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Effects of Lime, Inorganic Fertilizer and Compost as Amendment on Soil Chemical Properties: Field Experimental Approach to Reclaim Acidic Nitisol, South Western Ethiopia

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Abstract

Soil acidity is a series problem in south western part of Ethiopia due to high rain fall that aggravate the concentration of toxic elements like Al3+ and Fe2+. This study was conducted to evaluate the effects of lime with different fertilizer sources on soil chemical properties at Seka chekorsa area. Seven different treatments were applied with randomized complete block design along three replications. The study pointed out the response of soil pH (5.01) which was increased by 91.8% when compared to control plot (4.60), H+(0.25 cmol/kg), Al3+(0.19 cmol/kg), Exchangeable Acidity (0.44 cmol/kg), Available Potassium (1.96 Cmol/kg) and CEC (22.76 Cmol(+)/Kg) were attained significantly different result at ($p<0.05$) on CompL treated plot. However, OC (2.14%) and OM (3.69%) were attained the highest result on HCHNP and TN (0.1%) and Available K (2.00Cmol/kg) was significantly different at ($p<0.05$) on HCHNPL treated plot. The combined application of compost with lime was better than other combination including solely applied treatments to enhance different soil chemical properties in most of soil parameters. The integration of lime with organic and inorganic nutrient sources generally increased soil pH when compared with sole applied and control plot. Finally, the Integration of full recommended compost and Lime of agriculture could be promising alternative to amend acidic nitosol.

Keywords: Soil Acidity; Soil Chemical Properties; Lime; Seka Chekorsa; Ethiopia

Abbreviation: CompL: Compost Plus Lime; HCHNP: Half Compost Plus Half Nitrogen and Phosphorus; HCHNPL: Half Compost Plus Half Nitrogen and Phosphorus with Lime; OC: Organic Carbo; OM: Organic Matter; TN: Total Nitrogen; Al: Aluminum; Fe: Iron.

Introduction

Agriculture plays a central role in both food availability and food quality and is also the main source of income and livelihood for 70–80% of people who currently sufer from hunger in developing countries [1]. Food production bosting is needed to feed the projected 9.3 billion global populations and 2.5 billion African populations by 2050 [2]. Declining soil fertility has continued to be a major constraint to food production in many parts of the tropical region Giday O, et al. [3] and wider areas of sub-saharan Africa [4,5].

Soil acidity is a critical issue requiring urgent attention in most highlands of Ethiopia due to its impact on crop production and productivity [6]. Recent studies have also indicated that soil acidity affects large areas of the cultivated lands in different parts of Ethiopia [7]. Soil acidity is one of the major crop production constraints in Ethiopia Oumer AM, et al. [8], covering 43% of cultivated land Kassahun B [9], Abebe M [10], of which 28% is strongly acidic. Soil acidification is a natural process that might be aggravated by human agricultural activities such as the removal of plant and animal products and leaching of excess nitrate addition of some nitrogen-based fertilizers [11].

Continuous addition of fertilizers containing Nitrogen (N) and Phosphorus (P) alone would mainly increase uptake and depletion of secondary nutrients such as sulfur and micronutrients like zinc and boron. In recent years, blended fertilizers have been introduced to include sulfur (S), zinc (Zn) and boron (B) in addition to N and P fertilizers [12]. Nevertheless, continued use of chemical fertilizer is not a sustainable solution as it may cause soil quality deterioration such as increasing of soil acidity, loss of organic matter and depletion of nutrients that are not supplied in the fertilizer formulation [13].

Lime in the form of calcium carbonate or dolomite is applied to acid soils to improve the pH, Ca concentration, Cation Exchange Capacity (CEC) and base saturation, and to eliminate Aluminium (Al) and Manganase (Mn) toxicity and Phosphorus-fixation Ano A, et al. [14] and significantly increase in Olsen P [15]. Application of OM like compost and manures provide nutrients and improve the physical properties the soil [16]. The role of composts as a complimentary amendment for improving the soil aggregation, increasing the microbial biomass, improving the moisture holding capacity, raising the CEC and pH of the soil has been recognized by various researchers [17].

Compost plays a vital role in improving soil properties such as increasing soil porosity, available water, organic matter, nutrients status, crop yields as well as lowering soil bulk density [18,19].

Nonetheless, in countries like Ethiopia large-scale use of this option is not common where animal manure and crop residues have widespread use as fuel and animal feed, labour shortage for preparation and transporting of compost given the bulkiness of compost [20].

In Jimma zone, Nitosol's are the dominant soil types and it is much utilized for crop production. There are about 6827 Km^2 of Nitosol in the zone covering about 35% of the district's landmass [21]. According to Weigel G [22] and Elias E [12], Nitosols are inherently fertile, but large areas in Ethiopia have now been depleted due to continuous cultivation, leaching and erosion.

Lithology and soils of south-western Ethiopian highlands developed along the western margin of the Rift Valley and Ghibe valley as a result of uplifting over the past 18 million years [23,24]. The underlying basement rock is of Precambrian origin which strongly folded and faulted basement rocks are mostly directly covered by Tertiary volcanic rocks that dominate the geology of the area [25]. The major reference soil groups of the south-western highland plateaus are Nitisols, Vertisols, Leptosols, Regosols, Cambisols, and Acrisols [26]. Nitisols are the dominant reference soil groups in coffee growing areas of southwest Ethiopia. Nitisols have a depth of more than 1.5 m, are clayey and red in color. The primarily occupy slopes steeper than 5%. These soils are well-drained with good physical properties; they have high water-storage capacity, a deep rooting depth, and stable soil aggregate structure. Nevertheless, rates of decomposition of organic matter and leaching of nutrients are extremely fast. Acidity ranges from medium to strong, and pH is generally less than 6 [27].

Now a days, multi-varied using organic, inorganic, lime and their combination to improve acidic nitisol fertility status as well as acidic condition reclamation is needed furthermore resaerch works. Therefore, the objective of this study was to evaluate the effect of integrated uses of lime and different fertilizer sources on soil chemical properties, at seka chekorsa, South Western Ethiopia.

Materials and Methods

Description of the Study Area

Location: The experimental site was in Melko kebele, Seka chekorsa, Jimma zone which is located on 7°29’59.99” N and 36°04’60.00” E and laid at an altitude of 1746-1770 m.a.s.l and far away 355km from Addis Ababa in South west and19km from Jimma city to south east.

Land Forms and it's use type: The landform of Seka chekorsa is hilly and rugged having dark reddish brown color developed in situ from the underlying basaltic. A survey of the land in this District showed that 45.3% is arable or cultivable (44.9% was under annual crops), 6.1% pasture, 25.8% forest, and the remaining 22.8% is considered swampy, degraded or otherwise unusable [28].

Climatic Condition: The rainfall is bimodal, and the long term (1981–2022) mean annual rainfall is 2022 mm. More than 75% of the annual rainfall is received between March and October. The long term (1981–2022) mean minimum and maximum temperature are 9.82°C and 24.5°C respectively.

Experimental Treatment and Design

The treatments were conventional compost, Inorganic Fertilizer (Urea and TSP (Triple Supper Phosphate) fertilizer), Lime and their Full recommended based combination with other amendment was applied along the control treatment. The nutrient content of those organic fertilizers' were analyzed before used on experimental site. Lime with a known mesh size was added based on the Liming rate (LR) of the soil. The lime used for the experiments was found to have a neutralization average value of 95% commercial grades with 36-39 calcium content and The mathematical model developed by Kamprath EJ [29] was used to calculate LR determination.

$$LR, CaCO3\left(g/ha\right) = \frac{cmolEA/Kgsoil * 0.2m * 10000m^2 * BD\left(mg/cm^3\right) * 1000}{2000}$$

A Randomized Completely Block Design (RCBD) was used and treatments were replicated three times. The study was conducted in open field which carefully selected for the Experiment. Randomized Complete Block design was conducted with three replications. The compost was prepared under standerdized condition for three months until manually broadcasted on the experimental site (Table 1).

S/N	Soil				Compost		
	Parameter	Value	Rating	Reference	Parameter	Value	Rating
1	BD	1.49	Moderate	(Harte (pers. comm.))	BD (g/cm^3)	0.23	
2	OC (%)	2	low	Charman PE, et al. [30]	OC (%)	19.8	-
3	Soil pH	4.59	very strongly acid	Bruce RC, et al. [31]	Soil pH	7.25	-
4	Avil.P (mg P/kg)	0.58	Very low	Holford I, et al. [32]	Avil.P (ppm)	498	-
5	Avail. K (cmol/kg)	1.23	High	Abbott T [33]	Avail.K (cmol/kg)	1580	
6	TN (%)	0.03	Very low	Bruce RC, et al. [31]	TN (%)	2.45	-
7	CEC (cmol/kg)	12	Low to moderate	Metson AJ [34]	Exc.Ca	-	-

Table 1: Some Selected Parameters Laboratory Result before Application.

Estimation of 2.16ton/ha of lime was broadcasted and then incorporated in the soil within 15cm depth, which was equivalent with 20 kg P/ha of TSP (46% P2O5 (0-46-0) was applied with the soil and the recommended rate of N (92kg/ha). Seven treatments were laid on full recommended amount of the applied compost on nitisol of jimma area is 8.1 ton/ha which drived from 9.2 and 7 ton/ha according to Gurmu S, et al. [35] and Zerssa GW, et al. [36] respectively (Table 2).

Treatments	Rate in kg/ha(ton/ha)	Treatment code
Control	No any amendments	Con
Nitrogen and Phosphorus Fertilizers	N and P (92 N and 20 P)	NP
Compost	8.1ton/ha	Com
50% Compost + 50% NP	4.05 ton/ha+(46 N and 10 p/year)	HCHNP
Compost + Lime	8.1ton/ha+2.16ton/ha	CompL
NP + Lime	(92 N and 20 P/ year)+2.16ton/ha	NPL
50%Compost+50%NP+lime	4.05 ton/ha+(46 N and 10p/year)+2.16ton/ha	HCHNPL

Table 2: Treatments and Experimental Design.
HCHNP=50%Compost+ 50% Urea and TSP, NPL= urea and TSP +Lime, COMP=Compost, NP=Urea + urea and TSP, CON=Control, COMPL=Compost +Lime, HCHNPL=50% Compost+50% Urea and TSP + Lime.

Soil Sampling Procedure and Analysis

Representative soil samples were collected at a depth of 0-20 cm from unplowed plots before treatments were applied and after harvest. Laboratory analysis was done in Jimma Agricultural Research Centre by following standard procedures.

Soil pH was measured by using digital pH meter in 1:2.5 and the electrical conductivity (EC) of soils was measured from a soil water ratio of 1:5 by electrical conductivity method [37]. The Walkley A, et al. [38] wet digestion method was used to determine soil carbon content and percent soil OM was obtained by multiplying percent soil OC by a factor of 1.724. Total N was analyzed using the Kjeldahl method as described by Walkley A, et al. [38] and the Bray RH [39] method was the most widely used for Available P extraction under acidic range of pH. Cation exchange capacity (CEC) and exchangeable bases (Ca, Mg, K and Na) were determined after extracting the soil samples by ammonium acetate (1N NH_4OAc) at pH 7.0 [37]. Exchangeable Ca and Mg in the extracts was analyzed using atomic absorption spectrophotometer, while Na and K were analyzed by flame photometer [37]. Percentage base saturation (PBS) was calculated by dividing the sum of the charge equivalents of the base-forming cations (Ca, Mg, Na and K) by the CEC of the soil and multiplying by 100. Exchangeable acidity was determined by saturating the soil samples with potassium chloride solution and titrated with sodium hydroxide as described by SAS System for Windows [40].

Statistical Data Analysis

Soil analytical data were subjected to the analysis of variance using the general linear model procedure of the statistical analysis software with 9.2 versions [41]. The least significance difference (LSD) test was used to separate significantly differing treatment means after main effects were found significant at P < 0.05.

Result and Discussion

Effects of Compost, Inorganic Fertilizers, Lime and Their Different Rate of Combination on Soil Ph and Exchangeable Acidity

Across all treatments, soil treated by COMPL was recorded highest pH (5.01) value whereas, lowest for NP (4.6) treated plot even when compared to control treatments (4.61). All the results of soil pH of the study site were rating as very strongly acidic according to [31]. The statistical analysis showed that Soil pH-H_2O was varied significantly at (P<0.05) across the all treatment (Table 3). This high rate of soil acidic might be due to losses of basic nutrients because the study was conducted in high rain fall received area and depletion of by products to use for fuel and shelter purposes. Like this finding Hede A, et al. [42] reported the soil pH range declines in erratic rainfall area. All compost contained treatment showed at least numerical change in soil pH relative to control treatment. The application of the combination of compost and lime with full recommendation was increased soil pH by 9.20% when compared to compost alone applied plot and 10.6% when compared to control treated plot. This result proved that the research output of Ejigu W, et al. [43] which stated as Soil pH increased, while exchangeable acidity and Al levels reduced with increasing compost and lime.

Treatments	Soil PH	EC(dS/m)	Exch.Al3+(cmol/kg)	Exch.H+(cmol/kg)	EA cmol/kg
HCHNP	4.98±0.17a*	0.070±0.004bc	0.29±0.15 e*	0.27±0.43 de	0.56±0.46 e*
NPL	4.63±0.03cde	0.070±0.004bc	0.77±0.17b*	0.58±0.36bc	1.35±0.52bc
COMP	4.67±0.26cde	0.071±0.005bc	0.34±0.01d*	0.28±0.03cd	0.62±0.03d*
NP	4.60±0.02e*	0.064±0.003d*	0.95±0.07ab	0.93±0.19 a*	1.88±0.26 a*
COMPL	5.10±0.11a*	0.079±0.004a*	0.19±0.11 f*	0.25±0.22 e*	0.44±0.14 f*
HCHNPL	4.95±0.20ab	0.073±0.003ab	0.63±0.04bc	0.40±0.37cd	1.04±0.34cd
CON	4.61±0.16de	0.062±0.004d*	1.0±0.02 a*	0.93±0.18a*	1.93±0.20 a*
P-value	0.0001	0.0007	0.0009	0.001	0.0008
LSD(0.05)	0.18	0.0059	0.05	0.09	0.12
CV%	2.23	5.01	9.57	20.19	12.61

Table 3: Effects of applied treatments on soil pH, Soil EC and Exchangeable acidity (Mean (±) SD.
Means followed by the same letters with in column are not different statistically at P<0.05; HCHNP=50%Compost+ 50% Urea and TSP,NPL= urea and TSP +Lime, COMP=Compost, NP=Urea + urea and TSP, CON=Control, COMPL=Compost +Lime, HCHNPL=50% Compost+50% Urea and TSP + Lime.

Besides, McBride M, et al. [44], reported as increasing soil pH through liming can significantly affect the adsorption of heavy metals in soils but, separately NP treated plot was low record of soil pH which shared Kundu MC, et al. [45] report. Furthermore, declining of soil pH increased exchangeable acidity, and Al levels under plots treated with chemical fertilizers alone can be associated with an increase in hydrogen ions (H+) Singh D, et al. [46] and loss of exchangeable bases [47].

The overall treatments effect on Al3+was significantly difference at (p<0.05) Table 4 in acidic nitisol of the study area. Addition of Compost and lime with organic fertilizers had reducing exchangeable acidity, Al^{3+} and H^+ but the magnitude of their reduction varied with each of those amendments. The Al^{3+} trends among the treatments were generally similar with those of exchangeable acidity and H^+ in the study area (Table 3). COMPL combination treatment was decreased Al^{3+} concentration by -81% when compared to control plot. According to Fekadu E, et al. [48] lime and compost in conjunction could be consistent with increased soil pH, decreased exchangeable Al3+ and thereby reduced P fixation.

The value of H^+ on COMPL in experimental site was shown statistically significant difference at (p<0.05) followed by HCHNP in the study area. Likely, COMPL treated plot was reduced H^+ by -7.40% when compared to HCHNP treated plot and reduced H^+ by -73% when compared to control plot (Table 3). This might be due to mineralization of nutrient from organic fertilizers like compost and dominate the soil solution by alleviating H^+ ions from soil solutions.

Eventually, the result of exchangeable acidity value was significantly difference at (p<0.05) (Table 3). At study site the application of, compost either alone or in combination with in organic fertilizer and lime significantly reduced exchangeable acidity against to the control treatment. This result is in line with Sultana BS, et al. [49] report which pointed out that, the increase in soil pH, reduction of exchangeable acidity, and Al^{3+} with the addition of compost and lime together could be attributed to greater concentrations of exchangeable cations that can exchange H^+ , Al^{3+}, and Fe^{3+} on the surfaces of the soil.

Effects of Compost, Inorganic Fertilizers, Lime and Their Different Rate of Combination on Soil

Electrical Conductivity

The overall mean value of soil Electrical Conductivity was attained significance difference at (P<0.05) (Table 3) and control treatment recorded (0.062 dS/m) numerically lowest value of electrical conductivity followed by NP treated plot (0.064dS/m) as compared to other treatments. This value shows that the study site is ranged in low level of salinity content since the soil pH is in strongly acidic soil. The range of electrical conductivity in the study area was rating as non-saline soil because the recorded result was <2dS/m according to Richards LA [50]. However, the highest value means (0.079dS/m) was recorded in Compost-lime integrated treatment plot was relatively contained much amount of basic nutrients like calcium, Potassium, sodium and sulphates comparatively. The highest Electrical Conductivity value under Lime contained treatment plot might be due to its highest exchangeable bases like Ca and Mg whereas, the lowest EC value under control treatment plot could be associated with loss of basic cation's in a reverse after intensive cultivation for different trial with different crop. This idea confirmed by Rhoades J, et al. [51], who reported as non-saline soils, conductivity variations are primarily a function of soil texture, basic cations and cation exchange capacity.

Effects of Compost, Inorganic Fertilizers, Lime and Their Different Rate of Combination on SOM, SOC and TN

OM and OC content of soil in the study area were significantly varied (p≤0.05) across the experimental siteas shown on below (Table 4). SOM and SOC were highest (3.69%, 2.14%) under HCHNP treated plot followed by (3.45%, 2.00%) in COMPL plot respectively. According to Charman PE, et al. [30] both SOC and SOM resulted was lying between Moderate to high. In both SOM and SOC the highest result was recorded on HCHNP when compared to the control treatment because chemical fertilizers are create conducive environment for the rest parameters improvement and also, easily available in a short period of time. This idea is revealed with Zhao Z [52] who pointed out as Compost and chemical fertilizers amendment significantly increased the organic C content in soil by increasing organic C in macro aggregates (>250 μm) and micro aggregates (<250 μm) respectively.

Treatments	OC %	OM%	Avail P(ppm)	Avail k Cmol/kg	TN%
COMP	1.76±0.21^{cde}	3.03±0.36^{cde}	1.17±0.03^{abc}	1.53±0.21^{bcd}	0.046±0.02^{bc}
COMPL	2.00±0.22^{ab}	3.45±0.37^{ab}	1.44±0.32^{a*}	1.96±0.15^{a*}	0.07±0.00^{a*}
NPL	1.72±0.10^{de}	2.96±0.18^{de}	1.09±0.40^{bc}	1.36±0.07^{de}	0.09±0.06^{a*}
HCHNPL	1.94±0.33^{abcd}	3.35±0.57^{abcd}	1.41±0.20^{ab}	2.00±0.26^{a*}	0.10±0.02^{a*}

NP	1.81±0.04[bcd]	3.12±0.07[bcd]	1.05±0.46[c*]	1.42±0.22[cde]	0.09±0.06[a*]
HCHNP	2.14±0.005[a*]	3.69±0.01[a*]	1.41±0.20[ab]	1.79±0.22[ab]	0.10±0.03[a*]
CON	1.53±0.10[e*]	2.64±0.17[e*]	0.57±0.06[d*]	1.24±0.30[e*]	0.03±0.02[c*]
P-value	0.0028	0.0031	0.0083	0.0001	0.007
$LSD_{(0.05)}$	0.24	0.41	0.38	0.26	0.03
CV%	7.65	7.67	19.02	9.83	21.44

Table 4: Effects of applied treatments on OC, OM, Avail.P, Avail.K and TN (Mean (±) SD.
Means followed by the same letters with in column are not different statistically at P<0.05; HCHNP=50%Compost+ 50% Urea and TSP,NPL= urea and TSP +Lime, COMP=Compost, NP=Urea + urea and TSP, CON=Control, COMPL=Compost +Lime, HCHNPL=50% Compost+50% Urea and TSP + Lime.

Effects of Compost, Inorganic Fertilizers, Lime and Their Different Rate of Combination on Available Phosphorus, Available Potassium and Total Nitrogen

The available phosphorous (APh) value on the study site was significantly different at (p<0.05) and ranged from 0.57ppm to 1.44ppm in control and COMPL treated plot respectively (Table 5). The available phosphorus on the COMPL treated plot was increased by 152.6% when compared to control treatment. According to Tes home B, et al. [53], application of compost with intermediate rate of lime and high rate of P increased the residual available P the highest of all. However, according to Holford I, et al. [32] the available phosphorus in the study site was ranged in very low level. This could be due to P-fixation problem in high rainfall received area. This result shared the idea of Johan PD, et al. [54] who concluded as soil pH of below 5.5, P precipitates with both Al and Fe ions.

The result of available potassium has shown significantly different result at (p<0.05) in the study area (Table 4). The result on experimental site ranged from 1.24 to 2.00cmol/kg in control and HCHNPL treated plot respectively. Thus, HCHNPL treated plot increased Available K by 61.3% when compared to control plot and rated as high value according to Abbott T [33]. Available K has tendency to fixed by clay minerals but, the textural class of the study site is sandy clay which has less capacity to fix the available potassium.

TN responses received significantly different value at (p<0.05) in HCHNP and HCHNPL treated plots (Table 4) and the result was ranged from 0.03-0.1% which implies increased by 233% when compared to control plot. However, still the content of TN in the study area is laid below the optimum or and, very low to low level according to Bruce RC, et al. [31].This could be due to susceptibility of Nitrogen element to leaching under heavy rainfall condition. The finding of Abebe Z, et al. [55] also revealed that, the cumulative rainfall distribution is highly favor N losses through runoff and leaching.

Effects of Compost, Inorganic Fertilizers, Lime and Their Different Rate of Combination on Cation Exchange Capacity (CEC)

Cation exchange capacity (CEC) value a significantly varied at (P<0.05) across the treatment on experimental site (Table 5). The value of CEC ranged from 12.72 cmol/kg on control treatment plot to 22.76 Cmol/kg on COMPL treated plot. Thus, the value of CEC in COMPL treated plot was increased by 78.93% when compared to control plot. This might be due to relative improvement of soil pH in COMPL plot and the environment is conducive to retain and exchange cations in soil solution. The soil CEC in the study site before treatment was poor because of leaching problem as well as low CEC content of Nitisol in nature. The relevant report was done by World reference base WRB IW [56], which stated as the clay assemblage of Nitisol is dominated by kaolinite which has the CEC value of 3-15Cmol (+)/kg. The mean value of CEC rated as low to moderate in all experimental plots according to [34].

Treatments	CEC(Cmol(+)/Kg)	Ca^{++}(cmol(/kg)	Mg^{++}(cmol/kg)	K^{+}(cmol/kg)	Na^{+}(cmol/kg)	PBS
COMP	18.88±4.62[ab]	8.29±3.60[ab]	1.10±0.48[d*]	0.23±0.05[a*]	0.056±0.006[abc]	51.25±10.70[ab]
COMPL	22.76±2.63[a*]	11.31±2.05[a*]	1.5±0.27[a*]	0.28±0.02[a*]	0.063±0.005[a*]	57.78±3.58[a*]
NPL	18.63±1.12[ab]	8.09±0.88[ab]	1.07±0.12[d*]	0.21±0.09[a*]	0.056±0.006[abc]	50.61±2.34[ab]
HCHNPL	22.38±2.71[a*]	11.02±2.12[a*]	1.46±0.28[b*]	0.28±0.04[a*]	0.060±0.000[ab]	56.99±3.83[a*]

NP	15.08 ± 0.59^{bc}	5.32 ± 0.46^{bc}	$0.71\pm0.06^{e*}$	$0.21\pm0.09^{a*}$	0.053 ± 0.005^{bc}	$41.73\pm1.58^{b*}$
HCHNP	$22.76\pm2.63^{a*}$	$11.00\pm1.05^{a*}$	$1.50\pm0.27^{a*}$	$0.28\pm0.03^{a*}$	0.056 ± 0.006^{abc}	$57.23\pm3.41^{a*}$
CON	$12.72\pm2.59^{c*}$	$3.48\pm2.01^{c*}$	$0.46\pm0.26^{f*}$	$0.11\pm0.011^{b*}$	$0.050\pm0.000^{c*}$	$30.80\pm11.43^{c*}$
P-value	0.0048	0.0047	0.0048	0.013	0.124	0.0006
$LSD_{(0.05)}$	4.94	2.84	0.25	0.08	0.008	5.28
CV%	14.76	20.42	20.45	20.18	8.49	11.84

Table 5: Effects of applied treatments on CEC, Exchangeable bases and PBS (Mean (±) SD.
Means followed by the same letters with in column are not different statistically at P<0.05; HCHNP=50%Compost+ 50% Urea and TSP,NPL= urea and TSP +Lime, , COMP=Compost, NP=Urea + urea and TSP, CON=Control, COMPL=Compost +Lime, HCHNPL=50% Compost+50% Urea and TSP + Lime.

Effects of Compost, Inorganic Fertilizers, Lime and Their Different Rate of Combination on Exchangeable Bases (EB) and Percentage of Base Saturation (PBS)

The average value of exchangeable Ca and Mg had statistically significant difference at (p<0.05) (Table 5). Both Ca and Mg parameters recorded the highest value in COMPL treated plot and increased by (225%, 226%) respectively when compared to control plot. Because calcium carbonate (agricultural lime) treated plots were increased Ca and Mg nutrient content through increasing soil pH via avoiding acid characterized elements like Al and Fe in acidic soil of the study site. Similar research result was reported by Fageria NK, et al. [57], who reported that lime application raises soil pH, base saturation, and Ca and Mg contents, and reduces aluminum concentration in acidic soils. Besides, Ca and Mg are the most dominant basic elements on exchangeable site compared to the other exchangeable cations (Table 5). Because the content of those elements are mostly significant to change the status of the soil when compared to K+ and Na+. This one was proved Brady N, et al. [58] report, which disclosed as exchangeable Mg commonly saturates only 5 to 20% of the effective CEC and 60 to 90% typical for Ca in neutral to somewhat acid soils. The average value for exchangeable K in the study area was shown significance variation (Table 5). It's value was ranged from 0.11cmol/kg (control) plot to 0.28cmol/kg (COMPL, HCHNP and HCHNPL) plot which is increased over by 154.5% when compared to control treatment. This might be due to the application of different amendments like lime, organic and inorganic fertilizer which used to highly tied exchangeable K on clay or OM site and save from leaching since the element is among easily leachable cation's. Shared the idea of Landon JR [59] who stated as the increment of value of Exchangeable K in the soil is used as deficiency threshold level for both soil Ca and Mg in tropics.

Percentage of Base Saturation (PBS) was recorded very highly significant change at (P<0.05) (Table 5). The PBS was high in COMPL treated plot (57.78cmol/kg) whereas Control plot was contained the least (30.80cmol/kg) PBS value. The COMPL treated plot was increased PBS value over by 88.5% when compared to control treated plot. Because, COMPL treated plot was expected to have dominant basic cation elements like Ca and Mg which directly increase the content of PBS in the study area. However, the founded result on experimental site was rated as low to moderate level according to Metson AJ [34].

Conclusion and Recommendation

According to the result of the study, acidic status of the nitisol across the plot is under series acidic problem (4.6-5.01) soil pH which ranges as very strongly acidic condition. Almost all of the disclosed results of the chemical properties of the soil were below optimum level which tends to limit the productivity of the soil. However the integrated use of more than two various rates of organic nutrient and NP fertilizers with agricultural lime are better than the application of either NP fertilizers or organic manure solely use. For Instance, the effects of COMPL on pH(5.01), EA(0.44cmol/kg), CEC(22.76cmol/kg), Ca^{++}(11.31cmol/kg), Mg^{++}(1.5cmol/kg), K^{+}(0.28cmol/kg), and Na+(0.063 cmol/kg), HCHNP impacts on OC (2.14%), OM (3.69%), TN (0.1%) and HCHNPL treated plot on Available K (2.00 cmol/kg) were significantly affect the parameters. Therefore, advanced dose of lime with different organic fertilizer is highly needed to boost up crop Productivity in strongly acidic area. From the recorded result across the study area, Compost-lime combination might be recommended as best treatment to increase selective soil chemical properties parameter. Any Extension Programmes on soil fertility/nutrient management should be promote low income communities regarding to integration use of organic and inorganic fertilizers with lime combination. Long term effects of those amendments must be checked since, this research was limited to one season impact assessment.

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