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Effect of Different Rate of Vermi-compost and Inorganic Fertilizer (NPSB) on Agronomic Performance, Yield and Yield related Component of Cowpea (*Vignaunguculata L.*) In Mattu District, Mattu Zone, South Western Ethiopia

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Animal Production

M.Sc. Thesis

By:

Asfaw Olana Keno

Advisor: Zena Kidane (PhD)

June, 2025

Addis Ababa, Ethiopia

Effect of Different Rate of Vermi-compost and Inorganic Fertilizer (NPSB) on Agronomic Performance, Yield and Yield related Component of Cowpea (*Vignaunguculata L.*) In Mettu District, Ilu Aba Bor Zone, South Western Ethiopia

A Thesis Submitted to Federal Technical and Vocational Training Institute, Faculty of Agro-Processing Technology

Department of Dairy Processing Technology

In Partial Fulfillment of the Requirements for the Degree of Master of Science in Animal Production Technology

Asfaw Olana Keno

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ADVISORS' APPROVAL SHEET

This is to certify that the MSc thesis prepared by Mr. Asfaw Olana Keno entitled as **"**Effect of Different Rate of Vermicompost and Inorganic Fertilizer (NPSB) On Agronomic Performance, Yield and Yield component of Cowpea (Vignaunguculata L.) In Mettu District, Ilu Aba Bor Zone, South Western Ethiopia'' in partial fulfillment of the requirement for the degree of Master of Technology in Dairy Processing Technology with the field of specialization in Animal Production Technology. As thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared under my guidance and Supervision. Therefore, I recommend that this student has fulfilled the requirements and hence hereby can submit the thesis research for defense.

_____	_____	_____
Name of Advisor	Signature	Date

THESIS APPROVAL SHEET

As Thesis Research advisors, I here certify that I have read and evaluated this Thesis prepared under my guidance, by Asfaw Olana Keno entitled: Effect of Different Rate of Vermi-compost and Inorganic Fertilizer (NPSB) on Agronomic Performance, Yield and Yield related Component of Cowpea (*Vignaunguculata* L.) In Mettu District, Ilu Aba Bor Zone, South Western Ethiopia. I recommend that it be submitted as fulfilling the MSC Thesis requirement.

As member of the Board of Examiners of the MSc Thesis Open Defense Examination, we certify that we have read and evaluated the Thesis prepared by Asfaw Olana Keno, and examined the candidate. We recommend that the Thesis be accepted as fulfilling the Thesis requirement for the Degree of Master of Science in Animal Production Technology.

_____	_____	_____
Name of advisor	Signature	date
_____	_____	_____
Chairperson	Signature	Date
_____	_____	_____
Internal Examiner	Signature	Date
_____	_____	_____
External Examiner	Signature	Date

DEDICATION

I dedicate this thesis to my beloved brother, mother, and wife, as well as to my dear friends, whose unwavering support and encouragement have been instrumental in my academic journey.

DECLARATION

I hereby certify and declare that this thesis entitled "Effect of Different Rate of Vermicompost and Inorganic Fertilizer (NPSB) On Agronomic Performance, Yield and Yield component of Cowpea (*Vigna unguculata* L.) In Mettu District, Ilu Aba Bor Zone, South Western Ethiopia'' was prepared by me under the supervision of Zena Kidane (PhD) The work contained here is genuinely my own and results embodied in this thesis have not been submitted in whole or part to any other Institution/University for the award of any degree/diploma or any other professional qualification.

Name of student	Signature	Date
Name of advisor	Signature	Date

BIOGRAPHICAL SKETCH

The author, Asfaw Olana Keno, was born in April 1988 in Ulmaya Kebele, In B/Nopa District, Ilu Aba Bor Zone, South Western Ethiopia. He completed his elementary, secondary, and preparatory education at Hurumu School from 1999 to 2008 G.C. In 2018 G.C, he earned his BSc degree in Animal Sciences from Haramaya University.

Following his graduation, he worked at the Bilo Nopha District Office of Agriculture before joining Dabena Polytechnic College as an instructor. In October 2015 G.C, he enrolled at Federal Technical and Vocational Training Institute to pursue his MSc degree in Animal Production Technology

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ABBREVIATIONS AND ACRONYMS

ADMY	Average Dry Matter Yield
AGDP	Agricultural Gross Domestic Product
AADMY	Average Adjusted Dry Matter Yield
ANOVA	Analysis of Variance
CSA	Central Statistical Agency
DF	Date of Flowering
DG	Date of Germination
DMY	Dry Matter Yield
ETB	Ethiopian Birr
FAO	Food and Agriculture Organization of the United Nations
FBY	Fresh Biomass Yield
GB	Gross Benefit
GDP	Gross Domestic Product
LL	Leaf Length
MRR	Marginal Rate of Return
NI	Net Income
NLPP	NLPP Number of Leaf per Plant
NPSB	Nitrogen, Phosphorus, Sulfur and Boron
OC	Organic Carbon
OM	Organic Matter
PBA	Partial Budget Analysis
PH	Plant height
TFC	Total fixed cost
TR	Total revenue
TVC	Total variable cost
VC	Vermicompost
BARC	Bako Agricultural Research Center

ABSTRACT

Cowpea (Vigna unguiculata L.) is a staple crop in Ethiopia, yet its productivity is limited by inappropriate agronomic practices, particularly the misapplication of organic and inorganic fertilizers. This study was conducted at Mettu District, Bishari site, to evaluate the effects of different rates of vermicompost and NPSB fertilizer on cowpea's agronomic performance, yield, and yield-related components. The experiment followed a randomized complete block design (RCBD) with three replications. The treatments consisted of three vermicompost levels (0 kg/ha, 2500 kg/ha, 5000 kg/ha) and four NPSB fertilizer rates (control, 50 kg/ha, 100 kg/ha). Data collection focused on phenology, growth parameters, yield, and yield-related traits. The results showed that both NPSB fertilizer and vermicompost significantly affected various growth indicators, while some traits were influenced by their interaction effects. Among the treatments, 100 kg/ha NPSB fertilizer and 5000 kg/ha vermicompost yielded the best results in terms of biomass production and economic feasibility. Therefore, for optimal cowpea production in Mettu District, integrating 100 kg/ha NPSB fertilizer with 5000 kg/ha vermicompost is recommended. However, further studies across different seasons and locations are necessary to validate these findings

Keywords: Cowpea, NPSB, Grain Yield, Vermicompost.

1. INTRODUCTION

Cowpea (*Vigna unguiculata* L.), a vital ancient crop, has been cultivated for millennia as a multi-purpose, warm-season legume (Kalloo *et,.al* 2012). It belongs to the Fabaceae family and originates from West and Central Africa, later expanding to Southeast Asia and Latin America (Ibrahim *et. al* 2017). In Ethiopia, cowpea serves as a staple food, consumed in grains, fresh pods, and tender leaves. Additionally, it plays a crucial role in livestock feed and soil fertility enhancement (Alemu et al., 2016).

Cowpea is rich in essential amino acids such as valine, leucine, phenylalanine, and lysine, making it a vital component in livestock feed and meat production. Its leaves contain proteins, vitamins (A, C, B1, B2, B5, B9), and essential minerals, contributing to food security and nutrition (Gerrano *et.,al* 2019). Additionally, cowpea serves as animal fodder, hay, silage, and green manure, supporting soil fertility through nitrogen fixation (Alemu et al., 2016). Due to its drought tolerance and ability to suppress weeds, cowpea thrives in Ethiopia's semi-arid regions where other legumes struggle (Belay et al., 2017).

Despite its significant agronomic and economic value, cowpea production in Ethiopia remains below potential due to poor soil fertility, lack of improved crop management, and limited access to modern agricultural technologies. In response to these challenges, sustainable soil fertility practices such as vermicomposting and inorganic fertilizers (NPSB) have gained attention.

Vermicomposting enhances soil aggregation, structure, fertility, and moisture retention, while supporting microbial diversity and increasing crop yields. It serves as an eco-friendly alternative to chemical fertilizers, improving sustainability. However, due to its low nutrient concentration, vermicompost alone cannot fully satisfy cowpea's nutrient demands in large-scale production (Singh et al., 2008) .

To bridge this gap, integrated nutrient management combining vermicompost and inorganic fertilizers has proven effective in enhancing crop productivity while maintaining soil health. Farmers often use nitrogen (N), phosphorus (P), sulfur (S), and boron (B) fertilizers due to their high nutrient concentration and rapid availability. Nitrogen, in particular, plays a crucial

role in photosynthesis and chlorophyll production, improving cowpea's agronomic performance. However, rising mineral fertilizer costs pose challenges for smallholder farmers (Oliveira et al., 2016).

1.1. Statement of Problem

Although 66.5% of Ethiopia's arable land is suitable for cowpea production, yields remain below the global average due to soil nutrient deficiencies, feed shortages, and limited access to modern agricultural inputs. The high cost of fertilizers and the lack of research on integrated nutrient management further constrain cowpea productivity (Simion, 2018).

In Mattu District, Mattu Zone, limited information on cowpea's role in livestock feed improvement exacerbates these challenges. Despite the region's high livestock production potential, feed shortages persist, affecting milk and meat yields, livestock health, and overall productivity. Additionally, no research has yet examined the effects of vermin compost and inorganic fertilizers on cowpea agronomic and biomass yield in this area

1.2. Objectives

1.2.1. General Objective:.

- To evaluate the effect of different rates of vermin compost and inorganic fertilizer (NPSB) on agronomic performance, dry biomass yield, and yield-related parameters of cowpea in Mettu District, Ilu Aba Bor Zone, and Southwestern Ethiopia.

1.2.2.Specific Objectives:

- To assess the combined application of vermin compost and inorganic fertilizer on cowpea agronomic performance and biomass yield in the Mettu area.
- To investigate the effects of different ratios of vermin compost and inorganic fertilizers on cowpea productivity.
- To analyze the economic feasibility of integrated nutrient management practices for cowpea production.

2. LITERATURE REVIEW

2.1. Origin and History of Cowpea

Cowpea (*Vigna unguiculata*) (diploid, 2n=22) is an annual herbaceous legume cultivated for its edible seeds and for fodder. Cultivated cowpeas are either erect, prostrate or climbing annuals with a tap root and virtually all are glabrous. It is a self-pollinated crop, with natural cross-pollination of up to 1% and can grow up to 80 cm and up to 2 m for climbing cultivars.
Several authors have reported different probably centers of origin and domestication of cowpea is in Africa. Reports by OECD (Organization for Economic Co-operation and Development) (2016) indicated that cowpea was domesticated probably in West Africa about 2000 B.C. according to (Agbogidi, 2010) cowpea has originated and domesticated in Southern Africa; late, it was spread to East and West Africa and Asia.

The crop belongs to the family Fabaceae and also known as southern pea and black eye pea. The southern African region (Namibia, Botswana, Zambia, Zimbabwe, Mozambique and South Africa) and the semi-arid West and Central Africa are reportedly considered the center of diversity of cowpea (Rivas et al., 2016). People in these areas (Centre of diversity) consume cowpea and other pulses as supplements to their daily diet.

2.2. Importance, Production System and Distribution Of Cowpea.

Cowpea is one of the most important food and a multipurpose grain and forage legumes in the semi-arid tropics including parts of Asia, Africa, Southern Europe, Southern United States, and Central and South America (Alemu et al., 2016). Among the legume crops, cowpea is grown in 45 countries across the world (Abate et al., 2011). According to the report of FAOSTAT (2016), the global area under cultivation of some of the major legumes (groundnuts, chickpea, pigeon pea, common bean, cowpea, and soybean) in 2014 was about 220 million hectares (ha), with the production of about 430 million metric tons (MT) at average productivity of 1.7 MT per ha (beans = 1.6, chickpea = 1.4, cowpea = 0.44, groundnut = 2, pigeon pea = 1.4, soybean = 1.8). An estimated 14.5 million ha of land is planted to cowpea each year worldwide, with over 6.5 million metric tons produced annually. The world average yield is estimated at 450 kg per ha with most of the world cowpea production coming from Africa where countries such as

Nigeria, Niger, Burkina Faso, Tanzania, Cameroon, Mali, and Kenya are the most important producers.

Cowpea is referred to as the "hungry- season crop" given that it is the first crop to be harvested before the cereal crops are ready. Its entire plant part can be used for either human or livestock consumption (Pottorff et al., 2012).hence it is most important native food and forage legumes grown in Sub- Saharan Africa and some temperate regions of the world (Srivastava et al., 2016). The young leaves, green pods and green grains are used as vegetables, and the dry grains are used in various preparations for both human food and livestock feed (Owade et al., 2020).

In Ethiopia, farmers feed cowpea fodder to livestock to increase income and collect the manure produced for use in their fields thereby reduces farmers' reliance on commercial fertilizers and sustain soil fertility, Gebreyowhans and Gebremeskel (2014). In Ethiopia, cowpea seed is mostly used in the form of food dishes '*nifro*', '*shiro*' and its grain is highly nutritious and contains about 22.8 - 28.9% protein with an average of 25.6% (Weng et al. 2019).

In addition to its importance in human food and animal feed, cowpea is also useful for soil fertilization through symbiotic nitrogen fixation. Over the last three decades, global cowpea production grew at an average rate of 5%, with 3.5% annual growth in area and 1.5% growth in yield, and the area expansion accounting for 70% of the total growth during this period (Boukar et al., 2016). Concerning its consumption, 52% for food, and 13% as animal feed, 10% for seeds, 9% for other uses, and 16% are wasted. Being a drought tolerant and warm weather crop, it is a promising food and forage species in a typical tropical lowland climate (Alemu et al., 2016; Belay et al., 2017).

Cowpea production system has significant differences across the major producing areas of Ethiopia, and its production is practiced under varying cropping systems including sole cropping, intercropping, mixed and relay cropping. In Ethiopia, cowpea is grown in drier pockets of the Rift Valley, and in the eastern and northeastern part of the country. Cowpeas are grown as warm-season-adapted annuals in Ethiopia, like Oromia, Amhara, Tigray, Gambella and SNNP region

The production of cowpea in the country are hindered by the lack of access to modern technologies such as seed of improved varieties, disease and the accompanying crop and pest management practices, inputs such as fertilizers Erana and Zelalem (2020), However, Ethiopia has a high potential for the production of various crops as more than 66.5% of the arable land is very suitable for cowpea production (Simion, 2018).

Average national yield of cowpea is estimated to be 400 kg ha−1, whereas yields of 2200 to 3200 kg ha^{-1} have been commonly recorded from improved varieties with proper crop management and protection practices (Ashinie et al., 2020). According to Zewdu et al. (2021) the higher average grain yield means of 15.2466 Quintal/ha (1524.66 kg/ha) was obtained from white wonder and the lowest grain yield of 6.319 Quintal/ha (631.9kg/ha) obtained from Bole varieties. Bilatu et al. (2012) reported the highest grain yield of 28.9 Quintal/ha which was recorded from Black-eyed bean. Belay (2017) reported the early maturing varieties have been shown to yield better than the late maturing varieties.

2.3. Effect of Vermicomposts on Dry Biomass Yield and Agronomic Performance of Cowpea and its Preparation Methods

Vermicomposting is a method of making compost, with the use of earthworms, which eat biomass and excrete it in a digested form. This compost is generally called vermicompost or worm compost Vermi compost is living organic material produced through the mutual association of microorganisms and worms. Vermi compost produces readily available nutrients for plants due to microbial activity within the compost.

Through the process of mineralization, microorganisms in vermin compost release nutrients into plants available form which are essential for the growth of plants. Bacteria and fungi initiate this process, mineralizing large amounts of organic material (Condron, 2017).Red worms (Eiseniafoetida) graze on these microorganisms and turn over large areas of vermin compost through bioturbation. Nematodes contained in the vermin compost also influence mineralization and immobilization. The red worms (Eiseniafoetida) process the vermin compost by shedding the organic material into finer fragments which increases the surface area exposed to microorganisms (Orgiazzi et al., 2016).

This accelerates mineralization by the microbes, converting a great quantity of the nutrients held in the vermicompost into a plant-available form. Red worms (Eiseniafoetida) consume each layer of vermicompost and excrete vermicast which is rich in bioavailable nutrients. Once the material is broken down, it's spread across fields to amend crop and soil health as an organic fertilizer or as an alternative source of energy (Singh et al., 2016).

Vermicompost can influence the growth and productivity of plants due to their micro and macro elements, vitamins, enzymes and hormones (Singh et al., 2016). Vermicompost contain nutrients such as nitrates, exchangeable phosphorus, soluble potassium, calcium, and magnesium in plant-available forms (Ibrahim et al., 2016) and have a large particular surface area that provides many microsites for microbial activity and the strong retention of nutrients (Singh et al., 2016).

Singh et al. (2008) reported that adding vermicompost to soil improves soil structure, fertility, plant growth and suppresses diseases caused by soil-borne plant pathogens, increasing biological yield. On the other hand, Adhikary (2012) reported the nutrient status of vermicompost with organic carbon 284.83–288.17g/kg, total nitrogen 22.1—24.1g/kg, available phosphorus 9.75–9.95g/kg, available potassium 15.01—15.39g/kg, calcium 20.9—26.7g/kg, and magnesium 6.64–6.84g/kg, copper 0.93—1.01g/kg, zinc 16.73—17.07g/kg, organic mater 492.8—498.2g/kg and exchangeable C/N ratio 12.17—12.43g/kg that nutrient status of vermicomposting.

Vermicomposting may increase the leaf area and canopy size of leaves which consequently increases photosynthetic potential and yield. Vermicompost contains a high amount of nitrate which may move to the growth areas of the plant and increase the leaf area index (Abernethy, 2017). This in turn can increase the absorption of light, enabling the plant to undergo photosynthesis. This leads to a dry matter yield increase in plants. Papathanasiou et al. (2012) compared applications of fertilizers and compost on the yield of lettuce. It was found; the highest leaf number (23.67) was recorded in the 10% vermicompost treatment and highest leaf dry weight (7.8 g) in the 20% vermicompost treatment. Shoot and root elongation: Crops supplied with vermicompost may have strong early development due to an increased supply of nutrients. Vermicompost contains high availability of nitrate and potassium, allowing ready

absorption of nutrients and shoot elongation. Vermicompost may encourage strong initial growth of seedlings by enhanced root formation, elongation of stem and production of biomass (Chavda&Rajawat, 2015).

The application of vermicompost can accelerate pasture production due to the increased supply of nutrients. This may encourage the early establishment and greater root growth to increase the plants access to nutrients (Abernethy, 2017). Sabrina et al. (2013) assessed the effectiveness of phosphorus enriched vermicompost on the DM production of Setaria grass and after assessment the treatment which has vermicompost increases DM production of the grass. Vermicompost can improve crop yield due to the reduction of plant toxicity and the deterrence of insects. Phytotoxicity is a plant injury inflicted by compounds added to the soil, such as phenolic acid. This often occurs when chemicals are applied to regulate growth or fertilize plants (Ievinsh, 2011). Vermicompost however, produces a stable product and reduces phenol acids in the waste material. In the study of Masciandaro et al. (2010) assessed the ability of worms to reduce phenolic compounds, and found they decreased the phytotoxicity by 50%. This increased germination by 70% under vermicompost addition compared to 43% germination in the conventional compost. Besides, other literature suggests the presence of phenolic compounds provides a benefit to plant growth, as it acts as a deterrent to pests.

2.4. Effect of Inorganic Fertilizer (NPSB) on Dry Biomass Yield And Agronomic Performance of Cowpea.

Inorganic fertilizers are good for the rapid growth of plants because the nutrients are already water-soluble. Therefore, the effect is usually immediately and fast, contains all necessary nutrients that are ready to use. Inorganic fertilizers are quite high in nutrient content and only relatively small amounts are required for productivity. The correct number of applications of inorganic fertilizer can increase soil organic matter through higher levels of root mass and crop residues. Chemical fertilizers are rich in three essential nutrients nitrogen, phosphorous, and potassium and/or sulfur. Without these nutrients, plants cannot grow to their full potential, will provide lower yields, and be more susceptible to disease (Grant et al., 2001). The cost of inorganic fertilizers is increasing enormously, to the extent that they are out of reach for small and marginal farmers. The benefit of inorganic fertilizer plays a significant role in increasing agricultural production and productivity over the last half-century. However, the productivity

boost provided by fertilizer technology may be reaching a point of diminishing return (Gruhn et al., 2000), with industrial fertilizer use becoming increasingly unsustainable and environmentally damaging. Nitrogen is an integral component of many compounds such as chlorophyll, nucleotides, alkaloids, enzymes, hormones, and vitamins and these are essential for plant growth processes (Brady and Weil, 2008). However, the application of fertilizer alone is not sustainable solution to improve soil fertility and maintain yield increases (Gruhn, 2000), rather, it has been widely realized that application of excessive inorganic fertilizer, especially N, may Couse soil deterioration and other environmental problems due to more rapid organic matter mineralization.

2.5. Effect of Integrated Use of Inorganic Fertilizer (NPSB) and Vermi-Composting on Dry-Biomass Yield aand Agronomic Performance of Cowpea.

The role of nutrients is one of paramount importance in boosting productivity and quality of plant which is a heavy feeder of mineral elements and continuous use of inorganic fertilizers resulted in deficiency of micronutrients, imbalance in soil physicochemical properties and unsustainable crop production (Jeyathilake et al., 2006).Nutrients contained in the vermicompost, may not match the requirements of the plant. Aisha et al. (2007) declared that, chemical fertilizers alone generate several deleterious effects to the environment and human health and they should be replenished in every cultivation season because, the synthetic N, P and K fertilizer is rapidly lost by either evaporation or by leaching in drainage water and it causes dangerous environmental pollution. Generally N, P and K uptakes were significantly higher in both organically and inorganically fertilized plants than their unfertilized counterparts (Babajide et al., 2008).

Application of vermicompost in combination with mineral fertilizers can also be of economic benefit. Supplementing vermicompost with mineral fertilizer may lift nutrient levels which are lacking in the organic material (Abernethy, 2017). Bajracharya et al. (2007) study on the effect of vermicompost in combination with bacteria and mineral fertilizers on soybean found applying amendments together showed an increase in shoot and root dry weight. Despite vermicompost treatment applied alone reaching the highest yield for the soybean crop; the total root dry weight peaked when vermicompost was applied in combination with fertilizer. Thus, the research suggests vermicompost alone may give the highest overall yield, however, to

achieve higher root and shoot dry weight, vermicompost should be applied in combination with fertilizer for best results.

3. MATERIALS AND METHODS

3.1 Description of the Experimental Location

The field experiment was conducted In Mettu District, South Western Ethiopia, during the 2024 cropping season under rain-fed conditions. Mettu Ale buya Kebele Bishari site is situated along the road to Gambela, approximately 605 km from Addis Ababa.

Geographically, the experimental area (Mettu Ale buya Kebele Bishari site) is located at 8°31'12" N latitude and 30°09'54" E longitude, with an elevation ranging between 1,500 m and 1,700 m above sea level (m a.s.l.). The region experiences mean annual temperatures of 11.8°C (minimum) and 24.3°C (maximum), averaging 18.05°C (Mettu District Agriculture Office, 2023). Additionally, Mattu receives an average annual rainfall of 1,823.5 mm, contributing to its agricultural potential.

3.1.1. Agro-Ecological Characteristics

Mettu's agro-ecology is classified as 90% Weyna Dega (1,500–2,027 m a.s.l.) and 10% Kola (900–1,500 m a.s.l.), making it highly suitable for both agriculture and human settlement. Despite its favorable climate, the undulating terrain coupled with heavy rainfall leads to serious soil erosion.

3.1.2. Soil Composition and Agricultural Practices

Soil is composed of minerals, organic matter, water, and air. The typical breakdown is about 45% minerals, 5% organic matter, 20-30% water, and 20-30% air. Soil texture, which refers to the size of mineral particles (sand, silt, and clay), also influences soil composition.

The dominant soil types in Mettu Sandy loam and Nito soiland black soils, which support a diverse range of crops. The district is known for cultivating coffee, along with staple cereal crops such as maize, sorghum, and teff, regardless of land classifications. (Mettu District Agriculture Office, 2023)

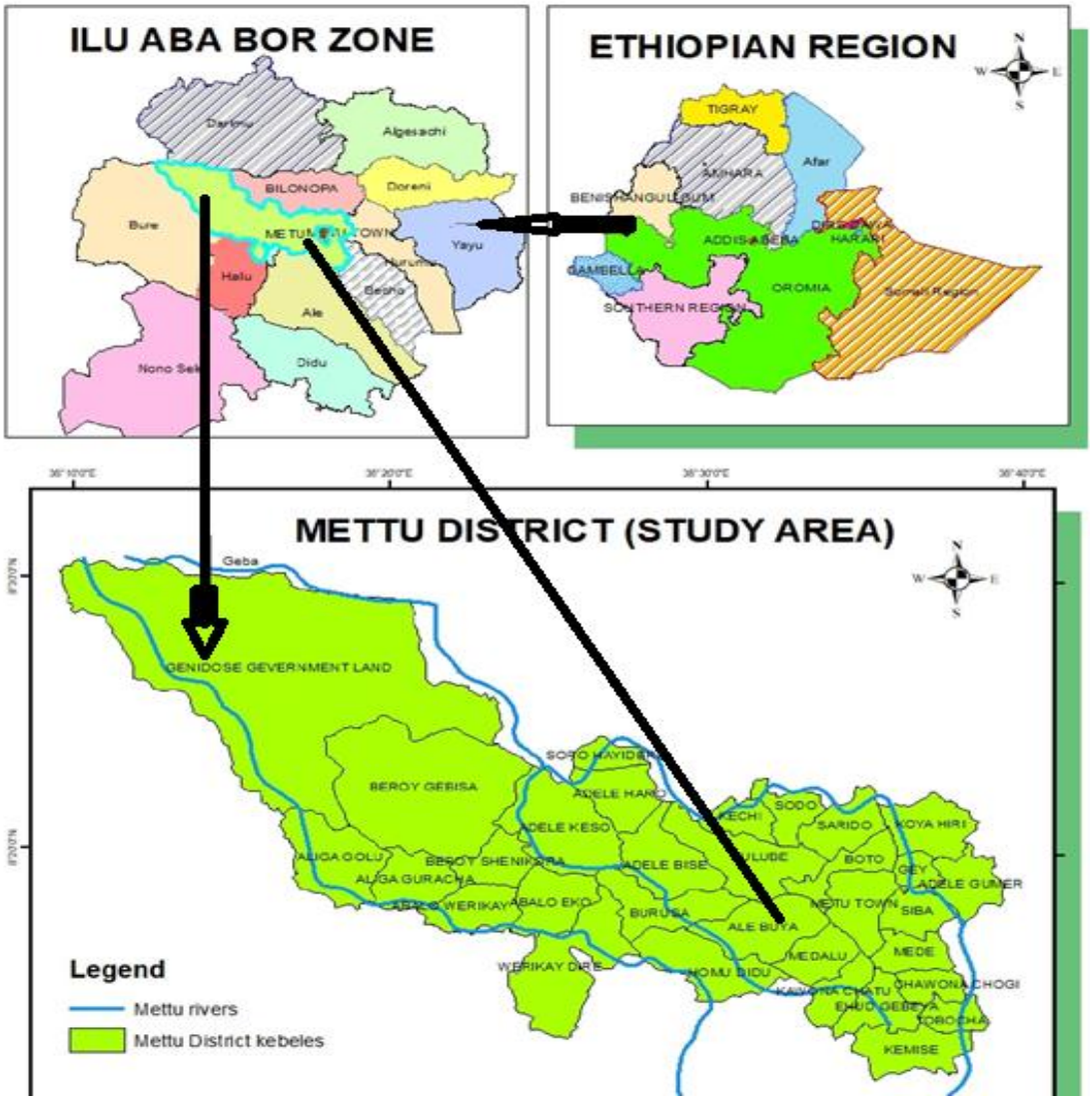


Figure 1: Map of the study area (sample please modify your map like this)

3.2 Description of Experimental Materials

An improved cowpea variety, Qophe Early Type, was procured from Bako Agricultural Research Center for use in the study area. This variety was selected based on its adaptability, agronomic performance, biomass yield, and its successful cultivation by farmers in Southwestern Ethiopia

Table.1. Agronomic and morphological Characteristics of cowpea variety (BARC in 2022)

The following table summarizes the key characteristics of the **Qophe Early Type** cowpea variety:

No	Varieties	Released by	Year of release	Adaptation		Grain yield		Maturity
				Altitude (m.a.s.l)	Rainfall (mm)	Seed yield t ha^{-1}	Biomass yield t $ha^{-1.}$	Days
1.	Qophe early types	BARC	2022	1500-1700	800- 2000	1.53	4.35	90-120

3.3. Treatments and Experimental Design

The experiment was conducted using a randomized complete block design (RCBD) in a factorial arrangement. The study involved a combination of four different rate of NPSB inorganic fertilizer (0kg/h,50 kg/h, 75 kg/h and 100 kg/h) with three different rate of vermicomposting (0 kg/h, 2500 kg/h, 5000 kg/h) in randomized complete block design (RCBD) with three replications. The total experimental area was 30.5m length x13m width (396.5m^2). The sizes of each plot were 2m length x 3m (6m^2) and the space between the blocks and plots were kept at 1m and 0.5m respectively. All plot contained equal number of rows per plot and equal number of plants per row which were six (6) and ten (10) respectively. From each plot area a net plot area 1.8m*2m (3.6m^2) selected and data were taken from it.

Table.2.Treatment combination

Treatment Code	NPSB*(kg/ha)*	Vermicompost*(kg/ha)*	Combination*(kg/ha*
1	0	0	0 *0
2	50	0	50 *0
3	75	0	75 *0
4	100	0	100 *0
5	0	2500	0 *2500
6	50	2500	50 *2500
7	75	2500	75 *2500
8	100	2500	100 *2500
9	0	5000	0 *5000
10	50	5000	50 *5000
11	75	5000	75 *5000
12	100	5000	100*5000

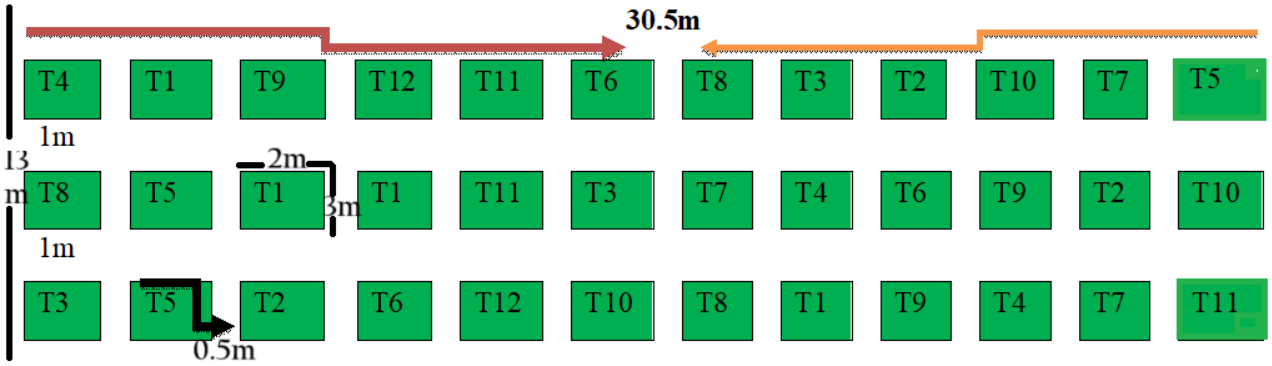


Figure 2: The treatment replication and design layout

3.4. Field Preparation and Seed Sowing

The experimental field was plowed and harrowed using oxen mounted with moldboard plow and disc harrow to make seedbed with desirable soil tilth in June 2024 before plots were laid out and the forage seeds planted. Seeds of cowpea were obtained from Bako agricultural research center Seeds of cowpea were planted on well prepared seed beds at a recommended seed rate of 25kgha^{-1}. The seeds were planted with 20 cm spacing between plant and 50 cm spacing between rows in a plot of 2m length and 3m width(2m× 3 m=6m^2). Vermicomposting was applied at different rate of 0kgha^{-1}, 2500kgha^{-1}, and 5000kgha^{-1} to all plots ten days before planting. Before sowing the seeds, fertilizer were applied in the form of NPSB (Nitrogen, Phosphorus, Sulphur and Boron) in different level at a rate of 0kgha^{-1},50kgha^{-1}, 75 kgha^{-1}and 100kgha^{-1}.Weeding was practiced by hoeing and hand weeding during the seedling establishment stage, and subsequently all agronomic management were conducted as needed.

3.5. Data Collection

3.5.1. Soil sample collection and analysis

Composite soil samples were collected from nine points in a diagonal pattern at a depth of 0–20 cm using an auger. The samples were air-dried, crushed using a mortar and pestle, and passed through a 2 mm sieve (Anderson, 2010). Laboratory analysis was conducted at Bedele Soil Laboratory to assess the soil's physicochemical properties, including:

- pH (determined using a glass electrode pH meter in a 1:2.5 soil-to-water suspension).

- Organic Carbon (OC) (analyzed using the Walkley and Black method, 1934).
- Total Nitrogen (TN) (determined using the Kjeldahl method, Black, 1965).
- Available Phosphorus (P) (extracted with 0.03 Ammonium Fluoride in 0.1M Hydrochloric Acid, following Olsen II method, 1954).
- Organic Matter (OM) (estimated indirectly using the formula OM% = 1.72 × %OC).

3.5.2. Soil physical and chemical properties of the study area.

The analysis results revealed the following soil characteristics:

The analysis result of Soil Physical and Chemical Properties of the Study Area showed that the proportions of soil particle size distribution were 36% sand, 23% silt and 41 % clay with a clay textural class (Table.3). The soil pH was 5.01 (1:2.5 soils: water ratio). The pH was moderately acidic (Tekalign, 1991) which suggests the presence of substantial quantity of exchangeable H+ and Al3+ ions. Soil organic carbon (OC) content was 2.53%, which is within the high range (Tekalign, 1991). It has organic matter (OM) content of 5.6 % which can be classified as high. Total nitrogen (TN) value of the experimental soil was medium (0.218). According to Ethio SIS (2014), TN contents regarded as medium. The available Phosphorus was 5.93 mg/kg which is rated as very low according to Bray (1954). This low phosphorous content could be due to intensive mining of the farm fields and fixation by heavy metal cations. Masresha (2014) has also reported low amount of Phosphorus in soils which are cultivated repeatedly due to fixation and mining. Similarly, Habtamu et al., (2015) have reported that low contain of Phosphorus was due to fixation problem. Soil Cation Exchange Capacity (CEC) value (21.32 cmol/kg) of the study area was rated as moderate (Table 4) (Landon 1991).

Table 3.Major physical and chemical property of soil in study area

Soil properties	Value	Rating	Reference
Textural class	clay	-	
Clay (%)	41	-	
Silt (%)	36	-	
Sand (%)	23	-	
pH (1: 2.5 H2O)	5.01	strongly acidic	(Tekalign, 1991)
CEC [Cmol(+)kg-1 soil]	21.32	Moderate	(Landon ,1991)
Organic Carbon (%)	2.53	High	(Tekalign, 1991)
Organic Matter (%)	4.36	High	(Tekalign, 1991)
Total N (%)	0.218	Medium	(Ethio SIS ,2014)
Available phosphorus(mg/kg)	5.93	Low	(Bray ,1954)

3.6. Statistical Model and Data Analysis

All data collected were checked and subjected to analysis of variance (ANOVA) procedure using SAS software Program (SAS 9.3). The significance differences between treatments were compared by LSD (Least Significance Difference) test at 5% level of significance (Gomez and Gomez, 1984).

4. RESULTS AND DISCUSSION

4.1 Phonological parameter

4.1.1 Days to 50% Emergence

As analysis of variance showed days to 50% emergence of cowpea was significantly ($P<0.01$) affected by main effect of NPSB and vermicompost but their interaction effect was none significantly on days to 50% emergence (Table 4).

The application of cowpea with 100kgha^{-1}NPSB fertilizer is the early emerged which has taken shortest days (6.9) to reach 50% days to emergence, which is statistically similar with application of 50kgha^{-1}NPSB fertilizer. The longest day (7.8) to reach 50% days to emergence is with control (0kgha^{-1}) application. This difference might be attributed due to the difference in amount of major nutrients application which discourages early germination date due to the reduced supply of nutrients. Presence of major nutrients and other essential nutrients like N, P, K, can improves soil structure due to organic matter present in it.

The application of cowpea with 0kgha^{-1}vermicompost inorganic fertilizer is the early emerged which has taken shortest days (6.3) to reach 50% days to emergence. The longest day (8.2) to reach 50% days to emergence is with control (0kgha^{-1}) application of vermicomposting. This difference might be attributed due to the difference in amount of major nutrients present in vermicomposting which discourages early germination and encourage late germination of cowpea at low and high rate respectively. As mentioned by Bewley et al. (2012) during vermicomposting, nitrogen is not lost; rather some nitrogen gets added in the form of earthworm mucus. As both nitrate and ammonium are efficient breakers of seed dormancy, their enrichment in vermicomposting makes the early a facilitator of germination Similarly, Arancon (2012) reported that vermicomposting application encourages early germination date due to the increased supply of nutrients and an improvement of the environments physical conditions.

4.1.2 Days to flowering

As analysis of variance displayed days to flowering of cowpea was significantly (P<0.01) affected by both main effect of NPSB and vermicomposting, but their interaction effect was none significantly on day to flowering (Table 4).

The late flowered cowpea with 71.0 days to reach 50% to flowering is with (100kgha^{-1}) application of NPSB fertilizer. The application of cowpea with control (0kgha^{-1})NPSB fertilizer is the early flowered which has taken shortest days (66.55) to reach 50% days to flowering. This difference might be attributed due to the difference in amount of major nutrients application which discourages early germination date due to the reduced supply of nutrients.

The application of cowpea with 0kgha^{-1})vermicompost inorganic fertilizer is early flowered which has taken shortest days (63.2) to reach 50% days to flowering. The longest day (74.9) to reach 50% days to flowering is with (5000kgha^{-1}) application of vermicompost. Similarly, Atiyeh et al. (2000) reported that vermicomposting stimulates the emergence of plants because of the presence of major nutrients and other essential nutrients like N, P, K, and improves soil structure due to organic matter present in it.

4.1.3. Days to 90%maturity

As analysis of variance revealed days to 90% physiological maturity of cowpea was significantly (P<0.01) affected by both main effect of NPSB and vermicomposting, but their interaction effect were none significantly influenced days to 90% physiological maturity (Table 4)

The late matured cowpea with 125.7 day to reach 90% days to physiological maturity is with (100kgha^{-1}) application of NPSB fertilizer. The application of cowpea with control (0kgha^{-1}) NPSB fertilizer is the early matured which has taken shortest days (121.0) to reach 90% days to physiological maturity. This difference might be attributed due to the difference in amount of major nutrients application which discourages early germination date due to the reduced supply of nutrients

The shortest number of days required for 90% physiological maturity (117.4 days) was recorded in control application of vermicompost and the longest growth period (129.1 days) was noted from application of vermicompost with 5000kgha^{-1}(Table 4). This difference might be due to intense plant competition at low inorganic fertilizer leading to depletion of the available nutrient and as a

result plants tended to mature earlier. In addition, with available nutrient, competition reduced among plant which able to utilize all allocated resources efficiently.

4.2 Growth Parameters Collection

4.2.1 Plant height (cm)

The analysis of variance revealed that a significant variation was observed among the treatments on the plant height of cowpea. The tallest plant height (138.6) was observed by application of 100kgha^{-1}NPSB while the shortest plant height (122.2) was observed from control.

The current finding also indicated that cowpea height decreased at lower proportion of each sources fertilizer application. This might be due to the positive effect of vermicompost on the growth of cowpea which is related to the presence of plant growth regulators, humic acids, increased microbial diversity and activity and improvement of the physical structure of the soil. Sarker et al. (2004) reported that the variation in plant height observed were due to nutrient sources varied in the availability of major nutrients. Concerning vermicompost the highest plant height (151.2) was obtained from application of 5000kgha^{-1} and lowest plant Height of cowpea (105.9) was obtained from control application of vermicompost (Table 8 and Appendix

Table 4.Main effect of NPSB and Vermicompost on some parameters of cowpea in 2025 at Mettu District Southwest Ethiopia

TRT	DE	DF	DPM	PH	NLP	NSP	NPP	TW	AGBY	HI
VC										
0kgha-1	8.27[a]	63.2[c]	117.4[c]	105.9[c]	274.2c	8.7[c]	50.0[c]	127.2[c]	38.9[c]	31.62[c]
2500kgha-1	7.45[b]	67.8[b]	123.6[b]	133.71[b]	338.7[b]	11.6[b]	57.4[b]	135.6[b]	42.5[b]	35.60[b]
5000kgha-1	6.37[c]	74.9[a]	129.1[a]	151.2[a]	413.6[a]	15.6[a]	66.9[a]	145.04[a]	45.97[a]	36.99[a]
LSD(0.05)	0.18	1.06	1.37	3.99	8.7	0.82	1.87	2.00	2.19	1.39
P-value	0.0003	0.001	0.001	0.0008	0.0001	0.0005	0.0009	0.0003	0.0012	0.0015
NPSB										
0kgha-1	7.47[b]	66.5[d]	121[c]	122.2[c]	319.8[d]	10.6[c]	61.25[a]	132.4[c]	40.5[b]	34.1
50kgha-1	7.18[c]	67.9[c]	122.7[b]	126.5[C]	335.36[c]	11.7b	59.72[a]	134.66[c]	41.9[b]	34.2
75kgha-1	6.98[c]	69.1[b]	124.1[ab]	133.9[b]	348.02[b]	12.61[ab]	56.51[b]	137.0[b]	42.7[ab]	35.2
100kgh-1	0.21	71.0[a]	125.7[a]	138.6[a]	365.44[a]	13.16[a]	55.11[b]	139.7[a]	44.8[a]	35.3
LSD(0.05)	2.9	1.2	1.5	4.61	10.05	0.95	2.16	2.31	0.64	1.76
CV (%)	7.830	1.8	1.3	4.7	3.0	8.08	3.8	1.7	2.53	5.1
P-value	0.0045	0.0001	0.0002	0.0001	0.0001	0.0003	0.0010	0.0005	0.0002	0.0004

4.2.2. Pod length (cm)

The analysis of variance showed that a significant variation was observed for both main effect of NPSB and Vermicompost and significantly (P<0.01) affected by both main effect of NPSB and vermicomposting, also their interaction effect was significantly influenced Pod length (Table 5).

The highest pod length (25.58) was obtained from interaction application of 100kgha^{-1} NPSB fertilizer with 5000 kgha^{-1}vermicompost and lowest pod length of cowpea (13.8) was obtained from control application of NPSB fertilizer and vermicompost (Table 5)

Table 5. Interaction effect of NPSB and Vermicompost on some parameters of cowpea in 2025 at Mettu District.

VC	NPSB	NBP	PL	GY
0kgh^{-1}	0kgh^{-1}	4.91^{g}	13.83^{k}	11.16^{h}
	50kgh^{-1}	6.66^{f}	14.8^{jk}	11.75^{h}
	75kgh^{-1}	7.50^{e}	15.5^{ji}	13.0^{g}
	100kgh^{-1}	7.83^{ed}	16.5^{hi}	13.4^{gf}
2500kgh^{-1}	0kgh^{-1}	7.91^{ed}	17.4^{hg}	14.16^{ef}
	50kgh^{-1}	8.08^{ed}	18.3^{fg}	14.83^{ed}
	75kgh^{-1}	8.53^{cd}	19.6^{fe}	15.50^{cd}
	100kgh^{-1}	8.54^{cd}	21.16^{df}	16.08^{cb}
5000kgh^{-1}	0kgh^{-1}	9. 0^{c}	22.16^{dc}	16.3^{cb}
	50kgh^{-1}	9.25^{c}	23.08^{bc}	16.75^{cb}
	75kgh^{-1}	10.3^{b}	23.8^{b}	16.9^{ab}
	100kgh^{-1}	12.5^{a}	25.58^{a}	17.8^{a}
LSD(0.05)		0.81	1.5	1.02
CV (%)		5.6	4.7	4.1

4.2.3 Number of leaves per plant

The statistical analysis showed that the number of leaves per plant were significantly affected (P<0.05) by both main effect of vermicompost and NPSB fertilizer application (Table 4). The highest number of leafs per plant (365.4) was found in a plot supplied with 100kgha^{-1}NPSB while the lowest number of leafs per plant (319.8) was recorded in control.

Concerning vermicompost the highest number of leafs per plant (413.5) was obtained from application of 5000kgha^{-1} and lowest number of leafs per plant of cowpea (274.2) was obtained from control application of vermicompost(Table 4)

4.2.4 Number of branches per plant

The analysis of variance showed that a significant variation was observed for both main effect of NPSB and Vermicompost and significantly ($P<0.01$) affected by both main effect of NPSB and vermicomposting, also their interaction effect was significantly influenced number of branches per plant (Table 5).

The highest number of branche**s** per plant (12.5) was obtained from interaction application of 100kgha^{-1} NPSB fertilizer with 5000 kgha^{-1}vermicompost and lowest number of branches per plant of cowpea (4.9) was obtained from control application of NPSB fertilizer and vermicompost (Table 5)

4.2.5 Number of pods per plant

Number of pods per plant was determined by counting pods of the ten randomly selected plants and their average were taken from each plot.

4.3 Yield and Yield Related Traits

Both the main effect of vermicompost and NPSB fertilizer showed significant effect on number of pods per plant of cowpea (Table 4)

The maximum number of pods per plant (61.25) was obtained from 100kgh^{-1}NPSB and the minimum number of pods per plant (55.11) was recorded from control (Table 4).

Regarding vermicompost the highest number of pods per plant (66) was obtained from application of 5000kgha^{-1} and lowest number of pods per plant of cowpea 50.8 was obtained from control application of vermicompost (Table 4)

4.3.1 Number of seeds per pod

Both the main effect of NPSB and vermicompost showed significant ($p<0.01$) effect on number of seeds per pod of cowpea (Table 4)

The maximum number of seeds per pod (13.16) were obtained from 100kgha^{-1}NPSB which statistically similar with 75 kgha^{-1}NPSB and the minimum number of seed per pod (10.61) were obtained from control

Concerning vermicompost the highest number of seeds per pod (15.6) was obtained from application of 5000kgha^{-1} and lowest number of seeds per pod of cowpea was obtained from control application of vermicompost (8.7) (Table 4)

4.3.2 Thousand Seed weight (g)

The main effect of NPSB and vermicompost showed significant ($p<0.01$) effect for thousand seed weight. But their interaction was non-significant for this parameter (Table 4).

The maximum thousand seed weight (139.7) was recorded from 75kgha^{-1}NPSB, while minimum thousand seed weight (132.4) was recorded from 0kgha^{-1}NPSB (Table 4). At maximum fertilizer the plant gets ample amount of resource element like nutrients and as result the maximum thousand seed weight was recorded from it and might be due to efficient utilization of nutrients resulting of minimal resource competition and lower plant population. On the other hand, the possible reason for decreasing thousand seed weight is insufficient photosynthesis during grain filling stage in control due to resource limitation.

The maximum thousand seed weight (145.0) was recorded from 5000kgha^{-1}vermicompost, while minimum thousand seed weight (127.2) was recorded from 0kgha^{-1}vermicompost (Table 4). At maximum fertilizer the plant gets ample amount of resource element like nutrients and as a result the maximum thousand seed weight was recorded from it and might be due to efficient utilization of nutrients resulting of minimal resource competition and lower plant population. On the other hand, the possible reason for decreasing thousand seed weight is insufficient photosynthesis during grain filling stage in control due to resource limitation.

4.3.3. Grain yield (quintal)

The main effect of NPSB and vermicompost showed significant ($p<0.01$) effect for thousand seed weight and their interaction was significant for this parameter (Table 4). The highest grain yield (17.8) was obtained from application of interaction effect of 100kgha^{-1} NPSB and 5000kgha^{-1} while

lowest plant height of cowpea (11.6) was obtained from interaction effect of control application NPSB fertilizer and vermicompost

4.3.4 Above ground biomass yield (t ha^{-1})

Analysis of variance showed that the main effect of NPSB and vermicompost showed significant ($p<0.01$) effect for above ground biomass yield. But their interaction was non-significant for this parameter (Table 4). NPSB fertilizer the highest above ground biomass yield (4.48) was obtained from application of 100$kgha^{-1}$ and lowest above ground biomass yield of cowpea (4.0) was obtained from control application of NPSB fertilizer which is statistically with 75$kgha^{-1}$ NPSB fertilizer
Concerning vermicompost the highest above ground biomass yield (4.59) was obtained from application of 5000$kgha^{-1}$ and lowest above ground biomass yield of cowpea (3.89) was obtained from control application

4.3.5. Harvest index

Analysis of variance showed that the main effect of NPSB and vermicompost showed significant ($p<0.01$) effect for harvest index. Concerning NPSB fertilizer the highest harvest index (3.53) was obtained from application of 100$kgha^{-1}$ and lowest Harvest index of cowpea (3.41) was obtained from control application. Concerning vermicompost the highest harvest index (3.69) was obtained from application of 5000$kgha^{-1}$ and lowest harvest index of cowpea (3.16) was obtained from control application of vermicompost

5. PEARSON CORRELATION

Results revealed that grain yield displayed positive and significant correlation with agronomic and yield components and negative correlation with days to 50% Emergence. Grain yield was positively and significantly correlated with days to 50% flowering (r=0.56***), days to 90% physiological maturity(r=0.49***), plant height(r=0.66***), number of branch per plant (r=0.51***), number of leaf per plant (r=0.73***),fresh weight per plant (r=0.49***),dry weight per plant (r=0.74**),thousand seed weight (r=0.51**),above ground biomass yield (r=0.79***), harvest index(r=0.52*), and negatively correlated with days to 50% to emergence (r=-0.66***).

This result showed that, increased days to 50% emergence result in reduction of grain yield, while days to 50% flowering, days to 90% physiological maturity, plant height, number of branches per plant, fresh weight per plant, dry weight per plant, thousand seed weight, above ground biomass yield, harvest index have resulted in increasing cowpea yield.

The results on the association of grain yield in this study agree with the findings of Gebreyesus (2008) who reported that, grain yield was positively and highly significantly associated with total above ground dry biomass and yield components of the crop.

Table 6. Correlation coefficient between yield and yield components of cowpea in 2025 at Mettu District .

	DE	DF	DPM	PH	NBP	NLP	FWP	DWP	NPP	PL	NSP	TW	GY	AGBY	HI
DE	1														
DF	0.35*	1													
DPM	0.43**	0.43**	1												
PH	-0.64**	0.53***	0.75***	1											
NBP	-0.65***	0.39*	0.49***	0.78***	1										
NLP	-0.33*	0.58***	0.71***	0.82***	0.62***	1									
FWP	0.59***	-0.53	0.58***	0.71***	0.71***	0.71***	1								
DWP	-0.61***	0.50***	0.53***	0.68***	0.80***	0.68***	0.94***	1							
NPP	-0.46***	0.69***	-0.46***	0.69***	0.75***	0.77***	0.74***	0.61***	1						
PL	-0.60***	0.71***	0.76***	0.81***	0.79***	0.55***	0.80***	0.86***	0.64***	1					
NSP	-0.46***	0.69***	0.75***	0.77***	0.74***	0.61***	0.74***	0.72***	0.77***	0.80*	1				
TW	-0.60***	0.71***	0.76***	0.81***	0.81***	0.79***	0.55***	0.80***	0.80**	0.86**	0.75**	1			
GY	-0.66***	0.56***	0.49***	0.66***	0.74***	0.51***	0.73***	0.49***	0.66**	0.74**	0.51**	0.79***	1		
AGB	-0.65***	0.43***	0.40*	0.57***	0.52***	0.22ns	0.41*	0.48***	0.41*	0.44**	0.63***	0.88**	0.85**	1	
HI	-0.16ns	0.33*	0.25ns	0.46***	0.50***	0.58***	0.54***	0.46***	0.50**	-0.09ns	0.52*	0.57***	0.75**	0.55***	1

DE = day to 50% emergency, DH = days to 50% heading, DPM = Days to 90%physiological maturity, PH = plant height, NBP = number of branch per plant ,FWP=fresh weight per plant ,DWP= dry weight per plant ,NLP = number of leaf per plant, NSP = number of seed per pod, NPP = number pod per plant, TW = thousand weight, AGBY = above ground biomass yield, GY= grain yield, HI = harvest index, r = correlation, *** = very high significant different(<0.001and0.005), ** = highly significant Different(<0.01),*=significantdifferent(<0.05),ns=non–significant(>0.05)

5.1 .Economic Feasibility of Cowpea Production

The partial budget analysis as described by CIMMYT, (1988) was used to determine the economic feasibility of NPSB and Vermicompost on cowpea production. The result of partial budget analysis indicated that the highest net benefit with highest marginal rate of return and value to cost ratio per unit of investment was obtained from integration uses of NPSB and Vermicompost from T12.

Table 7. Economic feasibility of NPSB and Vermicompost on cowpea production in 2025 at Mettu District .

Treatment	**Adj Yield (Kg/ha)**	**TVC (ETB)**	**GB (ETB)**	**NB**	**MRR (%)**
T1	1116	7000	111600	104600	0
T2	1175	11000	117500	106500	95
T3	1300	13000	130000	117000	525
T4	1340	15000	134000	119000	44.4
T5	1416	19500	141600	122100	77.5
T6	1483	23500	148300	124800	135
T7	1550	25500	155000	129500	235
T8	1608	27500	160800	133300	84.4
T9	1630	32000	163000	131000	D
T10	1675	36000	167500	131500	25
T11	1690	38000	169000	131000	D
T12	1780	40000	178000	138000	D

6. CONCLUSION AND RECOMMENDATIONS

A number of cowpea varieties have been developed in Ethiopia through research. Optimum NPSB inorganic fertilizer and Vermicompost organic fertilizer has a vital role to increase its production and alleviates food security problem in terms of Animal product However, the recommended NPSB and Vermicompost fertilizers being used across the country not well known. Hence, Field experiment was conducted during the cropping season of 2024 in Ale buya Kebele bishari site in Mettu district to determine Effect of Different Rate of Inorganic Fertilizer (NPSB) on Agronomic Performance, Yield and Yield related Component of Cowpea in response to Vermicompost. The experiment comprised of 12 treatments with four NPSB fertilizers ($0kgha^{-1}$, $50kgha^{-1}$, $75kgha^{-1}$, and $100kgha^{-1}$) and three Vermicompost ($0kgha^{-1}$, $2500kgha^{-1}$, and $5000kgha^{-1}$) in factorial arrangement in a randomized complete block design with three replications. The data analysis were carried out on growth, yield and yield parameter and the result showed the maximum and minimum days to 90% physiological maturity ,plant height, pod number, number of leaves, thousand seed weight were gained from both main effect of NPSB at $100kgha^{-1}$and $0kgha^{-1}$ and Vermicompos at $5000kgha^{-1}$ and $0kgha^{-1}$ respectively on the other hand the maximum and minimum pod length, number of primary branch and grain yield were obtained from interaction effect of NPSB at $100kgha^{-1}$and Vermicompos at $5000kgha^{-1}$ and NPSB at $0kgha^{-1}$ and Vermicompos at $0kgha^{-1}$respectively

The current results also indicated that Vermi compost can be a better replacement of inorganic fertilizer by 50% to improve agronomic, yield and yield related component of cowpea (Karmegam & Daniel; 2008). In the current result, as both net income and total variable cost increases; the greater increase in net income and the higher marginal rate of return as well as the highest grain yield (17.8) was obtained from treatment (T12). Hence, the use of $100kgha^{-1}$NPSB and $5000kgha^{-1}$Vermicompos is advised in study area.

A number of cowpea varieties have been developed in Ethiopia through research. Optimum NPSB inorganic fertilizer and Vermicompost organic fertilizer has a vital role to increase its production and alleviates food security problem in terms of Animal product However, the

recommended NPSB and Vermicompost fertilizer being used across the country not well known. Hence, Field experiment was conducted during the cropping season of 2024 in A/Fago Kebele in Mettu district to determine Effect of Different Rate of Inorganic Fertilizer (NPSB) on Agronomic Performance, Yield and Yield related Component of Cowpea in response to Vermicompost. The experiment comprised of 12 treatments with four NPSB fertilizers (0kgha^{-1}, 50kgha^{-1}, 75kgha^{-1}, and 100kgha^{-1}) and three Vermicompost (0kgha^{-1}, 2500kgha^{-1}, and 5000kgha^{-1}) in factorial arrangement in a randomized complete block design with three replications. The data analysis were carried out on growth, yield and yield parameter and the result showed the maximum and minimum days to 90% physiological maturity ,plant height, pod number, number of leafs, thousand seed weight were gained from both main effect of NPSB at 100kgha^{-1}and 0kgha^{-1} and Vermicompos at 5000kgha^{-1} and 0kgha^{-1} respectively on the other hand the maximum and minimum pod length, number of primary branch and grain yield were obtained from interaction effect of NPSB at 100kgha^{-1}and Vermicompos at 5000kgha^{-1} and NPSB at 0kgha^{-1} and Vermicompos at 0kgha^{-1}respectively

The current results also indicated that Vermicompost can be a better replacement of inorganic fertilizer by 50% to improve agronomic, yield and yield related component of cowpea. In the current result, as both net income and total variable cost increases; the greater increase in net income and the higher marginal rate of return as well as the highest grain yield (17.8) was obtained from treatment (T12). Hence, the use of 100kgha^{-1}NPSB and 5000kgha^{-1}Vermicompos is advised in study area.

Thus, the following are suggested as recommendations:

- The combined use of vermicompost and inorganic NPSB fertilizer is recommended for improving agronomic performance, biomass yield, and economic feasibility of cowpea production.
- Future research should focus on optimizing the fertilizer ratio for maximum yield benefits while ensuring environmental sustainability.
- As this study was conducted within one agro-ecology and a single growing season, repeating the experiment under different seasonal and ecological conditions will strengthen its reliability and applicability across varied farming systems.

- Comparative trials across multiple locations will help refine region-specific recommendations.
- Before large-scale implementation, the effectiveness of integrated vermicompost and NPSB fertilizer application should be tested under farmers' field conditions.
- Collaboration with local agricultural extension services and farmer groups can facilitate knowledge transfer and adoption at the grassroots level.

By implementing these recommendations, cowpea production in Southwestern Ethiopia can be optimized, ensuring high productivity, sustainable soil fertility management, and enhanced economic returns for local farmers

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8. APPENDIXES

Appendix Table 1.Raw data of cowpea agronomic and yield traits under vermicompost and NPSB treatment in 2025 at Mettu

Trt	VC (t/ha)	NPSB (kg/ha)	DE	DF	DM	PH	NLP	NTP	PL	NPP	NSP	TW	AGBY	GY	HI (%)
T1	0	0	8.27	63.2	117.4	105.9	7.1	2.3	13.6	50.0	8.7	127.2	2742.3	934.5	31.62
T2	0	50	7.95	65.4	120.5	112.5	7.9	2.5	14.1	53.2	9.5	130.8	2893.1	1074.2	37.15
T3	0	75	7.64	66.7	121.3	117.8	8.2	2.6	14.9	55.6	10.1	132.9	2978.6	1198.7	40.23
T4	0	100	7.43	67.9	122.6	121.3	8.5	2.9	15.2	57.1	10.6	134.3	3023.4	1264.8	41.84
T5	2.5	0	7.72	65.8	121.2	113.4	8.3	2.7	14.5	54.8	9.9	130.5	2867.1	1104.6	38.52
T6	2.5	50	7.64	67.6	123.5	121.1	9.2	2.8	15.3	58.6	10.8	134.4	3102.2	1378.4	44.42
T7	2.5	75	7.52	68.1	124.7	125.9	9.4	3.0	15.6	59.8	11.0	135.6	3206.3	1482.2	46.22
T8	2.5	100	7.48	68.5	125.2	128.3	9.8	3.1	15.9	60.7	11.3	137.2	3257.4	1551.8	47.63
T9	5	0	7.65	66.2	122.7	117.2	8.8	2.9	14.9	56.0	10.4	132.0	2920.4	1217.5	41.70
T10	5	50	7.38	67.9	124.1	129.4	9.6	3.1	15.7	59.2	11.1	136.8	3311.7	1604.7	48.47
T11	5	75	7.26	68.1	125.4	133.2	10.1	3.2	16.3	60.8	11.4	138.6	3358.1	1702.3	50.67
T12	5	100	7.18	68.3	126.5	137.5	10.4	3.3	16.7	61.3	11.7	140.3	3389.5	1780.3	52.50

District Southwest Ethiopia on some parameters of cowpea in 2025 at Mettu District Southwest Ethiopia

Appendix Table 2. Main effect of Vermi compost on some parameters of cowpea in 2025 at Mettu District Southwest Ethiopia

TRT	DE	DF	DPM	PH	NLP	NSP	NPP	TW	AGBY	HI
VERM VC										
0kgha-1	8.27[a]	63.2[c]	117.4[c]	105.9[c]	274.2c	8.7[c]	50.0[c]	127.2[c]	38.9[c]	31.62[c]
2500kgha-1	7.45[b]	67.8[b]	123.6[b]	133.71[b]	338.7[b]	11.6[b]	57.4[b]	135.6[b]	42.5[b]	35.60[b]
5000kgha-1	6.37[c]	74.9[a]	129.1[a]	151.2[a]	413.6[a]	15.6[a]	66.9[a]	145.04[a]	45.97[a]	36.99[a]
LSD(0.05)	0.18	1.06	1.37	3.99	8.7	0.82	1.87	2.00	2.19	1.52
P-value	0.0003	0.001	0.001	0.0008	0.0001	0.0005	0.0009	0.0003	0.0012	0.0015

Appendix Table 3.Main effect of NPSB on some parameters of cowpea in 2025 at Mettu District Southwest Ethiopia

NPSB	DE	DF	DPM	PH	NLP	NSP	NPP	TW	AGBY	HI
0kgha-1	7.47[b]	66.5[d]	121[c]	122.2[c]	319.8[d]	10.6[c]	61.25[a]	132.4[c]	40.5[b]	34.1
50kgha-1	7.18[c]	67.9[c]	122.7[b]	126.5[C]	335.36[c]	11.7b	59.72[a]	134.66[c]	41.9[b]	34.2
75kgha-1	6.98[c]	69.1[b]	124.1[ab]	133.9[b]	348.02[b]	12.61[ab]	56.51[b]	137.0[b]	42.7[ab]	35.2
100kgh-1	0.21	71.0[a]	125.7[a]	138.6[a]	365.44[a]	13.16[a]	55.11[b]	139.7[a]	44.8[a]	35.3
LSD(0.05)	2.9	1.2	1.5	4.61	10.05	0.95	2.16	2.31	0.64	1.76
CV (%)	7.830	1.8	1.3	4.7	3.0	8.08	3.8	1.7	2.53	5.1
P-value	0.0045	0.0001	0.0002	0.0001	0.0001	0.0003	0.0010	0.0005	0.0002	0.0004

Appendix Table 4. Interaction effect of NPSB and Vermicompost on some parameters of cowpea in 2025 at Mettu District Southwest Ethiopia

VC	NPSB	NBP	PL	GY
0kgh^{-1}	0kgh^{-1}	4.91^{g}	13.83^{k}	11.16^{h}
	50kgh^{-1}	6.66^{f}	14.8^{jk}	11.75^{h}
	75kgh^{-1}	7.50^{e}	15.5^{ji}	13.0^{g}
	100kgh^{-1}	7.83^{ed}	16.5^{hi}	13.4^{gf}
500kgh^{-1}	0kgh^{-1}	7.91^{ed}	17.4^{hg}	14.16^{ef}
	50kgh^{-1}	8.08^{ed}	18.3^{fg}	14.83^{ed}
	75kgh^{-1}	8.53^{cd}	19.6^{fe}	15.50^{cd}
	100kgh^{-1}	8.54^{cd}	21.16^{df}	16.08^{cb}
5000kgh^{-1}	0kgh^{-1}	9. 0^{c}	22.16^{dc}	16.3^{cb}
	50kgh^{-1}	9.25^{c}	23.08^{bc}	16.75^{cb}
	75kgh^{-1}	10.3^{b}	23.8^{b}	16.9^{ab}
	100kgh^{-1}	12.5^{a}	25.58^{a}	17.8^{a}
LSD(0.05)		0.81	1.5	1.02
CV (%)		5.6	4.7	4.1

Appendix Figures1 : Photos and Videos captured during the treatment work

1. Photos during field work













T1
50kg NPS/ha with 0 kg VC /ha
T3
0kg NPS/ha with 5000 kg VC /ha
T2
0kg NPS/ha with 2500 kg VC /ha
T4
0kg NPS/ha with 0 kg VC /ha
T1
0kg NPS/ha with 5000 kg VC /ha
T2
0kg NPS/ha with 2500 kg VC /ha
T1.1
100kg NPS/ha with 7500 kg VC /ha



