OPEN ACCESS
Global Journal of Research in Agriculture & Life Sciences
ISSN: 2583-4576 (Online)
Volume 05 | Issue 06 | Nov.-Dec. | 2025
Journal homepage: https://gjrpublication.com/gjrals/
Research Article

Effect of Vermi-compost and Nitrogen Fertilizer on Onion (*Allium cepa* L.) Yield and Soil Properties under Irrigation in Bena-Tsemay, Southern Ethiopia

*Genanaw Tesema [1], Shimlies Gizachew [2]

[1] South Ethiopia Agricultural Research Institute, Jinka Agricultural Research Center, departments of natural resource directorate P.O. Box 96, Jinka, Ethiopia.
[2] Hawassa University, College of Agriculture, School of Plant and Horticultural Sciences, Hawassa, Ethiopia.

DOI: 10.5281/zenodo.18042143 **Submission Date:** 15 Oct. 2025 | **Published Date:** 24 Dec. 2025

***Corresponding author:** Genanaw Tesema
South Ethiopia Agricultural Research Institute, Jinka Agricultural Research Center, departments of natural resource directorate P.O. Box 96, Jinka, Ethiopia.
ORCID ID: https://orcid.org/0009-0003-2994-2296

Abstract

Onion (Allium cepa L.) productivity in Ethiopia is limited by continuous cultivation and low soil fertility. Vermi-compost (VC) has been proposed to improve soil health, but optimal rates remain unclear. This study in Bena-Tsemay district, South Omo Zone (May–October 2021), evaluated the effects of VC (0, 2, 4, 6 t ha⁻¹) combined with nitrogen (N) fertilizer (0, 69, 138, 207 kg ha⁻¹) on onion yield and soil properties under irrigation. A randomized complete block design with three replications and sixteen treatments was used. Post-harvest soil analysis showed that VC, N, and their interaction significantly ($p<0.01$) influenced soil organic matter, N content, and cation exchange capacity, while VC alone improved bulk density and phosphorus availability. The highest bulb yield (24.833 t ha⁻¹) was achieved with 4 t ha⁻¹ VC + 138 kg N ha⁻¹, a 37.5% increase over the control. Economic analysis indicated this treatment provided the highest net benefit (338,684.9 ETB ha⁻¹) with an acceptable marginal rate of return (20,520). Integrating 4 t ha⁻¹ VC with 138 kg N ha⁻¹ is recommended for sustainable onion production in the study area and similar agro-ecologies.

Keywords: *Onion, Vermi-compost, Nitrogen fertilizer, Soil properties, Cost-benefit analysis.*

Introduction

Onion (*Allium cepa* L.) is among the most important vegetable crops in Ethiopia, valued for its wide consumption and economic contribution, particularly under irrigated production systems (Muluneh, 2016; Gebretsadik & Dechassa, 2016). Despite its significance, the national average yield of onion (9.14 t ha⁻¹) remains far below the global average range of 22–56.4 t ha⁻¹. This low productivity is largely attributed to soil fertility decline and the inappropriate use of fertilizers (CSA, 2017/2018; Fekadu & Dandena, 2006). Nitrogen is a critical nutrient for onion growth and bulb development; however, the blanket fertilizer recommendations currently applied across regions fail to account for site-specific soil fertility variations and crop nutrient demands (Aklilu, 1997; Singh et al., 2013).

Integrated Soil Fertility Management (ISFM), which emphasizes the combined use of organic and inorganic nutrient sources, has been recognized as a sustainable strategy to improve soil fertility and enhance crop productivity. Vermicompost, an organic fertilizer produced through the decomposition of organic matter by earthworms, is rich in essential nutrients and beneficial microorganisms that improve soil structure, nutrient availability, and microbial activity (Azarmi et al., 2008; Alemu, 2014). When integrated with mineral fertilizers, vermicompost can enhance nutrient use efficiency and promote sustainable crop production.

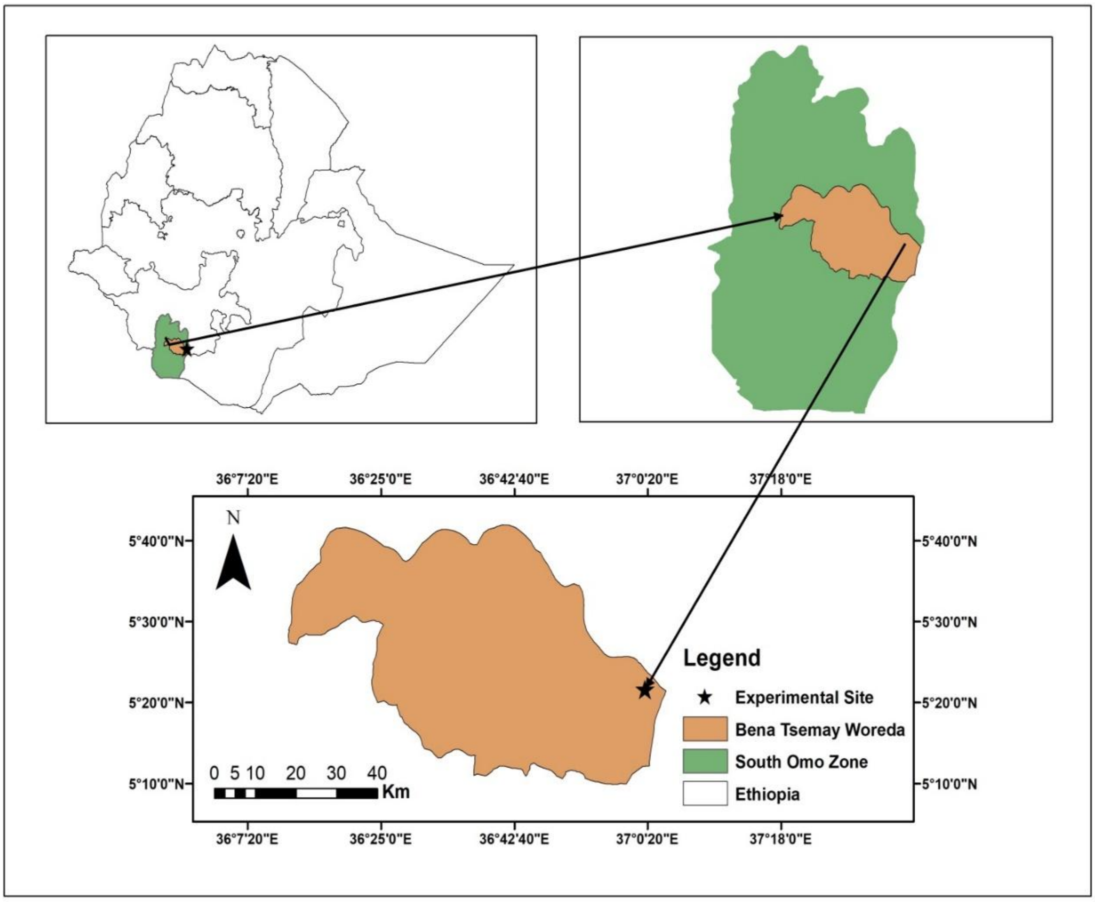
In Bena-Tsemay District, farmers commonly face challenges related to high fertilizer prices, limited availability, and declining soil fertility, which collectively constrain onion productivity. However, limited research has been conducted on the integrated application of vermicompost and nitrogen fertilizers for onion production under the district's irrigated farming conditions. Therefore, this study was undertaken to evaluate the effects of vermicompost and nitrogen fertilizer, applied alone and in combination, on onion (*Allium cepa* L.) yield, yield components, and selected soil physico-chemical properties under irrigation in Bena-Tsemay District. Additionally, the study assessed the economic feasibility of integrated nutrient management practices to identify sustainable fertilizer options for onion production in the area.

Materials and Methods

Description of the Study Area

The field experiment was conducted during the 2021/2022 cropping season at Woito experimental site of Jinka Agricultural Research Center, located in Bena-Tsemay Woreda, South Omo Zone, Southern Ethiopia. The site lies at 5°18′–5°31′ N and 36°52′–37°05′ E, with an altitude of 660 m a.s.l., about 82 km from Jinka. The area is characterized as hot arid to semi-arid, with erratic rainfall (200–578 mm annually), mean temperatures of 26–40°C, and an annual reference evapotranspiration of 2364 mm (BOFED, 2015). The farming system is predominantly mixed crop–livestock, with maize, sesame, cotton, banana, and vegetables as major crops.

Figure 1: Map of the Study Area



Experimental Design and Treatments

The experiment consisted of 16 treatment combinations arranged in a randomized complete block design (RCBD) with three replications. Treatments included four nitrogen (N) levels (0, 69, 138, and 207 kg N ha^{-1}, applied as urea) and four vermicompost (VC) levels (0, 2, 4, and 6 t ha^{-1}). The plot size was 2.4 × 3 m (7.2 m^2), with the central three rows (1.2 × 3 m) used for data collection. The recommended national rates (69 kg N ha^{-1} and 6 t VC ha^{-1}) were included (EIAR, 2012). Treatment combinations are presented in Table 1.

Table 1. Treatment combinations used in the experiment

Code	Treatment Description
T1	Control (no fertilizer)
T2	2 t VC ha^{-1}
T3	4 t VC ha^{-1}
T4	6 t VC ha^{-1}
T5	69 kg N ha^{-1}
T6	138 kg N ha^{-1}
T7	207 kg N ha^{-1}
T8	2 t VC + 69 kg N ha^{-1}
T9	2 t VC + 138 kg N ha^{-1}
T10	2 t VC + 207 kg N ha^{-1}
T11	4 t VC + 69 kg N ha^{-1}
T12	4 t VC + 138 kg N ha^{-1}
T13	4 t VC + 207 kg N ha^{-1}
T14	6 t VC + 69 kg N ha^{-1}
T15	6 t VC + 138 kg N ha^{-1}
T16	6 t VC + 207 kg N ha^{-1}

Soil Sampling and Analysis

Composite soil samples (0–20 cm depth) were collected before planting and post-harvest for selected physico-chemical properties. Analyses included pH (potentiometric method), organic carbon (Walkley & Black, 1934), total N (Kjeldahl method), available P (Olsen et al., 1954), exchangeable K (ammonium acetate method), cation exchange capacity (CEC), and particle size distribution (hydrometer method) following standard laboratory procedures (Jackson, 1973; Tekalign, 1991).

Data Collection

Growth and yield parameters were recorded from the net plot area. Agronomic traits included plant height and leaf number, while yield components included bulb diameter, bulb length, average bulb weight, and marketable/unmarketable yields. Total bulb yield (t ha^{-1}) was computed from harvested bulbs and expressed on a hectare basis.

Economic Analysis

Partial budget analysis was performed according to CIMMYT (1988). Adjusted yields (90% of mean yield) were used to calculate gross benefit (GB), total variable cost (TVC), net benefit (NB), and marginal rate of return (MRR).

Statistical Analysis

Data were subjected to analysis of variance (ANOVA) using SAS software, and treatment means were separated using the least significant difference (LSD) test at 5% probability level.

Results and Discussion

Baseline Soil Properties and Vermi-Compost Composition

Pre-planting soil analysis indicated that the experimental site contained 54% sand, 28% silt, and 18% clay, classifying the soil as sandy loam (Tekalign, 1991), which is suitable for onion production. The high sand content suggests good drainage, favorable for root development and crop growth (Szilas et al., 2002).

Table 2: Selected physicochemical properties of the experimental soil before planting

Soil Properties	Values	Rating
Sand (%)	54	
Silt (%)	28	
Clay (%)	18	
Textural Class		Sandy loam
Bulk Density (g/cm-3)	1.42	Moderately compacted
Soil reaction (pH (1:2.5 H2O))	7.46	Slightly alkaline
Organic Carbon (%)	2.43	Medium
CEC (cmol (+) kg soil–1))	24.3	Medium
Electrical Conductivity (ds cm−1)	0.34	Low
Total Nitrogen (%)	0.1	Low
Available Phosphorous (ppm)	16.08	Medium

The soil at the experimental site was slightly alkaline, with a pH value of 7.46, which falls within the suitable range for onion production (6.2–6.8) (Nikus and Mulugeta, 2010). The electrical conductivity (EC) of 0.34 dS m^{-1} indicated non-saline conditions (Hazelton and Murphy, 2007). The soil contained 2.43% organic carbon and 4.19% organic matter, suggesting moderate organic matter content (Walkley and Black, 1934; EthioSIS, 2017). Total nitrogen was low (0.10%), whereas available phosphorus was within the medium range (16.08 ppm) (Tekalign, 1991; Olsen et al., 1954). The cation exchange capacity (CEC) was 24.3 cmol(+) kg^{-1}, which is considered moderate and adequate for onion cultivation (EthioSIS, 2017). Overall, these results indicate that the soil, though generally suitable for onion production, requires supplementary organic and inorganic nutrient inputs to achieve optimal yield performance.

Table 3: Chemical Properties of vermi-compost

Chemical Properties	Values	Method used
Soil reaction (pH (1:2.5 H_2O))	7.08	Glass electrode pH meter (Jackson, 1973)
Organic Carbon (%)	10.76	Walkley and Black method (1934)
Total Nitrogen (%)	1.62	Kjeldahl method (Jackson, 1973)
Available Phosphorous (ppm)	46.08	Olsen method (Olsen et al. 1954)
C:N ratio	6.64	Organic carbon divided by TN

Where, N = nitrogen, P = phosphorus, C: N = carbon nitrogen, ppm = parts per million.

Effects of Different Rates of Vermi-Compost and Nitrogen Fertilizer on Onion Growth

The application of different rates of vermi-compost and nitrogen (N) fertilizer had a significant effect on the growth parameters of onion, including plant height, leaf number, and leaf length in the Bena-Tsemay district. The results, summarized in Table 6, show the main effects of these treatments on growth parameters.

Table 4: Main effects of different rates of vermi-compost and nitrogen fertilizer application on onion growth parameters

Treatment combinations	Plant height (cm)	Leaf number per plant	Leaf length (cm)
Vermi-compost (t ha-1)			
0	44.9c	14.3b	39c
2	47.1b	15.1ab	43.2b
4	49.3a	15.6a	46.5a
6	49.8a	16.0a	46.4a
LSD (0.05)	1.8640	0.9327	2.4379
CV (%)	4.75	7.44	6.78
Nitrogen rate (kg ha-1)			
0	44.1c	14.0c	41.9b

69	47.1b	15.1b	43.1ab
138	49.8a	15.5ab	44.8a
207	50.1a	16.3a	45.3a
LSD (0.05)	1.8640	0.9327	2.43
CV (%)	4.75	7.44	6.78

Means values with different letters in the column are significantly different ($p < 0.05$).

The combined application of vermi-compost and N fertilizer significantly influenced the plant height and leaf length of onions (Table 7). However, the leaf number per plant was not significantly affected by the interaction between these two factors.

Table 5: Plant height and leaf length as influenced by the interaction of vermi-compost and nitrogen fertilizer rates

Treatment combinations	**Plant height (cm)**	**Leaf length (cm)**
0 (no fertilizer)	38.38i	33.33f
2 VC	42.43h	41.67cde
4 VC	45.95fgh	45.48abc
6 VC	49.71abcdef	47.28ab
69 N	44.61gh	37.44ef
138 N	46.57efg	40.48de
207 N	50.19abcde	44.67abcd
2 VC + 69 N	46.72defg	42.62bcde
2 VC + 138 N	50.81abc	44.00bcd
2 VC + 207 N	48.66bcdefg	44.53bcd
4 VC + 69 N	47.14cdefg	46.66ab
4 VC + 138 N	53.48a	49.43a
4 VC + 207 N	50.47abcd	44.62abcd
6 VC + 69 N	49.81abcde	45.57abc
6 VC + 138 N	48.47bcdefg	45.47abc
6 VC + 207 N	51.05ab	47.28ab
LSD (0.05)	3.5493	4.6421
CV (%)	4.75	7.44

Means values with different letters in the column are significantly different ($p < 0.05$).

Table 6: Plant height and leaf length as influenced by the interaction of vermi-compost and nitrogen fertilizer rates

Treatment combinations	Plant height (cm)	Leaf length (cm)
0 (no fertilizer)	38.38i	33.33f
2 VC	42.43h	41.67cde
4 VC	45.95fgh	45.48abc
6 VC	49.71abcdef	47.28ab
69 N	44.61gh	37.44ef
138 N	46.57efg	40.48de
207 N	50.19abcde	44.67abcd
2 VC + 69 N	46.72defg	42.62bcde
2 VC + 138 N	50.81abc	44.00bcd
2 VC + 207 N	48.66bcdefg	44.53bcd
4 VC + 69 N	47.14cdefg	46.66ab
4 VC + 138 N	53.48a	49.43a
4 VC + 207 N	50.47abcd	44.62abcd
6 VC + 69 N	49.81abcde	45.57abc
6 VC + 138 N	48.47bcdefg	45.47abc
6 VC + 207 N	51.05ab	47.28ab
LSD (0.05)	3.5493	4.6421
CV (%)	4.75	7.44

Means values with different letters in the column are significantly different ($p < 0.05$).

Plant height was significantly influenced by the main effects of vermicompost (VC), nitrogen (N), and their interaction (Tables 5 and 6). The tallest plants (53.48 cm) were recorded from the combined application of 138 kg N ha^{-1} and 4 t VC ha^{-1}, whereas the shortest plants (38.38 cm) were observed in the control treatment. No significant differences were detected between 2 and 4 t VC ha^{-1} when combined with either 138 or 207 kg N ha^{-1}. The increase in plant height with higher fertilizer rates could be attributed to improved photosynthetic activity, enhanced cell division and elongation, and better nutrient availability resulting from the synergistic effects of organic and inorganic inputs (Surindra, 2009; Kokobe et al., 2013; Negasi et al., 2017; Yohannes et al., 2017).

Leaf number per plant was significantly affected by the main effects of nitrogen (N) and vermicompost (VC), but their interaction was not significant. Increasing N application rates enhanced leaf number by 86.6%, likely due to improved chlorophyll synthesis and photosynthetic efficiency. Similarly, VC application increased leaf number by 88.6%, which may be attributed to the supply of essential micronutrients and plant growth-promoting substances that stimulated greater vegetative growth and overall plant vigor (Gupta, 2005; Melaku, 2010; Abdisa, 2008).

These positive growth responses established a strong foundation for enhanced yield components such as bulb diameter, average bulb weight, and total yield of onion under the irrigated conditions of Bena-Tsemay District.

Table 7: Main effects of different rates of vermi-compost and Nitrogen fertilizer rates on yield parameters of onion.

Treatment combinations	Bulb diameter (cm)	Average bulb weight (g)	Marketable bulb yield (t ha^{-1})	Unmarketable bulb yield (t ha^{-1})	Total bulb yield (t ha^{-1})
Nitrogen rate (Kg ha^{-1})					
0	4.90c	397.92b	11.52c	2.84	14.27c
69	5.29b	415.14b	14.39b	2.83	17.32b
138	5.75a	477.67a	17.44a	2.47	19.92a
207	5.65a	454.16a	16.83a	3.17	19.74a
LSD	0.3	24.53	1.12	NS	1.05
CV (%)	6.91	6.85	9.09	31.9	7.17
Vermicompost rate (t ha^{-1})					
0	4.88b	370.06c	11.63c	2.57	13.89c
2	5.18b	409.82b	13.56b	2.94	16.49b
4	5.80a	473.00a	17.01a	3.17	20.17a
6	5.73a	492.00a	17.97a	2.64	20.70a
LSD (0.05)	0.3	24.535	1.12	NS	1.05
CV (%)	6.91	6.85	9.09	31.9	7.17

Means values with different letters in the column are significantly different ($p<0.05$). Whereas mm=millimeter, N=nitrogen, VC=vermin- compost, t ha^{-1}=ton per hectare, kg ha^{-1}= kilo gram per hector, LSD= least significant difference, CV (%) =coefficient of variance in percent

The combined applications of vermi-compost and Nitrogen fertilizer rates had significantly affected Bulb diameter, Average bulb weight, Marketable bulb yield and Total bulb yield of onion that was grown at Bena-Tsemay district except that of unmarketable yield. The overall results were depicted below in (Table 8).

Table 8: Interaction effects of different rates of vermi-compost and Nitrogen fertilizer rates on yield parameters of onion.

Treatment combinations	BD (cm)	ABW (g)	MBY (t ha-1)	UMBY(t ha-1)	TBY (t ha-1)
0 (no fertilizer)	3.91f	309h	6.93i	2.7	9.3j
2 VC	4.58e	359.67g	10.77h	2.7	13.47i
4 VC	5.49bc	430de	13.13fg	3.1	16.23efgh
6 VC	5.66bc	493b	15.23ef	2.87	18.10def
69 N	4.76de	344.91gh	12.69fgh	1.59	14.35hi
138 N	5.37bcd	370.33fg	12.67gh	2.37	15.03ghi
207 N	5.50bc	456bcde	14.23efg	3.63	16.87efg
2 VC + 69 N	5.29cd	424de	13.23fg	2.87	16.10fgh
2 VC + 138 N	5.51bc	442.33cde	14.43efg	3.03	17.47def
2 VC + 207 N	5.37cd	413ef	15.80de	3.15	18.93cd
4 VC + 69 N	5.59bc	453bcde	14.1fg	4.17	18.27de
4 VC + 138 N	6.37a	544a	22.67a	2.17	24.83a
4 VC + 207 N	5.78abc	465bcd	18.13bc	3.23	21.37b
6 VC + 69 N	5.55bc	438.67cde	17.53cd	2.7	20.57bc
6 VC + 138 N	5.76abc	554a	20b	2.33	22.33b
6 VC + 207 N	5.98ab	482.33bc	19.13bc	2.67	21.80b
LSD0.05	0.5836	46.718	2.1384	NS	1.9981
CV (%)	6.91	6.85	9.09	31.9	7.17

Means values with different letters in the column are significantly different ($p<0.05$). Whereas mm=mili meter, BD=bulb diameter, ABW=average bulb weight,MBY=marketable bulb yield,UMBY=unmarketable bulb yield, TBY=total bulb yield N=nitrogen, VC=vermi-compost, in t ha^{-1}=ton per hectare, N in kg ha^{-1}= kilo gram per hectare, LSD= least significant difference, CV (%) =coefficient of variance in percent.

The combined application of vermicompost (VC) and nitrogen (N) significantly improved onion yield and yield components. The highest bulb diameter (6.37 cm) was recorded under 138 kg N ha^{-1} + 4 t VC ha^{-1}, whereas the smallest (3.91 cm) was obtained from the control treatment. This increase in bulb size could be attributed to enhanced nutrient availability, improved photosynthetic efficiency, and auxin-mediated cell expansion and growth (Soni et al., 2016; Yohannes et al., 2017).

Similarly, the highest average bulb weight (554 g) was obtained from the 138 kg N ha^{-1} + 6 t VC ha^{-1} treatment, reflecting improved nutrient uptake and efficient assimilate translocation to the bulbs (Gebremicael et al., 2017; Kokobe et al., 2013). Marketable bulb yield was also maximized (22.67 t ha^{-1}) at 138 kg N ha^{-1} + 4 t VC ha^{-1}, while unmarketable yield was not significantly affected by the treatments, indicating that bulb quality losses may be influenced more by pests, diseases, or varietal characteristics than by fertilizer management.

Total bulb yield followed a similar trend, with the highest value (24.83 t ha^{-1}) obtained under 138 kg N ha^{-1} + 4 t VC ha^{-1}. This result demonstrates the synergistic effect of integrating organic and inorganic nutrient sources in enhancing onion productivity under irrigated conditions in Bena-Tsemay District (Abrha et al., 2015; Yadav et al., 2015).

Overall, integrating vermi-compost with nitrogen fertilizer effectively improves onion yield and quality by enhancing growth, nutrient uptake, and soil health, with 138 kg N ha^{-1} + 4 t VC ha^{-1} identified as the optimal combination for the Bena-Tsemay district.

Partial Budget Analysis

Partial budget analysis evaluated the economic feasibility of vermi-compost and nitrogen fertilizer treatments by comparing total variable costs and net benefits (CIMMYT, 1988). Variable costs included N fertilizer and labor for VC preparation, while fixed costs were excluded. Onion market price was 17 Birr kg^{-1}. Results showed that combined VC and N applications produced the highest net benefits, indicating that integrating organic and inorganic fertilizers is both agronomic ally and economically advantageous.

Table 9: Partial Budget Analysis for Treatments

Treatments	10%AMBY (kg ha-1)	Revenue (ETB)	TVC	TCP (ETB/ha)	GM(ETB/ha)	NB(ETB/ha)	BCR (%)
0	8370	192,510	0	0	142,290	142,290	0.0
2 VC	12,120.3	278,766.9	5,000	5,000	201,045.1	196,045.1	39.21
4 VC	14,609.7	336,023.1	10,000	10,000	238,364.9	228,364.9	22.84
6 VC	16,290	374,670	15,000	15,000	261,930	246,930	16.46
69 N	12,912.3	296,982.9	5,315	5,315	214,194.1	208,879.1	39.30
138 N	13,529.7	311,183.1	10,630	10,630	219,374.9	208,744.9	19.64
207 N	15,180.3	349,146.9	15,945	15,945	242,120.1	226,175.1	14.18
2 VC + 69 N	14,490	333,270	10,315	10,315	236,015	225,700	21.88
2 VC + 138 N	15,720.3	361,566.9	15,630	15,630	251,615.1	235,985.1	15.10
2 VC + 207 N	17,033.4	391,768.2	20,945	20,945	268,622.8	247,677.8	11.83
4 VC + 69 N	16,440.3	378,126.9	15,315	15,315	264,170.1	248,855.1	16.25
4 VC + 138 N	22,349.7	514,043.1	20,630	20,630	359,314.9	338,684.9	16.42
4 VC + 207 N	19,230.3	442,296.9	25,945	25,945	300,970.1	275,025.1	10.60
6 VC + 69 N	18,510.3	425,736.9	20,315	20,315	294,360.1	274,045.1	13.49
6 VC + 138 N	20,099.7	462,293.1	25,630	25,630	316,064.9	290,434.9	11.33
6 VC + 207 N	19,620	451,260	30,945	30,945	302,595	271,650	8.78

Where, ETB=Ethiopian Birr, TVC=Total variable cost and MRR=marginal rate of return, D=Dominant Treatment, ND= non-dominated Treatment AMBY=Adjusted marketable bulb yield, VC=vermi-compost in t ha^{-1}, N=nitrogen in kg ha^{-1}.

Partial budget analysis revealed that marketable bulb yield and profitability were significantly influenced by the combined application of vermicompost (VC) and nitrogen (N) fertilizer. The highest net return (338,685 ETB ha^{-1}) was achieved with 4 t VC ha^{-1} + 138 kg N ha^{-1}, followed by 6 t VC + 138 kg N ha^{-1} (290,435 ETB ha^{-1}), 4 t VC + 207 kg N ha^{-1} (275,025 ETB ha^{-1}), and 6 t VC + 207 kg N ha^{-1} (271,650 ETB ha^{-1}). The lowest net return (142,290 ETB ha^{-1}) was recorded in the unfertilized control.

Marginal rate of return (MRR) analysis indicated that the integration of organic and inorganic fertilizers maximizes profitability relative to cost, providing guidance for cost-effective input decisions (CIMMYT, 1988). Dominance analysis further confirmed that treatments combining high net benefits with reasonable costs are the most economically viable, whereas treatments with lower returns relative to costs were dominated. Overall, the results demonstrate that integrating vermicompost with nitrogen fertilizer is both profitable and economically effective for onion production under irrigated conditions.

Table 10: Net Benefits and Marginal Rate of Return for Onion Production Response to N and Vermi-Compost (2021/2022)

Treatments	10% AMBY (kg ha-1)	TVC (ETB ha-1)	Net Benefit (ETB ha-1)	Dominance Analysis	MRR (%)
0	8370	0	142,290	-	-
2 VC	12,120.3	5,000	196,045	ND	1075.1
69 N	12,912.3	5,315	208,879.1	ND	415.9
4 VC	14,609.7	10,000	228,364.9	ND	D
2 VC + 69 N	14,490	10,315	225,700	D	D
138 N	13,529.7	10,630	208,744.9	D	D
6 VC	16,290	15,000	246,930	ND	44
4 VC + 69 N	16,440.3	15,315	248,855.1	ND	611
2 VC + 138 N	15,720.3	15,630	235,985.1	D	D
207 N	15,180.3	15,945	226,175.1	D	D
6 VC + 69 N	18,510.3	20,315	274,045.1	ND	1095
4 VC + 138 N	22,349.7	20,630	338,684.9	ND	20520
2 VC + 207 N	17,033.4	20,945	247,677.8	D	D
6 VC + 138 N	20,099.7	25,630	290,434.9	D	D
4 VC + 207 N	19,230.3	25,945	275,025.1	D	D
6 VC + 207 N	19,620	30,945	271,650	D	D

Where, ETB=Ethiopian Birr, TVC=Total variable cost and MRR=marginal rate of return, D=Dominant Treatment, ND= non-dominated Treatment AMBY=Adjusted marketable bulb yield, VC=vermi-compost in t ha^{-1}, N=nitrogen in kg ha^{-1}.

Net benefit analysis showed that non-dominated treatments 2 t ha^{-1} VC, 69 kg ha^{-1} N, 4 t ha^{-1} VC, and combinations such as 4 t ha^{-1} VC + 69 kg ha^{-1} N, 6 t ha^{-1} VC + 69 kg ha^{-1} N, and 4 t ha^{-1} VC + 138 kg ha^{-1} N offered increasing net benefits and are recommended for onion production. Dominated treatments, including higher-input combinations, incurred greater costs without proportional returns. The highest marginal rate of return (MRR, 20520%) was achieved with 4 t ha^{-1} VC + 138 kg ha^{-1} N, while the lowest (44%) occurred with 6 t ha^{-1} VC. For non-dominated treatments, each 1 ETB invested returned 4.15–205.2 ETB. Overall, 4 t ha^{-1} VC + 138 kg ha^{-1} N provided the maximum net benefit (338,684.9 ETB ha^{-1}) and MRR, exceeding the minimum acceptable MRR of 100%, making it the most profitable option for farmers.

Summary and Conclusion

The combined application of vermi-compost and nitrogen fertilizer significantly improved onion growth, yield, and soil properties in Bena-Tsemay district. Among treatments, 4 t ha^{-1} vermi-compost with 138 kg ha^{-1} N produced the highest marketable yield (22.67 t ha^{-1}) and net benefit (338,684.9 ETB ha^{-1}) with the greatest marginal rate of return. Vermi-compost enhanced soil organic matter, total nitrogen, cation exchange capacity, and reduced bulk density, while N fertilizer boosted yield components. These results demonstrate that integrating organic and inorganic fertilizers is an effective strategy for sustainable onion production. Application of 4 t ha^{-1} vermi-compost combined with 138 kg ha^{-1} N is recommended for maximizing yield and profitability, though multi-season trials are advised to confirm consistency.

Authors Contribution

Genanaw Tesema; conceptualization, information search and writing the manuscript. The research proposal was prepared and the final manuscript was revised by Genanaw Tesema and *Shimlies Gizachew*.

Acknowledgements

The authors thank South Ethiopia Agricultural Research Institute (SEARI) for financially supporting the field experiment. And also, very grateful to Jinka Agricultural Research Center for the analysis of the soil parameters and for the facilitation of the vehicle and other accommodations to conduct the field experiment.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

1. Abdisa, T. (2008). Effect of nitrogen and organic amendments on growth and yield of vegetables. *Ethiopian Journal of Horticultural Science, 6*(2), 12–20.
2. Abrha, B., Negasi, A., & Melaku, K. (2015). Effect of integrated nutrient management on onion yield and quality. *Journal of Horticultural Research, 23*(1), 45–52.
3. Aklilu, H. (1997). *Fertilizer recommendations for major crops in Ethiopia.* Addis Ababa: Ethiopian Agricultural Research Organization.
4. Alemu, D. (2014). Effect of organic and inorganic fertilizers on soil fertility and crop productivity. *Journal of Agricultural Science, 6*(4), 22–31.
5. Azarmi, R., Rezaei, M., & Shabani, R. (2008). Effect of vermicompost and mineral fertilizers on soil properties and crop yield. *International Journal of Plant Production, 2*(4), 375–386.
6. Bagali, R., Kulkarni, R., & Patil, S. (2012). Influence of organic amendments on plant growth and nutrient uptake in onion. *International Journal of Agricultural Sciences, 8*(2), 98–104.
7. BOFED. (2015). *South Omo Zone socio-economic profile.* Jinka: Bureau of Finance and Economic Development.
8. CIMMYT. (1988). *From agronomic data to farmer recommendations: An economics training manual.* Mexico: CIMMYT.
9. CSA. (2018). *Agricultural sample survey report on area and production of crops (private peasant holdings, main season) 2017/2018.* Addis Ababa: Central Statistical Agency.
10. EIAR. (2012). *Fertilizer recommendations for major crops in Ethiopia.* Addis Ababa: Ethiopian Institute of Agricultural Research.
11. EthioSIS. (2017). *Soil fertility status in Ethiopia.* Addis Ababa: Ministry of Agriculture.
12. Fekadu, G., & Dandena, G. (2006). Onion production constraints and research experiences in Ethiopia. *Ethiopian Journal of Agricultural Sciences, 18*(2), 45–58.
13. Gebremicael, T., Yohannes, M., & Gebre, H. (2017). Influence of organic and inorganic fertilizers on onion growth and yield. *Ethiopian Journal of Agricultural Sciences, 29*(1), 33–44.
14. Gebretsadik, K., & Dechassa, N. (2016). Productivity and marketing of onion in Ethiopia. *Journal of Horticultural Science, 8*(2), 12–20.
15. Hazelton, P., & Murphy, B. (2007). *Interpreting soil test results: What do all the numbers mean?* CSIRO Publishing.

16. Jackson, M. L. (1973). *Soil chemical analysis.* New Delhi: Prentice Hall of India.
17. Kokobe, T., Melaku, K., & Alemayehu, B. (2013). Effects of organic and inorganic nutrient sources on onion growth and yield. *African Journal of Agricultural Research, 8*(6), 456–462.
18. Landon, J. R. (1991). *Booker tropical soil manual: A handbook for soil survey and agricultural land evaluation in the tropics and subtropics.* Longman.
19. Melaku, K. (2010). Organic amendments for sustainable vegetable production in Ethiopia. *Ethiopian Journal of Horticulture, 7*(1), 23–30.
20. Muluneh, D. (2016). *Horticultural crop production and challenges in Ethiopia.* Addis Ababa: Ethiopian Horticulture Research Institute.
21. Nikus, D., & Mulugeta, L. (2010). Soil fertility requirements for onion production. *Ethiopian Journal of Soil Science, 3*(1), 15–22.
22. Olsen, S. R., Cole, C. V., Watanabe, F. S., & Dean, L. A. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *USDA Circular, 939,* 1–19.
23. Soni, P., Sharma, A., & Singh, R. (2016). Influence of integrated nutrient management on bulb yield of onion. *International Journal of Plant Production, 10*(3), 233–242.
24. Surindra, S. (2009). Effect of nitrogen on growth and yield of onion. *Journal of Horticultural Science, 4*(2), 112–118.
25. Szilas, C., Kacaniova, M., & Pizurova, N. (2002). Soil texture and plant growth: Implications for agriculture. *Journal of Agricultural Science, 14*(2), 77–84.
26. Walkley, A., & Black, I. A. (1934). An examination of the Degtjareff method for determining soil organic matter. *Soil Science, 37*(1), 29–38.
27. Yohannes, M., Gebremicael, T., & Negasi, A. (2017). Effect of integrated nutrient management on onion yield in Ethiopia. *Journal of Horticultural Science, 9*(3), 55–63.

CITATION

Tesema, G., & Gizachew, S. (2025). Effect of Vermi-compost and Nitrogen Fertilizer on Onion (Allium cepa L.) Yield and Soil Properties under Irrigation in Bena-Tsemay, Southern Ethiopia. In Global Journal of Research in Agriculture & Life Sciences (Vol. 5, Number 6, pp. 29–38).
https://doi.org/10.5281/zenodo.18042143