EFFECT OF DIFFERENT LEVELS OF VERMICOMPOST AND MACRO NUTRIENTS ON THE GROWTH AND YIELD OF GARLIC (*Allium sativum* L.)

Original Research Article

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: 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 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 T_{10} (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 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 T_{11} (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 relatebd 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. [31] 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[14]. 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[15]. 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[16]. 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 m^2 (1.0m x 1.0m) in size. Altogether there were 36 unit plots in experiment and required 36.0 m^2 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), Zypsim 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 2ndinstallments 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.Result 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 T_{10} (4.00 t ha^{-}

[1]vermicompost + 100% NPKS (RDF) treatment, which was statistically similar to T_{11} (22.07 cm and 35.60 cm) treatment whereas, the shortest plant (19.53 cm and 28.53 cm) was observed from T_0 (control) treatment which was statistically identical to T_1 (19.87 cm) at 30 DAS and similar to T_2 (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 T_{11} (6.00 t ha^{-1}vermicompost + 100% NPKS (RDF) treatment, which was statistically similar to T_{10} (36.20 cm) at harvest treatment and the shortest plant (39.33 and 32.30 cm, respectively) was observed from T_0 (control) treatment which was statistically similar to T_1 (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 [17]. 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. [18]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.

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, 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 (RDF), T_9 = 2.0 t ha^{-1}vermicompost + 100% NPKS (RDF), T_{10} = 4.0 t ha^{-1}vermicompost + 100% NPKS (RDF) and T_{11} = 6.0 t ha^{-1}vermicompost + 100% NPKS (RDF).

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, 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 T_{10} (4.0 t ha^{-1}vermicompost + 100% NPKS (RDF) treatment, which was statistically similar to T_{11} (4.37) and (5.73) treatment whereas, the lowest number of leaves $plant^{-1}$ (3.17) and (4.23) was observed from T_0 (control) treatment which was statistically similar to T_1 (3.37) and T_2 (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 T_{11} (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 T_0 (control) treatment which was statistically similar to T_2 (4.30) and T_1 (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 [17]in respect of number of leaves per plant. [19] 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}.

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, 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 (RDF), T_9 = 2.0 t ha^{-1}vermicompost + 100% NPKS (RDF), T_{10} = 4.0 t ha^{-1}vermicompost + 100% NPKS (RDF) and T_{11} = 6.0 t ha^{-1}vermicompost + 100% NPKS (RDF).

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 T_{11} (6.0 t ha^{-1}vermicompost + 100% NPKS (RDF) treatment which was statistically similar to T_{10} (3.15 cm) treatment, where the lowest bulb diameter of garlic (2.11 cm) treatment was recorded from T_0 (control) treatment, which was statistically identical (2.13 cm) with T_1 (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 [20] in garlic crop. Different levels of plant nutrient application showed significant influence on bulb diameter and it was supported by the findings of [17] 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.

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 T_{11} (6.0 t ha^{-1}vermicompost + 100% NPKS (RDF) treatment which was statistically identical (3.36 cm) with T_{10} (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 T_0 (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 T_{11} (6.0 t ha^{-1}vermicompost + 100% NPKS (RDF) treatment whereas, the lowest bulb length of garlic (1.65 cm) was recorded from T_0 (control) treatment. [21] and [22] observed that different nutrients had significant effect on bulb size.

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**

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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, 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 (RDF), T_9 = 2.0 t ha^{-1}vermicompost + 100% NPKS (RDF), T_{10} = 4.0 t ha^{-1}vermicompost + 100% NPKS (RDF) and T_{11} = 6.0 t ha^{-1}vermicompost + 100% NPKS (RDF).

3.6 Fresh weight of bulb (g)

Fresh weight bulb $plant^{-1}$ was significantly influenced due to different levels of nutrients application (Figure 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 T_{11} (6.0 t ha^{-1}vermicompost + 100% NPKS (RDF) treatment whereas, the minimum fresh weight of bulb (18.52 g) was recorded from T_0 (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 [17], [23], [22], [24], 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 [25]. [26]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 [27] 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 [28] in garlic crop.

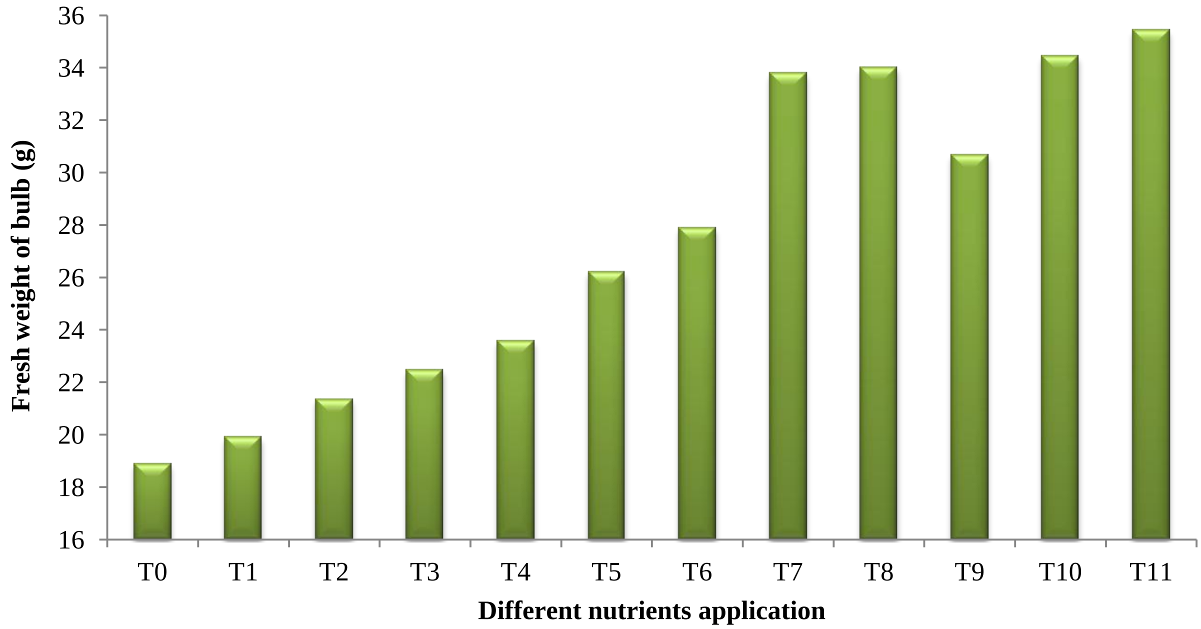

Fig. 1. Effect of different nutrients application on fresh weight of bulb(g) of garlic (LSD value = 0.4632)

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 [29].

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, 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 (RDF), T_9 = 2.0 t ha^{-1}vermicompost + 100% NPKS (RDF), T_{10} = 4.0 t ha^{-1}vermicompost + 100% NPKS (RDF) and T_{11} = 6.0 t ha^{-1} vermicompost + 100% NPKS (RDF).

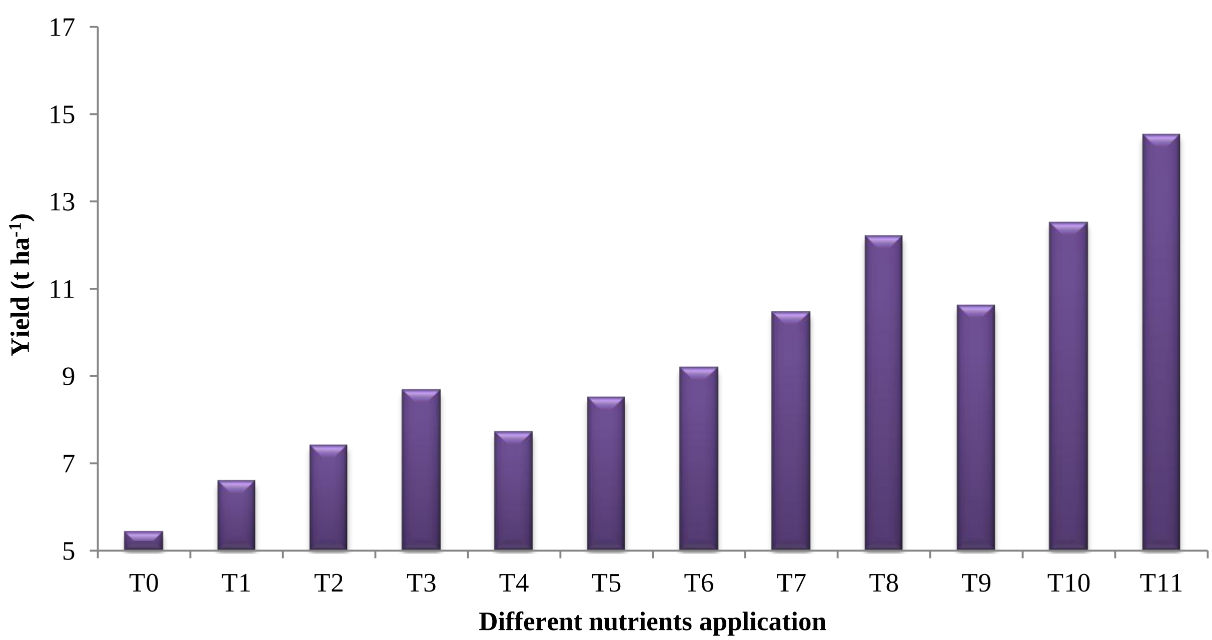

Fig. 2. Effect of different nutrients application on yield (t ha^{-1}) of garlic (LSD value = 0.1696)

Here, 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 (RDF), T_9 = 2.0 t ha^{-1}vermicompost + 100% NPKS (RDF), T_{10} = 4.0 t ha^{-1}vermicompost + 100% NPKS (RDF) and T_{11} = 6.0 t ha^{-1}vermicompost + 100% NPKS (RDF).

3.9 Yield (t ha^{-1})

Different levels of nutrients application showed significant variation on yield (t ha^{-1}) of garlic (Figure 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 [17], [21]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 [30]. 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 [20] in garlic crop.

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.

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