerations. In: H.D. Rabinowitch, and L. Currah (eds.). Allim Crop science. CABI publishing, UK. 2002; 237-250.

© 2022 Alam 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.sdiarticle5.com/review-history/88762>