Journal of Scientific Agriculture 2024, 8: 44-50
doi: 10.25081/jsa.2024.v8.8959
https://updatepublishing.com/journal/index.php/jsa

Research Article

ISSN: 2184-0261

Effect of integrated vermicompost and chemical nitrogen fertilizer for productivity of bread wheat (*Triticum aestivum* L.)

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ABSTRACT

The study was conducted at Horo district on six (6) farmers' fields to investigate the effect of integrated vermicompost and chemical nitrogen fertilizer for bread wheat and the soil nutrient content. The treatments consist of without any fertilizer, recommended chemical NP fertilizer, 100% N equivalent vermicompost + recommended P_2O_5, 75% N equivalent Vermicompost + 25% recommended N + recommended P_2O_5, 50% equivalent Vermicompost + 50% recommended N + recommended P_2O_5 and 25% equivalent Vermicompost + 75% recommended N + recommended P_2O_5. The experimental design was a randomized complete block design (RCBD) with three replications. Dendea seed variety with a rate of 150 Kg ha^{-1} was used for the trial. ANOVA analysis for after harvesting soil parameters showed significant ($P<0.05$) differences among treatments for available phosphorus, organic carbon, exchangeable acidity and cations exchange capacity while pH and exchangeable Ca and Mg were not statistically significant among the treatments. ANOVA showed that the treatments significantly influenced all collected yield and yield related parameters of the crop. Relatively the highest crop yield and yield related traits were obtained from T_2 (recommended chemical fertilizer) while the lowest was from control (without fertilizer). The highest net income (91971.70 birr/ha) was obtained from 25% equivalence vermicompost + 75% recommended N + recommended P_2O_5. To have more confidence in the technology; it should be verified in the same area with the same management procedure.

KEYWORDS: Nitrogen, Horo, Soil, Test, Vermicompost, Wheat

Received: March 22, 2024
Revised: July 10, 2024
Accepted: July 11, 2024
Published: July 31, 2024

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INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the largest major cereal crops produced in the Oromia Region (CSA, 2020). Despite the large area of land cultivated and a suitable climate for wheat production in Oromia, the region couldn't produce enough wheat grain to meet its annual demand. Low soil organic carbon and acidity are the two important soil fertility depletions associated with soil fertility. Acidity is the main factor that limits and prevents profitable and sustained soil productivity in many parts of the world (Wang *et al.*, 2006).

Organic production is an agricultural management system that preserves the soil, plants and ecosystem in their natural state. It is based on the application of non-synthetic naturally occurring pesticides and fertilizers of organic origin. Despite lower yields, especially in wheat production, the benefits from organic production are various, such as improved physical and chemical properties of soil, enhanced crop diversity and biodiversity of beneficial insects, enhanced nutrient uptake and use efficiency of the crop and reduced pollution (Gomiero *et al.*, 2011) and likely positive effect on human health (Mie *et al.*, 2017).

Integrated soil fertility management (ISFM) is one best option as it utilizes available organic and inorganic inputs to build ecologically sound viable farming systems (Teshome *et al.*, 2017). Integrated nutrient management involving judicious use of combined organic and inorganic fertilizer sources is a feasible and productive approach to overcome soil fertility constraints (Efthimiadou *et al.*, 2010). Adequate Input Sustainable Agriculture (AISA) is currently practiced based on the integrated use of chemical and organic fertilizers, especially bio-fertilizers as approach to alternative agriculture for producing and maintaining yield at an acceptable level (Dastmozd *et al.*, 2015).

Even though in western Oromia region including the Horo district is agro-ecologically suitable for crop production, the wheat yield is not good enough due to low soil fertility caused by soil acidity, use of only chemical fertilizers and leaching of soil nutrients due to rainfall. Increasing wheat productivity is a national target to fill the gap between the nutrient consumption of wheat and its production. Organic fertilizers such as farm yard manure and vermicompost can serve as a source of SOM and source of nutrients needed for the growth and production of crops. However, it is difficult to have a sufficient amount of organic fertilizer that can supply adequate amounts of nutrients needed by crops in smallholder famers' fields. Thus, integrated applications of inorganic and organic fertilizers are important to ensure an adequate and balanced supply of nutrients to crops. Integrated use of lime with organic and chemical fertilizers is considered a good approach for sustainable crop production (Bekele *et al.*, 2018). With an integrated nutrient management approach, inorganic fertilizers can supplement with readily available nutrients to plants at early stages whereas organic fertilizers at later growth stages of plants can boost yield and reduce the associated risks of chemical fertilizers (Mitiku *et al.*, 2014). Integrated application of inorganic and organic fertilizers increases fertilizer use efficiency, ensure a balanced nutrient supply to crops, improves soil sustainability, etc. There are several literatures indicating the multiple advantages of the integrated application of organic and inorganic nutrient sources over that obtained with the sole application of either source (Singh *et al.*, 2011; Kumar *et al.*, 2015). Therefore, by considering the beneficial effects of integrated organic and inorganic fertilizers for soil fertility management and crop production this study is proposed to investigate the effect of integrated vermicompost and chemical nitrogen fertilizer on the bread wheat yield, yield related parameters and the soil nutrient content in the Horo district and to determine the economically optimum amount of integrated vermicompost and chemical nitrogen fertilizer for bread wheat production in the study area.

MATERIALS AND METHODOLOGY

Description of Study Area

The study was conducted in the Horo district of Horo Guduru Wollega zone on six representative farmers in 2021 and 2022. The district is selected for the investigation because the District is part of the soil acidity affected area. Horo District is one of Horo Guduru Wollega Districts which is located at the center of the zone (Figure 1). The altitude range of the District is 1350 m to 2500 above sea level respectively. The mean monthly rainfall ranges from 12.8 to 343.8 mm, and the mean monthly temperature is 17.23-to 22.9 °C (Chimdessa & Takele, 2020).

Vermicompost Preparation

Vermicompost was prepared from animal manures and green leaves of locally available plants using earthworm (*Eisenia fetida*). It was produced in a place with shade, high humidity and cool. A covering material is provided to protect the process from sunlight and rain. The covering material was prepared from plastic that can protect sunlight from it. It was prepared in a box which is made from a flat tree. Vermibox was constructed from 1.5 m long, 0.5 m wide and 0.65 m high for vermicomposting. It was prepared at the home of one farmer in the District where the study was conducted. The selection of farmers for vermicomposting is based on the availability of the resources to prepare it and the importance of the location to transport the prepared vermicompost to each experimental field.

Soil Sampling

Soil samples were collected from 0-20 cm depth. Soil sampling was conducted two times, pre-planting and after harvesting soil sampling. The representative soil samples were collected from fields of six representative farmers per district from Didibe Kistana and Doyo Bariso Peasant Association and after harvesting soil samples were collected per plots by zigzag method using auger from 20 cm depth.

Soil Sample Analysis Procedures

Soil texture was determined by Bouyoucos Hydrometer method (Gee & Bauder, 1986) using Hydrometer ASTM No.152. The soil pH was measured potentiometrically with a pH meter in the supernatant suspension of 1:2.5 soil to water ratio (van

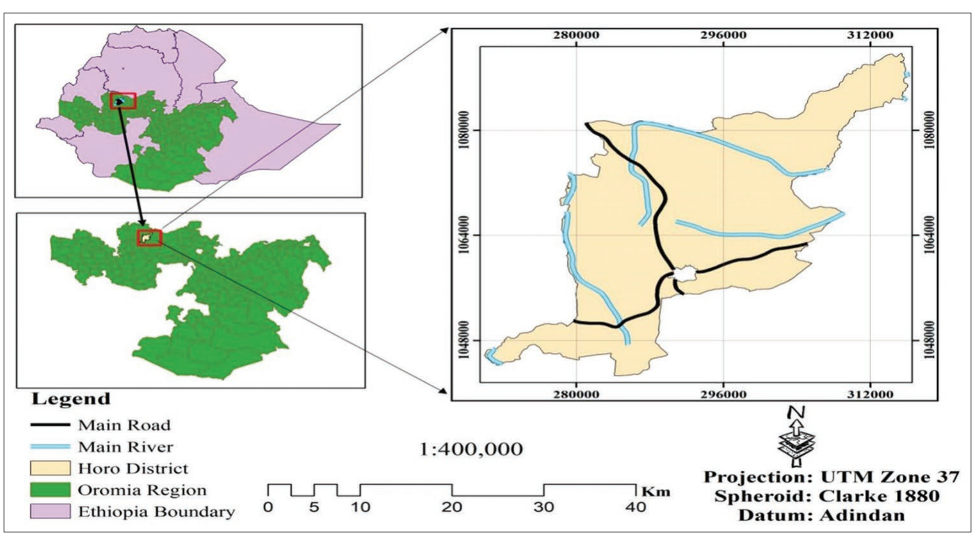

Figure 1: Map of the study area

Reeuwijk, 2002). Exchangeable acidity was determined by titration method (Sahlemedhin & Taye, 2000) using 0.02 N NaOH as titrant. Soil organic carbon was determined by Walkley and Black (1934) and organic matter was calculated from the organic content of soil. Total nitrogen was calculated from organic matter content. The exchangeable magnesium and calcium were extracted using 1 N KCl solution. The extracted calcium and magnesium were determined using 0.01N Na_2-EDTA volumetrically. The available phosphorus of soils was analyzed by Olsen *et al.* (1954) method.

Vermicompost Analysis Procedures

Among vermicompost's physical properties, its moisture content was determined by drying vermicompost in the oven at 105 °C. The soil pH was measured potentiometrically with a pH meter in the supernatant suspension of 1:2.5 vermicompost to water ratio (van Reeuwijk, 2002). Vermicompost organic carbon was determined by the Walkley and Black (1934) method. Available nitrogen was analyzed by the Alkaline Permanganate Method (Subbiah & Asija, 1956) and total nitrogen was calculated from organic matter content. Vermicompost exchangeable magnesium and calcium were extracted using a 1 N KCl solution. The extracted calcium and magnesium were determined by titration method using 0.02 N Na_4-EDTA as titrant. The available phosphorus was determined by Olsen *et al.* (1954) method.

Lime Requirement Determination

The liming material used for reclaiming the soil acidity of the study area was calcium carbonate ($CaCO_3$). The lime recommendation was based on the amount of exchangeable acidity measured by the titrimetric method. The amount of lime that was applied at each level is calculated based on the mass of soil per 20 cm hectare-furrow-slice, soil sample density and exchangeable acidity of each site. The lime rate will be determined by the following formula.

$$LR\left(\frac{Kg}{ha}\right) = \frac{EA\left(\frac{cmol(+)}{Kg}\right)*0.2m*BD\left(\frac{Mg}{m^3}\right)*\text{CCE factor}*10^4m^2*10^3}{2000\frac{cmol(+)}{Kg}}$$

Where *EA* = Exchangeable acidity (cmol(+)/Kg); *BD* = bulk density of the soil and *CCE* = calcium carbonate equivalent.

Experimental Design, Treatments and Procedures

The treatments were laid out in a randomized complete block design (RCBD). The treatments were T_1: without fertilizer (Control); T_2: recommended (rec.) chemical fertilizer (rec. N + rec. P_2O_5); T_3:100% N equivalent Vermicompost + rec. P_2O_5; T_4: 75% N equivalent Vermicompost + 25% rec. N + rec. P_2O_5; T_5: 50% N equivalent Vermicompost + 50% rec. N + rec. P_2O_5 and T_6: 25% N equivalent Vermicompost +75% rec. N + rec. P_2O_5. The treatments were replicated three times and assigned randomly to the experimental plot within block. The Size of each plot (experimental unit) was 3 m × 4 m (12 m^2) each with 0.2 m of row spacing. The distance between the plots and blocks was 0.5 m and 1 m respectively. The recommended lime was applied on the experimental field one month before planting. The seed rate was 150 Kg/ha and the recommended urea fertilizer rate was 100 Kg/ha (46 N Kg/ha). Urea was applied in split application 1/3 at planting and 2/3 at the tillering stage for maximum nitrogen utilization. The phosphorus fertilizer rate was applied based on the P-critical value of the study area.

Statistical Data Analysis

Statistical analysis was computed using SAS to test the significance difference between means of treatments. The mean separation was analyzed using the Least Significance Difference.

RESULTS AND DISCUSSION

Physico-Chemical Properties of Experimental Soil before Planting

Soil reaction (pH)

Soil pHs of the experimental sites before planting were ranged from 5.03 to 5.46. According to Chude *et al.* (2005) rating, the soil reaction of the experimental sites was under strongly acidic (Table 1) which is not suitable for the growth of most crops. Soil pH result indicated that for optimum wheat production, the soil acidity should be adjusted to the desired range through management intervention. Therefore, lime application is mandatory to optimize crop yield on this soil.

Available phosphorus

The phosphorus level of experimental soil before planting ranged from 7.32 to 9.95 ppm (Table 1). According to Cottenie (1980) rating, the available soil P level of the study sites ranged from low to medium very low (Mamo & Haque, 1987) and Solomon *et al.* (2002) reported that the availability of P in most soils of Ethiopia decline by the impacts of fixation as a result of low pH.

Organic carbon

The organic carbon content of experimental soils before sowing ranged from 2.14 to 2.9% (Table 1) which was rated as medium (Tadesse *et al.*, 1991). This low organic carbon content of the soil might be due to low input of organic sources such as animal manure, compost and household wastes.

Total nitrogen

The total nitrogen content of the experimental soils before planting ranged from 0.18 to 0.25 % (Table 1). The total nitrogen content of the soil is a measure of the total amount of nitrogen present in the soil, much of which is held in organic matter and

Table 1: Selected Physico- chemical properties of experimental sites before planting

Sites	pH (H_2O)	Av. P (ppm)	OC (%)	TN (%)	E. A cmol(+)/Kg	E. Ca (cmol(+)/Kg)	E. Mg cmol(+)/Kg	CEC cmol(+)/Kg	Textural Cass
1	5.19	8.00	2.30	0.20	0.88	13.06	7.44	26.05	C. Loam
2	5.45	7.58	2.33	0.20	0.37	12.00	6.77	28.04	C. Loam
3	5.14	9.06	2.63	0.23	1.18	10.19	5.87	25.22	C. Loam
4	5.03	7.32	2.14	0.18	1.28	8.44	3.93	24.85	Clay
5	5.11	8.75	2.25	0.19	0.66	13.19	6.97	24.97	C. Loam
6	5.46	9.95	2.90	0.25	0.55	15.99	4.83	28.12	C. Loam

pH=power of Hydrogen, Av. *P*=Available Phosphorus, TN=Total Nitrogen, E. Ca=Exchangeable calcium, E. Mg=Exchangeable Magnesium, CEC=Cation Exchange Capacity and C. Loam=Clay loam

is not immediately available to plants. It may be mineralized to available forms. However, total nitrogen cannot be used as a measure of the mineralized forms of nitrogen (NH_4^+, NO_3^-, and NO_2^-) as much of it is held in the organic matter in the soil.

Exchangeable cations

The soil analysis results showed that the concentration of exchangeable acidity, Ca, and Mg before planting ranged from 0.37 to 1.28, 8.44 to 15.99, 3.93 to 6.97 cmol(+) Kg^{-1} respectively. The values of the cation exchange capacity of the experimental soils ranged from 24.85 to 28.12 cmol(+) Kg^{-1} (Table 1). As per the rating of Hazelton and Murphy (2007), the CEC of the soil of the experimental sites was high, which is in the range of 24 to 45 cmol(+) Kg^{-1}.

Soil particle size distribution

Soil texture is an important soil physical characteristic as it determines water intake rate (infiltration), water holding capacity, ease of tilling, and the amount of aeration and also influence soil fertility (Gupta, 2000). The textural classes of most sites were clay loam. Soil texture is one of the inherent soil properties less affected by management and which determines nutrient status, organic matter content, air circulation and water holding capacity of a given soil. Clay loam soil is suitable for bread wheat production because it can hold sufficient water and contains a great deal of nutrients that are useful for plants (Kotu *et al.*, 2000).

VERMICOMPOST ANALYSIS RESULTS

The chemical analytical results for vermicompost applied to the research field in the 2021 and 2022 planting seasons are shown in Table 2. The vermicompost's pH was moderately alkaline (7.90 and 7.96) and 13.72% and 17.74% of OC, 1.069% and 1.29% of Av. N, 1.18% and 1.53% of TN and 305 ppm and 319 ppm of Av. P respectively.

Calculation of Nitrogen Rate in Vermicompost

The rate of nitrogen in vermicompost was calculated based one quation 1 Kg of VC= $\frac{\text{v\% Av. N of Kg VC}}{100\%}$ whereas VC is vermicompost, v% is the amount of percent of available nitrogen in vermicompost. The amount nitrogen calculated from vermicompost can be varied highly based on vermicompost moisture content at the time of rate calculation and the applied rate of vermicompost was multiplied by moisture correction factor of vermicompost at the moment of planting. The amount of applied rate of nitrogen from integrated vermicompost and nitrogen fertilizer planting per two years is tabulated in Table 3.

Table 2: Selected chemical properties of the vermicompost planting per planting years

Parameters	2021 year	2022 year
pH (1:2.5H_2O)	7.90	7.96
%OC	13.72	17.74
%OM	23.65	30.59
TN%	1.18	1.53
Av. %N	1.069	1.29
VMCF	1.21	2.85
Av. *P* (ppm)	305	319
E. Ca (cmol(+)/Kg)	30.28	36.26
E. Mg (cmol(+)/Kg)	21.81	25.99
CEC (cmol(+)/Kg)	63.54	65.35

pH=Power of Hydrogen activity, C=Carbon, N=Nitrogen, C: N=Carbon Nitrogen ratio, *P*=Phosphorus, E. Ca=Exchangeable Calcium, E. Mg=Exchangeable Magnesium, CEC=Cations Exchange Capacity, VMCF=Vermicompost Moisture Content Factor

Experimental Design, Treatments and Procedures

The treatments were laid out in a randomized complete block design (RCBD). The treatments were T_1: without fertilizer (Control); T_2: Recommended chemical fertilizer (Rec. N + Rec. P_2O_5); T_3: 100% N equivalent Vermicompost + Rec. P_2O_5; T_4: 75% N equivalent Vermicompost + 25% rec. N + Rec. P_2O_5; T_5: 50% N equivalent Vermicompost +50% rec. N + Rec. P_2O_5 and T_6: 25% N equivalent Vermicompost +75% rec. N + Rec. P_2O_5. The treatments were replicated three times and assigned randomly to the experimental plot within the block. The Size of each plot (experimental unit) was 3 m × 4 m (12 m^2) each with 0.2 m of row spacing. The distance between the plots and blocks was 0.5 m and 1 m respectively. The recommended lime was applied on the experimental field per plots on the experimental field one month before planting. The seed rate was 150 Kg/ha and the recommended urea fertilizer rate was 100 Kg/ha (46 N Kg/ha). Urea was applied in split application 1/3 at planting and 2/3 at tillering stage to get maximum n utilization. The phosphorus fertilizer rate was applied based on the P-critical value of the study area.

Effects of Vermicompost and Nitrogen Chemical Fertilizer on Soil Chemical Properties after Harvesting

The mean soil pH, Av. P, TN, OC, exchangeable acidity, exchangeable Ca, exchangeable Mg and CEC of experimental soil before and after planting are presented in Table 3. The results indicated that all treatments improve soil fertility characteristics as compared to before planting soil parameters (Table 3). ANOVA analysis for after harvesting soil parameters showed that significant ($P<0.05$) differences among treatments for soil available phosphorus, soil organic carbon, soil exchangeable acidity and soil cations exchange capacity while soil pH and soil exchangeable Ca and Mg weren't statistically significant among the treatments (Table 3). However, the greatest positive pH and exchangeable Ca and Mg were gained at the application of 75% N equivalence vermicompost + 25% recommended N with 100% recommended P_2O_5 when compared to other treatments. It is realized that soil pH is considered as one of the key soil properties as it controls many chemical processes that take place in the soil. This indicated that vermicompost enhanced soil organic carbon, exchangeable acidity and CEC (Marinari *et al.*, 2000). Cation exchange capacity is highly correlated with the organic carbon (OC) content of the soil, which in turn, is affected by different soil management practices such as intensive cultivation, fertilization, and changes in land use (Olorunfemi *et al.*, 2018).

Effects of Vermicompost and Chemical Nitrogen Fertilizer on Bread Wheat Grain Yield and Yield Related Parameters

Analysis of statistical variance at $\alpha<0.05$ showed that growth, yield and yield related parameters of bread wheat were highly and significantly affected by the treatments (Table 4). Applied integrated chemical fertilizer and vermicompost brought changes among treatments. Mostly, the highest of bread wheat agronomic parameters were recorded at the application of the recommended chemical fertilizer. However, it was not statistically different from the application of 25, 50 and 75% N equivalent vermicompost with 75, 50 and 25% recommended chemical nitrogen fertilizer (urea) respectively and this could be because of nitrogen rate applied from vermicompost might not mineralized well as can be immobilized in small portion due to soil properties and environmental characteristics and in addition rate of integrated nitrogen from vermicompost plus chemical nitrogen fertilizer is equivalent to recommended chemical nitrogen in terms of applied amount.

Partial Budget Analysis

The economic analysis showed that the highest net income (91971.70 ETB ha^{-1}) was obtained from the fertilizer application of 25% N equivalence vermicompost + 75% recommended N with 100% recommended P_2O_5 (Table 5). Therefore, this integrated organic and inorganic fertilizer rate was more

Table 3: Effects of the treatments on selected Soil chemical properties

	Soil chemical properties							
	pH	Av. P	TN (%)	OC (%)	EA	E. Ca	E. Mg	CEC
Before planting	5.23	8.44	0.21	2.43	0.82	12.15	5.97	26.21
Treatments (after harvest)								
Without fertilizer	5.44	6.85[b]	0.19[b]	2.20[b]	0.27[ab]	10.68	6.22	26.96[bc]
100% NP Recommended fertilizer	5.47	7.51[b]	0.19[b]	2.20[b]	0.30[a]	9.37	6.90	26.45[c]
100% N eq. VC+Rec. P_2O_5	5.53	9.94[ab]	0.26[a]	3.02[a]	0.19[bc]	10.43	7.81	31.95[a]
75% N eq. VC+Rec. P_2O_5+25% rec. N	5.54	10.56[a]	0.27[a]	3.02[a]	0.16[c]	11.44	8.05	29.19[abc]
50% N eq. VC+Rec. P_2O_5+50% rec. N	5.48	9.17[ab]	0.26[a]	3.02[a]	0.17[c]	11.62	7.34	32.37[a]
25% N eq. VC+Rec. P_2O_5+75% rec. N	5.49	9.67[ab]	0.26[a]	3.13[a]	0.17[c]	11.04	7.90	30.46[ab]
PV	0.89	0.018	<0.0001	<0.0001	0.01	0.74	0.71	0.02
LSD($\alpha<0.05$)	0.19	2.89	0.02	0.70	0.08	3.42	2.84	3.85
CV(%)	2.02	10.01	4.49	4.55	11.99	7.87	11.66	7.32

pH=Power of hydrogen activity, Av. *P*=Available Phosphorus, TN=Total Nitrogen, OC=Organic Carbon, E. A=Exchangeable Acidity, E. Ca=Exchangeable Calcium, E. Mg=Exchangeable Magnesium, CEC=Cations Exchange Capacity

Table 4: Treatment influences on grain yields and yield related traits of bread wheat in Horo district for 2022/23 cropping season

	Yield and yield related parameters of bread wheat					
Treatments	PH (cm)	SL (cm)	Till (no)	BM (Kg/ha)	GY (Kg/ha)	HI (%)
Without fertilizer	75.66[c]	6.01[c]	1.89[c]	6539.60[b]	1767.00[c]	27.79[b]
Rec. chemical fertilizer.	90.36[a]	7.04[a]	2.76[a]	9442.50[a]	3162.30[a]	33.18[a]
100% N eq. VC+rec. P_2O_5	77.22[c]	6.26[bc]	2.30[b]	6313.30[b]	2228.60[bc]	34.77[a]
75% N eq. VC+rec. P_2O_5+25% rec. N	79.99[c]	6.66[ab]	2.30[b]	7625.60[ab]	2704.90[ab]	35.23[a]
50% N eq. VC+rec. P_2O_5+50% rec. N	85.51[b]	6.90[a]	2.60[ab]	8184.80[ab]	2844.90[ab]	34.62[a]
25% N eq. VC+rec. P_2O_5+75% rec. N	87.69[ab]	6.96[a]	2.71[a]	9187.10[a]	3141.10[a]	33.96[a]
P Value	<.0001	0.0011	0.0002	0.0098	0.0071	0.0026
$LSD_{(\alpha<0.05)}$	4.6414	0.5165	0.3605	1961.4	795.66	3.6734
CV	4.76	6.56	12.60	21.10	24.55	9.37

PH=Plant height, Till=Tillers, BM=Biomass yield, GY=Grain yield, HI=harvest index

Table 5: Economic analysis for bread wheat production in Horo district

Treatments	GY (Qt/ha)	AGY (Qt/ha)	GFB (birr/ha)	TVC (birr/ha)	NB (birr/ha)	MRR (%)
without fertilizer	17.67	15.9	63612.0	3180.6	60431.4	
100% N eq. VC+rec. P_2O_5	22.28	20.1	80208.0	13840.4	66367.6	55.7
75% N eq. VC+25% rec. N+Rec. P_2O_5	27.05	24.3	97380.0	16572.5	80807.5	528.5
50% N eq. VC+5 0% rec. N+Rec. P_2O_5	28.45	25.6	102420.0	18698.0	83722.0	137.1
25% N eq. VC+75% rec. N+Rec. P_2O_5	31.41	28.3	113076.0	21104.3	91971.7	342.8
Recommended chemical fertilizer	31.62	28.5	113832.0	23015.6	90816.4	

GY=Grain yield, AGY=Adjusted Grain Yield, qt/ha=Quintal per hectare, GFB=Gross field benefit, TVC=Total variable cost, NB=Net benefit, MRR=Marginal rate of return. While the unit price of bread wheat at farm gate during harvesting time, urea, TSP and vermicompost during the planting time were 40, 38, 45.5 and 5 birr/kg respectively

economically beneficial and recommended for the production of bread wheat in the Horo district.

CONCLUSIONS

Even though in western Oromia region including the Horo district is agro-ecologically suitable for crop production, the wheat yield is not good enough due to low soil fertility caused by soil acidity, use of only chemical fertilizers and leaching of soil nutrients due to rainfall. The optimum productivity of any cropping system depends on an adequate supply of plant nutrients. Thus, integrated applications of inorganic and organic fertilizers are important to ensure an adequate and balanced supply of nutrients to crops. Therefore, this study was proposed to investigate the effect of integrated vermicompost and chemical nitrogen fertilizer on wheat yield, yield component and soil nutrient content and to determine the economically optimum amount of vermicompost and chemical nitrogen fertilizer for bread wheat production in Horo district.

Laboratory analysis results of soil samples collected before sowing showed a deficiency in soil chemical properties. However, post-harvest soil samples indicated significant differences and positive improvement with most of the soil fertility status tested. Moreover, the application of integrated vermicompost and chemical nitrogen fertilizer was effective in improving soil pH, available phosphorus, total, organic carbon, exchangeable acidity and cations exchange capacity. The analysis of variance among the treatments showed significant differences in the most of soil fertility characteristics and bread wheat yield and yield related parameters. The maximum grain yield (3162.30 and 3141.10 Kg/ha) of bread wheat was obtained from the fertilizer application of recommended chemical N fertilizer and 25% N equivalence vermicompost + 75% recommended N with 100% recommended P_2O_5, respectively.

However, it is not statistically different from integrated organic and nitrogen fertilizer at rates of 25, 50 and 75% N equivalent vermicompost with 75, 50 and 25% recommended chemical N fertilizer (urea) respectively with each 100% recommended P_2O_5; which indicated that bread wheat productivity in the study sites, was reduced due to high demand for external nutrient inputs. The highest net income (91971.70 ETB ha^{-1}) with an acceptable marginal rate of return (MRR) (>100%) was obtained from the fertilizer application of 25% N equivalence vermicompost + 75% recommended N with 100% recommended P_2O_5.

RECOMMENDATIONS

This integrated organic and chemical nitrogen fertilizer rate was more economically beneficial and recommended for the production of bread wheat in the Horo district. Further research has to be continued to verify and demonstrate the obtained output of integrated vermicompost and urea nitrogen fertilizer.

ACKNOWLEDGMENTS

The authors are thankful to Oromia Agricultural Research Institute (OARI) for financial support of the field and laboratory.

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