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Effect of Vermicompost and Earthing Up on the Growth and Yield of Onion

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Authors' contributions

This work was carried out in collaboration among all authors. Authors TM and KK planned the experiment and lead the research. Authors TM, KK and SM designed and carried out the research. Author MEH performed the statistical analysis. Authors SM and IAS carried out the research on the field. Authors SA, IS and AG collected the data. Authors SM and MEH wrote the manuscript. Authors IAS, SA, IS and AG managed the literature searches. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.

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ABSTRACT

A field research was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the period from October 2017 to March 2018 to study the effect of vermicompost and earthing upon growth and yield of onion. The experiment consists of two factors. Factor-A Vermicompost V_0 (control), V_1 (6 t ha^{-1} vermicompost), V_2 (10 t ha^{-1} vermicompost) and V_3 (14 t ha^{-1} vermicompost) and Factor-B Earthing up E_0 (control), E_1 (Two times earthing up) and E_2 (Three times earthing up). The experiment was laid out in RCBD (Randomized Complete Block Design) with three replications. The collected data were statistically

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analyzed. Results revealed that in terms of vermicompost application The highest fresh weight bulb-^{1} (40.07 g), yield plot-^{1} (527.89 g) and yield ha-1 (5.39 t) were found from the treatment V_3 compared to V_0 (control) treatment. Again, in terms of different earthing up treatments, the highest fresh weight bulb-^{1} (32.48 g), yield plot-^{1} (431.67 g) and yield ha-1 (4.41 t) were found from the treatment E_2 (Three times earthing up) compared to E_0 (control) treatment. Both vermicompost and earthing up and their combination showed a considerable variation on different growth and yield parameters of onion. The highest fresh weight bulb-^{1} (42.73 g), yield plot-^{1} (567.33 g) and yield ha-^{1} (5.79 t) were found from the treatment combination of V_3E_2 compared to control V_0E_0 (control) treatment combination. And it may be summarized that 14 t/ha vermicompost with three times earthing up performed the maximum yield compared to other treatments.

Keywords: Earthing up; onion; vermicompost and yield.

1. INTRODUCTION

Onion (*Allium cepa* L.) is an important herbaceous bulb and spice crop in the world which belongs to the family Alliaceae. It is also considered as the most important vegetable crops commercially grown in the world. It probably originated from Central Asia between Turkmenistan and Afghanistan where some of its relatives still grow in the wild. Onion is mainly used as spices but it is also used as condiments for flavoring food and also as delicious vegetables and salad crop. Onion is popularly referred as “Queen of Kitchen.” Onion is liked for its flavour and pungency which is due to the presence of a volatile oil ‘allyl propyl disulphide’- organic compound rich in sulphur. It is being used in several ways as fresh, frozen, dehydrated bulbs and green bunching types [1]. Onion has got good medicinal value. Recently onion is being used by processing industry to greater extent for preparing dehydrated forms like powder and flakes. Onion contains carbohydrates (11.0 g), proteins (1.2 g), fiber (0.6 g), moisture (86.8 g) and several vitamin like vitamin A (0.012 mg), vitamin C (11 mg), thiamin (0.08 mg), riboflavin (0.01 mg) and niacin (0.2 mg) and also some minerals like phosphorus (39 mg), calcium (27 mg), sodium (1.0 mg), iron (0.7 mg) and potassium (157 mg) per 100 g [2]. In Bangladesh it is commercially cultivated in the greater districts of Dhaka, Mymensingh, Rajshahi, Rangpur, Rajbari, Khustia, Khulna, Barisal and Pabna [3]. Among the spice crops grown in Bangladesh, onion ranks top in respect of production and second in respect of area [4]. Onion is generally grown in Rabi season in Bangladesh. Growth and yield of this crop is remarkably influenced by different nutrients management. There are two types of fertilizer one is Organic and another is Inorganic. Chemical fertilizers generate several deleterious effects on the environment and human health. The synthetic fertilizers are rapidly lost by leaching in drainage water; this causes dangerous environmental pollution [5]. It is an established fact that use of inorganic fertilizer for the crops is not so good for health because of residual effect but in the case of organic fertilizer such problem does not arise and on the other hand it increase the productivity of soil as well as crop quality and yield [6]. However, overall, excessive amounts of inorganic fertilizers are applied to onion in order to achieve a higher bulb yield [7]. Organic manure contains nutrient elements that can support crop production and enhance chemical and physical properties of soil. Application of organic fertilizers to the soils promoted nutrients availability, plant uptake, increased crop yield and quality [7,8]. Organic manure is a two way practice of saving the environment by transforming waste materials into a valuable resource that can be used to supplement soil nutrients [9]. Organic manure also helps to conservation of soil moisture. Available soil moisture also helps taking other nutrients for the plants. In this way organic manure helps up taking of different plant nutrients and to increase fertility and productivity of soil [10]. Manure like cowdung, poultry manure, mustard oil cake, vermicompost is becoming popular and they are also available locally. Vermicompost is organic manure which is important as a product of interactions between earthworm and microorganisms by degradation of organic waste [11]. Vermicompost is very important to increase Onion quality and yield. Several researchers have reported that vermicompost contains substaces which helps in building soil structure, stimulation of plant growth, particularly that of roots, drilling mud and emulsiliers. Vermicompost stimulates to influence the microbial activity of soil, increases the availability of oxygen, maintains normal soil temperature, increases soil porosity and infiltration of water, improves nutrient content and

increases growth, yield and quality of the plant [12]. It is documented that vermicompost is a rich source of vital macronutrients (N, P, K, Ca and Mg) and micronutrients (Fe, Mo, Zn, and Cu). The chemical analysis of vermicompost reveals that N, P, K content was 0.8, 1.1 and 0.5 percent respectively. It is scientifically proving as 'miracle growth promoter and also plants protector' from pests and diseases. Vermicompost retains nutrients for a long time and while the conventional compost fails to deliver the required amount of macro and micronutrients including the vital NKP to plants in a shorter time, the vermicompost does [11]. There are different types of intercultural operation have been observed on onion cultivation such as irrigation, weeding, thining, mulching, earthing up and so on. In which earthing up play vital role in growth and yield of onion. Earthing up is the technique in agriculture and horticulture of piling soil up around the base of a plant. Earthing up provided maximum number of tuber with large size [13]. Mukherjee et al. [14] reported that earthing up is an economically viable weed control practice. The well known benefits that earthing up provides are regulating soil moisture and temperature, improving germination and emergence etc. high yield and quality, prolonged growing season higher nutritive value of the produce, improved storability etc. are also well described advantages of earthing up, therefore, aids in reducing cost involved in crop production with irrigation. The present study was aimed to determine the effects of vermicompost and earthing up on the growth and yield of onion from Bangladesh.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at Sher-e-Bangla Agricultural University Farm, Dhaka-1207, Bangladesh. It is located at $90^{o}22'$ E longitude and 23°4l′ N latitude at an altitude of 8.6 meters above the sea level. The land belongs to Agro-ecological zone of Modhupur Tract, AEZ-28. Soil was having the texture of sandy loam with p^{H} 5.6.

2.2 Treatments of the Experiment

The experiment consists of two factors which are given below:

Factor A: Vermicompost – 4 levels

1) V_0 = Control
2) V_1 = 6 t ha^{-1} vermicompost
3) V_2 = 10 t ha^{-1} vermicompost
4) V_3 = 14 t ha^{-1} vermicompost

Factor B: Earthing up – 3 levels

1) E_0 = Control
2) E_1 = Two times earthing up (25 & 50 DAT)
3) E_2 = Three times earthing up (25,50 & 75 DAT)

Therefore the treatment combinations were given below: V_0E_0, V_0E_1, V_0E_2, V_1E_0, V_1E_1, V_1E_2, V_2E_0, V_2E_1, V_2E_2, V_3E_0, V_3E_1, V_3E_2.

2.3 Manures and Fertilizers

BARI recommendation doses of Urea, Triple Super Phosphate (TSP) and Muriate of Potash (MP) are 200 Kg ha^{-1}, 125 Kg ha^{-1}, and MP-180 Kg ha^{-1} respectively. But in the present study, no chemical fertilizer was used. Only vermicompost were applied in experiment field according to the treatment assigned under the present study. vermicompost with available amount of nutrient: N (1.5-2%), P_2O_5 (0.5-1.5%), K_2O (0.5-1%). Analyzed by soil science laboratory of Sher-e-Bangla Agricultural University.

2.4 Statistical Analysis

The collected data on various parameters under study were statistically analyzed using MSTAT-C computer package programme. The means for all the treatments were calculated and analysis of variance for all the characters was performed by the F- variance test Gomez and Gomez [15]. Significance of difference between means was evaluated by Least Significance Difference (LSD) and the probability level 5% and 1% for the interpretation of results.

3. RESULTS AND DISCUSSION

3.1 Plant Height (Cm)

There was a significant variation was found on plant height of onion influenced by different levels of vermicompost application at different growth stages (Fig. 1). Results revealed that the highest plant height (53.80 cm) at 60 DAT was found from the V_3 (14 t ha^{-1} vermicompost) treatment which was significantly different from all other treatments followed by V_2 (10 t ha^{-1} vermicompost) treatment. The lowest plant height (43.60 cm) at 60 DAT was found from the treatment V_0 (control). Similar result was also observed by [16,17]. Reddy and Reddy [16]

found that the plant height increased significantly with increasing levels of vermicompost from 10 to 30 t ha^{-1}.

Plant height at different growth stages was significantly influenced by earthing up of onion (Fig. 2). At 60 DAT the highest plant height (50.52 cm) at was found from the E_2 (Three times earthing up) treatment which was statistically identical with E_1 (Two times earthing up) treatment at 60 DAT where the lowest plant height (47.00 cm) was found from the E_0 (control) treatment. Similar result was also observed by Ali et al. [18] which supported the present study.

Table 1. Concentration of nitrogen, phosphorus and potassium in sample soil

Soil analysis interpretation	N	P	K	Cow dung (t/ha)
Optimum	0-30	0-15	0-40	
Medium	31-60	16-30	20-Nov	
Low	61-90	31-45	21-30	5
Very low	91-120	46-60	31-40	

Source: Fertilizer recommendation guide 2012 (BARI) [19]

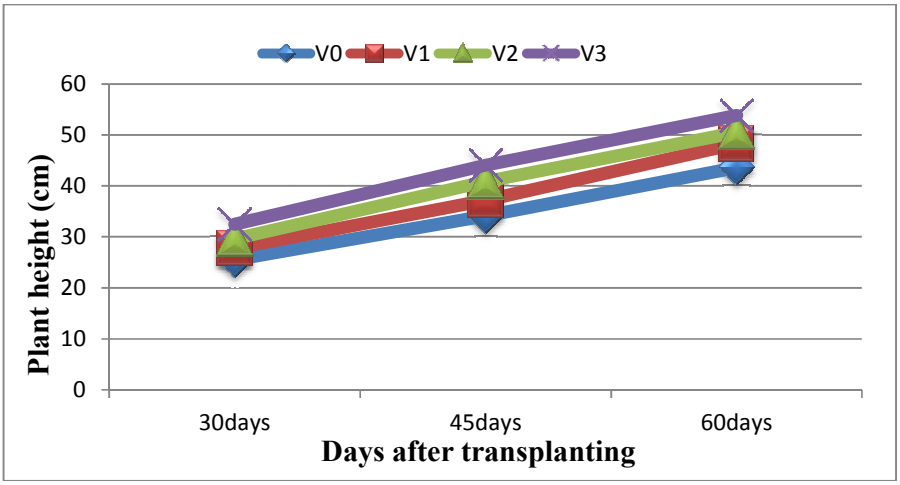

Fig. 1. Effect of vermicompost on plant height at different days after transplanting of onion
Here, V_0 = Control, V_1 = 6 t ha^{-1} vermicompost, V_2 = 10 t ha^{-1} vermicompost, V_3 = 14 t ha^{-1}, vermicompost

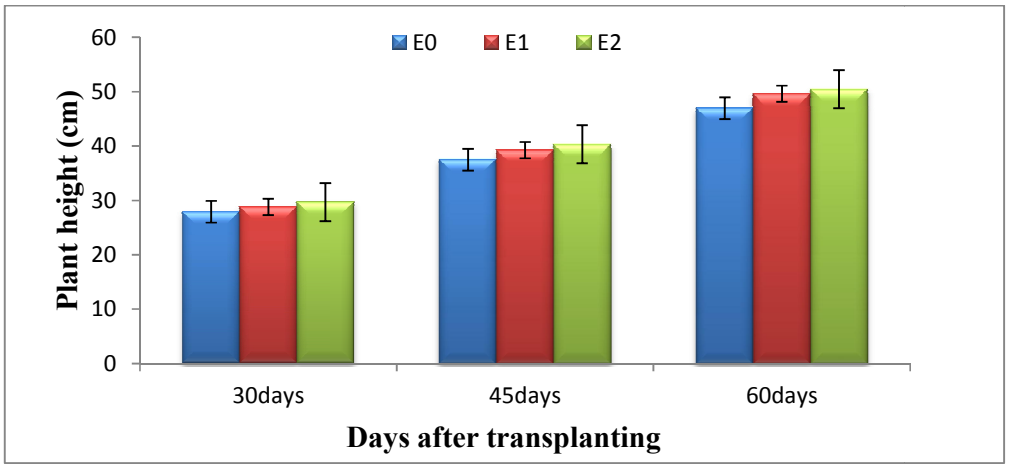

Fig. 2. Combined effect of earthing up on plant height at different days after transplanting of onion
Here, E_0 = Control, E_1 = Two times earthing up, E_2 = Three times earthing up

Significant variation was observed on plant height at different growth stages influenced by combined effect of vermicompost and earthing up of onion (Table 2). At the 60 DAT highest plant height (55.33 cm) was found from the V_3E_2 (treatment combination) which was statistically similar to V_2E_2, V_3E_0 and V_3E_1 treatment combination and the lowest plant height (39.00 cm) was found from the V_0E_0 (control) treatment combination.

3.2 Number of Leaves Plant^{-1}

Number of leaves plant^{-1} at different growth stages was significantly varied due to different levels of vermicompost application (Fig. 3). At the 60 DAT highest number of leaves plant^{-1} (7.09) was found from the treatment V_3 (14 t ha^{-1} vermicompost) and the lowest number of leaves plant^{-1} (5.56) and at 60 DAT was found from the V_0 (control) treatment. Similar result was also observed by Mukherjee et al. [14] and Gomez and Gomez [15]. They found that number of leaves per plant increased significantly with increasing levels of vermicompost from 10 to 30 t ha^{-1}.

Remarkable variation was observed on number of leaves plant^{-1} at different growth stages influenced by earthing up of onion (Fig. 4). At the 60 DAT highest number of leaves plant^{-1} (7.40) was found from the treatment E_2 (Three times earthing up) treatment and the lowest number of leaves plant^{-1} (6.13) at 60 DAT was found from the E_0 (control) treatment which was statistically identical with E_1 (Two times earthing up) treatment at all growth stages. The result obtained from the present study was similar with the findings of Ali [16].

Significant influence was noted on number of leaves plant^{-1} affected by combined effect of vermicompost and earthing up of onion (Table 3). At the 60 DAT highest number of leaves plant^{-1} (7.27) was found from the V_3E_2 (treatment combination) which was statistically identical to V_3E_1 and statistically similar with V_3E_0 and V_2E_1 (Treatment combination).The lowest number of leaves plant^{-1} (5.27) at 60 DAT was found from the V_0E_0 (treatment combination) which was statistically similar with the treatment combination of V_0E_1 at 60 DAT.

3.3 Root Length (cm)

Root length of onion varied significantly due to different levels of vermicompost application (Table 4). It was found that the highest root length (7.59 cm) was found from the V_3 (14 t ha^{-1} vermicompost) treatment and the lowest root length (5.04 cm) was found from the treatment V_0 (control) treatment. Significant variation was remarked as influenced by earthing up of onion (Table 4). Results indicated that the highest root length (6.32 cm) was found from the E_2 (Three times earthing up) treatment, which was statistically similar with E_1 (Two times earthing up) treatment where the lowest root length (5.86 cm) was found from the E_0 (control) treatment, which was statistically similar to E_1 treatment. Root length was significantly influenced by combined effect of vermicompost and earthing up of onion (Table 5). The highest root length (7.97 cm) was found from the V_3E_2 (treatment combination) which was statistically similar with the V_3E_1 (treatment combination). The lowest root length (4.89 cm) was found from the V_0E_0 (control) treatment combination, which was statistically identical with the treatment combination of V_0E_1 and statistically similar with V_0E_2, V_1E_0 and V_1E_1.

3.4 Bulb Length (cm)

Variation on bulb length was significantly influenced by different levels of vermicompost application (Table 4). The highest bulb length (3.15 cm) was found from the V_3 (14 t ha^{-1} vermicompost) treatment which was significantly different from all other treatments followed by V_2 (10 t ha^{-1} vermicompost). The lowest bulb length (2.51 cm) was found from the treatment V_0 (control; 0 t ha^{-1} vermicompost) which was also significantly different from all other treatments followed by V_1 (4 t ha^{-1} vermicompost). The result obtained from the present study was similar with the findings of [20,21]. Bulb length was significantly affected by earthing up of onion (Table 4). The highest bulb length (2.95 cm) was found from the E_2 (Three times earthing up) treatment which was significantly different from all other treatments and the lowest bulb length (2.76 cm) was found from the E_0 (control) treatment which was statistically identical with E_1 (Two times earthing up) treatment. The recorded data on bulb length was significantly influenced by combined effect of vermicompost and earthing up of onion (Table 5). The highest bulb length (3.35 cm) was found from the V_3E_2 (treatment combination), which was significantly different from all other treatment combinations followed by V_3E_1. The lowest bulb length (2.46 cm) was found from the V_0E_0 (control) treatment combination, which was statistically similar with the treatment combination of V_0E_1 and V_0E_2.

Table 2. Combined effect of vermicompost and earthing up on plant height at different days after transplanting of onion

Treatments	Plant height (cm)		
	30 DAT	45 DAT	60 DAT
V_0E_0	24.20 j	32.33 i	39.00 g
V_0E_1	25.67 i	34.73 h	45.60 f
V_0E_2	26.67 hi	35.33 h	46.20 ef
V_1E_0	27.40 gh	36.07 gh	47.27 d-f
V_1E_1	27.73 gh	37.33 fg	48.67 c-f
V_1E_2	28.13 fg	38.20 ef	49.00 c-f
V_2E_0	28.93 ef	39.33 de	49.73 c-e
V_2E_1	29.67 de	41.20 cd	50.27 b-d
V_2E_2	30.27 cd	42.07 bc	51.53 a-c
V_3E_0	31.27 bc	42.40 bc	52.00 a-c
V_3E_1	32.33 b	43.87 b	54.07 ab
V_3E_2	33.80 a	45.87 a	55.33 a
CV %	8.62	7.54	5.67
$LSD_{(0.05)}$	1.08	1.00	3.96

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

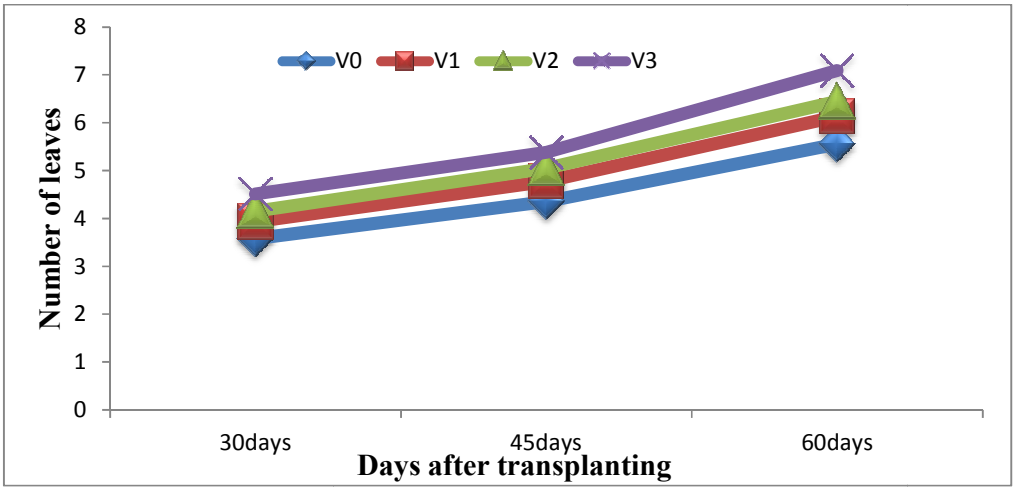

Fig. 3. Effect of vermicompost on number of leaves plant^{-1} at different days after transplanting of onion

Here, V_0 = Control, V_1 = 6 t ha^{-1} vermicompost, V_2 = 10 t ha^{-1} vermicompost, V_3 = 14 t ha^{-1} vermicompost

3.5 Bulb Diameter (cm)

Considerable influenced was observed on bulb diameter persuaded by different levels of vermicompost application (Table 4). The highest bulb diameter (4.38 cm) was found from the treatment V_3 (8 t ha^{-1} vermicompost) which was significantly different from all other treatments followed by V_2 (6 t ha^{-1} vermicompost). The lowest bulb diameter (3.42 cm) was found from the treatment V_0 (control; 0 t ha^{-1} vermicompost) followed by V_1 (4 t ha^{-1} vermicompost). Similar result was also observed by Kaswan et al. [17]. Remarkable variation was identified on bulb diameter due to the effect of earthing up of onion (Table 4). The highest bulb diameter (4.04 cm) was found from the E_2 (Three times earthing up) treatment, which was statistically similar with E_1 (Two times earthing up) treatmen. The lowest bulb diameter (3.79 cm) was found from the E_0 (control) treatment. Bulb diameter was significantly influenced by combined effect of vermicompost and earthing up of onion (Table 5). The highest bulb diameter (4.55 cm) was found from the V_3E_2 (treatment combination) which was statistically similar with the V_3E_1 (treatment combination). The lowest bulb diameter (3.22 cm) was found from the V_0E_0 (control) treatment

combination, which was statistically identical with the treatment combination of V_0E_1.

3.6 Neck Diameter (cm)

Neck diameter was varied significantly due to different levels of vermicompost application (Table 4). The highest neck diameter (1.26 cm) was found from the V_3 (14 t ha^{-1} vermicompost) treatment which was significantly different from all other treatments followed by V_2 (10 t ha^{-1} vermicompost). The lowest neck diameter (0.89 cm) was found from the V_0 (control) treatment which was also significantly different from all other treatments followed by V_1 (6 t ha^{-1} vermicompost). The result obtained from the present study was similar with the findings of Mandal et al. [22]. Significant variation was remarked on neck diameter as influenced by earthing up of onion (Table 4). The highest neck diameter (1.13 cm) was found from the E_2 (Three times earthing up) treatment which was significantly different from all other treatments where the lowest neck diameter (0.99 cm) was found from the E_0 (control) treatment which was statistically identical with E_1 (Two times earthing up) treatment. Neck diameter of onion was significantly influenced by combined effect of vermicompost and earthing up (Table 5). The highest neck diameter (1.45 cm) was found from the V_3E_2 (treatment combination), which was significantly different from all other treatment combinations followed by V_3E_1. The lowest neck diameter (0.83 cm) was found from the V_0E_0 (control) treatment combination, which was statistically similar to V_0E_1 treatment combination.

3.7 Fresh Weight Bulb^{-1} (g)

Variation on fresh weight bulb^{-1} was significant influenced by different levels of vermicompost application (Table 4). The highest fresh weight bulb^{-1} (40.07 g) was found from the V_3 (14 t ha^{-1} vermicompost) treatment where the lowest fresh weight bulb^{-1} (22.07 g) was found from the V_0 (control) treatment which was significantly different from all other treatments. Similar result was also observed by Dhaker et al. [23] which supported the present study. Fresh weight bulb^{-1} was affected significantly by earthing up of onion (Table 4). The highest fresh weight bulb^{-1} (32.48 g) was found from the E_2 (Three times earthing up) treatment, which was statistically similar with E_1 (Two times earthing up) treatment where the lowest fresh weight bulb^{-1} (28.47 g) was found from the E_0 (control) treatment which was statistically similar to E_1 (Two times earthing up) treatment. Similar result was also observed by Ali et al. [18] which supported the present study. The recorded data on neck diameter was significantly influenced by combined effect of vermicompost and earthing up of onion (Table 5). The highest fresh weight bulb^{-1} (42.73 g) was found from the V_3E_2 (treatment combination), which was statistically similar with V_3E_1 where the lowest fresh weight bulb^{-1} (19.07 g) was found from the treatment combination of V_0E_0 (control) which was statistically similar to V_0E_1 treatment combination.

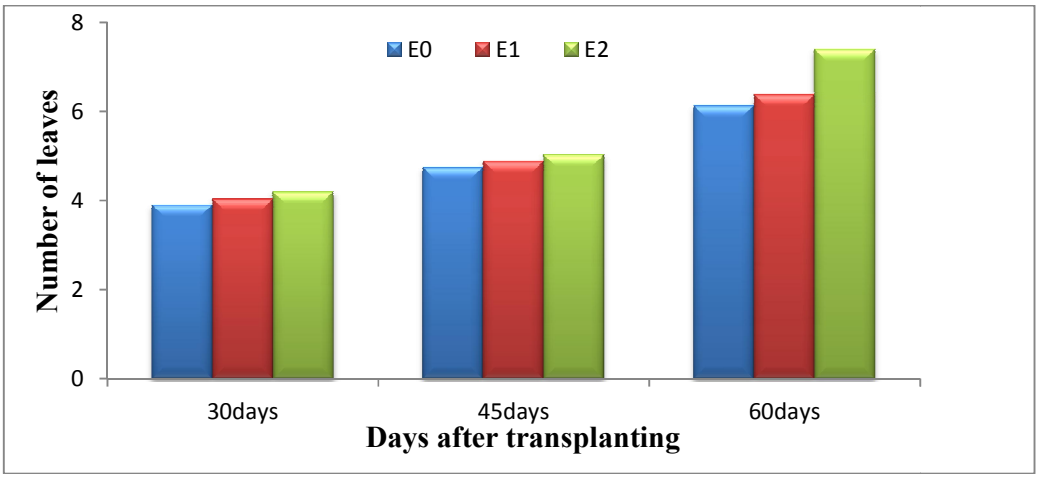

Fig. 4. Effect of earthing up on number of leaves plant^{-1} at different days after transplanting of onion

Here, E_0 = Control, E_1 = Two times earthing up, E_2 = Three times earthing up

Table 3. Combined effect of vermicompost and earthing up on number of leaves plant^{-1} at different days after transplanting of onion

Treatments	Number of leaves plant^{-1}		
	30 DAT	45 DAT	60 DAT
V_0E_0	3.33 e	4.13 h	5.27 f
V_0E_1	3.67 de	4.40 g	5.60 ef
V_0E_2	3.73 c-e	4.53 fg	5.80 d-f
V_1E_0	3.80 b-e	4.67 ef	5.93 de
V_1E_1	3.93 b-e	4.80 de	6.20 c-e
V_1E_2	4.07 b-d	4.87 de	6.27 cd
V_2E_0	4.13 b-d	4.93 d	6.40 b-d
V_2E_1	4.13 b-d	5.00 cd	6.67 a-c
V_2E_2	4.20 a-d	5.20 bc	6.27 cd
V_3E_0	4.33 a-c	5.27 b	6.93 ab
V_3E_1	4.40 ab	5.33 ab	7.07 a
V_3E_2	4.80 a	5.53 a	7.27 a
CV %	7.45	8.62	9.97
$LSD_{(0.05)}$	0.61	0.22	0.63

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

Table 4. Effect of vermicompost and earthing up on yield contributing parameters of onion

Treatments	Yield contributing parameters					
	Root length (cm)	Bulb length (cm)	Bulb diameter (cm)	Neck diameter (cm)	Fresh weight bulb^{-1} (g)	Dry matter of bulb (%)
Effect of vermicompost						
V_0	5.04 d	2.51 d	3.42 d	0.89 d	22.07 d	12.32 d
V_1	5.54 c	2.74 c	3.83 c	0.99 c	28.58 c	16.07 c
V_2	6.24 b	2.94 b	4.03 b	1.08 b	31.84 b	18.73 b
V_3	7.59 a	3.15 a	4.38 a	1.26 a	40.07 a	19.39 a
CV %	10.42	11.68	10.58	9.37	10.66	9.56
$LSD_{(0.05)}$	0.35	0.09	0.15	0.06	2.88	0.43
Effect of earthing up						
E_0	5.86 b	2.76 b	3.79 b	0.99 b	28.47 b	15.97 c
E_1	6.12 ab	2.81 b	3.91 ab	1.04 b	30.97 ab	16.59 b
E_2	6.32 a	2.95 a	4.04 a	1.13 a	32.48 a	17.32 a
CV %	10.42	11.68	10.58	9.37	10.66	9.56
$LSD_{(0.05)}$	0.30	0.08	0.13	0.05	2.50	0.37

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

3.8 Dry Matter of Bulb (%)

Considerable influenced was observed on dry matter (%) of bulb persuaded by different levels of vermicompost application (Table 4). The highest dry matter (%) of bulb (19.39%) was found from the V_3 (14 t ha^{-1} vermicompost) treatment, which was significantly different from all other treatments followed by V_2 (10 t ha^{-1} vermicompost). The lowest dry matter (%) of bulb (12.32%) was found from the V_0 (control) treatment. Similar result was also found by Degwale [24] which supported the present study.

Remarkable variation was identified on dry matter (%) of bulb due to the effect of earthing up of onion (Table 4). The highest dry matter (%) of bulb (17.32%) was found from the E_2 (Three times earthing up) treatment, which was significantly different from all other treatments where the lowest dry matter (%) of bulb (15.97 %) was found from the E_0 (control) treatment. Variation on dry matter (%) of bulb was significantly influenced by combined effect of vermicompost and earthing up (Table 5). The highest dry matter (%) of bulb (19.92%) was found from the V_3E_2 (treatment combination),

which was statistically similar to V_3E_1. The lowest dry matter (%) of bulb (11.50%) was found from the V_0E_0 (control) treatment combination, which was significantly different from all other treatment combinations followed by V_0E_1 by and V_0E_2.

3.9 Yield Plot^{-1} (g)

Yield plot^{-1} varied significantly due to different levels of vermicompost application. The highest yield plot^{-1} (527.89 g) was found from the V_3 (14 t ha^{-1} vermicompost) treatment, which was significantly different from all other treatments V_2 (10 t ha^{-1} vermicompost). The lowest yield plot^{-1} (324.11 g) was found from the V_0 (control) treatment which was also significantly different from all other treatments. Significant variation was remarked on yield plot^{-1} as influenced by earthing up of onion. The highest yield plot^{-1} (431.67 g) was found from the E_2 (Three times earthing up) treatment which was significantly different from all other treatments followed by E_1 (Two times earthing up) where the lowest yield plot^{-1} (388.00 g) was found from the E_0 (control) treatment. Combined effect of vermicompost and earthing up of onion was significantly influenced by yield plot^{-1} (Table 5).

Table 5. Combined effect of vermicompost and earthing up on yield contributing parameters of onion

Treatments	Yield contributing parameters					
	Root length (cm)	Bulb length (cm)	Bulb diameter (cm)	Neck diameter (cm)	Fresh weight bulb^{-1} (g)	Dry matter of bulb (%)
V_0E_0	4.89 g	2.46 i	3.22 g	0.83 h	19.07 h	11.50 g
V_0E_1	5.01 g	2.50 hi	3.35 g	0.91 gh	22.27 gh	12.37 f
V_0E_2	5.21 fg	2.57 ghi	3.69 f	0.95 fg	24.87 fg	13.08 f
V_1E_0	5.39 fg	2.67 fgh	3.77 ef	0.96 efg	27.53 ef	14.71 e
V_1E_1	5.50 efg	2.73 efg	3.86 def	0.99 defg	28.80 def	15.99 d
V_1E_2	5.73 def	2.83 def	3.87 def	1.03 cdef	29.40 def	17.50 c
V_2E_0	6.08 cde	2.88 cde	3.97 cde	1.07 cde	30.93 de	18.70 b
V_2E_1	6.26 cd	2.92 bcd	4.05 cd	1.08 bcd	31.67 cde	18.71 b
V_2E_2	6.39 c	3.02 bc	4.06 cd	1.10 bcd	32.93 cd	18.78 b
V_3E_0	7.09 b	3.03 bc	4.18 bc	1.13 bc	36.33 bc	18.97 b
V_3E_1	7.70 ab	3.07 b	4.40 ab	1.19 b	41.13 ab	19.28 ab
V_3E_2	7.97a	3.35 a	4.55 a	1.45 a	42.73 a	19.92 a
CV %	10.42	11.68	10.58	9.37	10.66	9.56
$LSD_{(0.05)}$	0.61	0.17	0.26	0.11	4.98	0.75

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

Table 6. Effect of vermicompost and earthing up on yield parameters of onion

Treatments	Yield parameters	
	Yield plot^{-1} (g)	Yield ha^{-1} (t)
Effect of vermicompost		
V_0	324.11 d	3.31 d
V_1	363.67 c	3.71 c
V_2	424.33 b	4.33 b
V_3	527.89 a	5.39 a
CV %	12.87	11.43
LSD (0.05)	21.92	0.22
Effect of earthing up		
E_0	388.00 c	3.96 c
E_1	410.33 b	4.19 b
E_2	431.67 a	4.41 a
CV %	12.87	11.43
LSD (0.05)	18.98	0.19

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

Table 7. Combined effect of vermicompost and earthing up on yield parameters of onion

Treatments	Yield parameters	
	Yield plot^{-1} (g)	Yield ha^{-1} (t)
V_0E_0	312.67 f	3.19 f
V_0E_1	324.33 f	3.31 f
V_0E_2	335.33 ef	3.42 ef
V_1E_0	338.67 ef	3.46 ef
V_1E_1	368.67 de	3.76 de
V_1E_2	383.67 d	3.91 d
V_2E_0	406.00 cd	4.14 cd
V_2E_1	426.67 c	4.35 c
V_2E_2	440.33 c	4.49 c
V_3E_0	494.67 b	5.05 b
V_3E_1	521.67 b	5.32 b
V_3E_2	567.33 a	5.79 a
CV %	12.87	11.43
$LSD_{(0.05)}$	37.97	0.38

The result obtained from the present study was similar with the findings of Dhaker et al. [23]. The highest yield plot^{-1} (567.33 g) was found from the V_3E_2 (treatment combination), which was significantly different from all other treatment combinations followed by V_3E_1 and V_3E_0. The lowest yield plot^{-1} (312.67 g) was found from the V_0E_0 (control) treatment combination which was statistically identical to V_0E_1 and statistically similar to V_0E_2 and V_1E_0 treatment combination.

3.10 Yield Ha^{-1} (t)

Variation on yield ha^{-1} was noted significant influenced by different levels of vermicompost application (Table 6). Results showed that the highest yield ha^{-1} (5.39 t) was found from the V_3 (14 t ha^{-1} vermicompost) treatment which was significantly different from all other treatments followed by V_2 (10 t ha^{-1} vermicompost). The lowest yield ha^{-1} (3.31 t) was found from the V_0 (control) treatment which was also significantly different from all other treatments followed by V_1 (6 t ha^{-1} vermicompost). The result obtained from the present study was similar with the findings of [14,25]. Yield ha^{-1} was affected significantly influenced by earthing up of onion (Table 6). The highest yield ha^{-1} (4.41 t) was found from the E_2 (Three times earthing up) treatment which was significantly different from all other treatments where the lowest yield ha^{-1} (3.96 t) was found from the E_0 (control) treatment. The result obtained from the present study was similar with the findings of Ali et al. (2007).

The recorded data on yield ha^{-1} was significantly affected by combined effect of vermicompost and earthing up (Table 7). The highest yield ha^{-1} (5.39 t) was found from the V_3E_2 (treatment combination), which was significantly different from all other treatment combinations followed by V_3E_0 and V_3E_1. The lowest yield ha^{-1} (3.31) was found from the V_0E_0 (control) treatment combination which was statistically identical to V_0E_1 and statistically similar to V_0E_2 and V_1E_0 treatment combination.

4. CONCLUSION

Considering the above result of this experiment it can be said that vermicompost (14t ha-1) was superior to the others. It may be concluded that the efficient production of onion is increased by the application of vermicompost and earthing up. Thus the combination effect of vermicompost & earthing up (V_3E_2) is more suitable for onion production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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