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Research Article

Better Barley Yield at Hankomolicha Sidama Zone, Ethiopia

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Abstract

Soil acidity is one of the major yields limiting factors for crop production in the Southren of Sidama Region, Ethiopia. A study experiment was done on acid soils to assess the ameliorating capacity of lime when applied in split application and its effects on Barley yield and selected soil properties in the study area. And The treatment was arranged five levels of lime such as control (T1):(without any input), (T2):(25% of the full dose of lime, 25% of the dose applied in the first year, 25% in the second year, 25% in the third year and the rest 25% in the (T3) 33% of the dose applied in the first year, 33% in the second year and the rest 33% in the third year, (T4) 50% of the dose applied in the first year and the rest 50% in the second year, (T5) 100% of the Full dose of lime apply on each treatment based on the experimental objectives, and laid out in a randomized complete block design with three replicates. Lime requirement was determined based on exchangeable acidity of the soil. Soil analysis revealed that split lime application at different year raised soil pH from 4.73 to 5.07 and reduced the exchangeable acidity from 1.09 - 0.74 cmolc/kg of soil. Likewise yield of Barley was significantly affected by the treatments. In order to reduce the large amounts of lime at once, split application of lime also gave similar higher yield of Barley as that of at 33% of the full dose split lime application. However, for sustainable and drastically increments of productivity of barley production in Hankomolicha southern Ethiopia. 33% of the full dose of split lime application had shown positive response on soil reaction and Exchangeable acidity. Therefore, application of lime at once is un-affordable due to large amounts required per hectare of land and split application of lime could be considered as an alternative option for poor resource farmers for sustainable soil health and crop productivity.

Keywords

Soil Acidity, Split Application of Lime, Barley Yield, Soil Properties

1. Introduction

Land degradation, including soil acidity, poses a significant threat to future agricultural production in Ethiopia [1]. One of the major chemical degradations affecting the highland soils of the country is soil acidity. This issue can arise from leaching due to high rainfall, the uptake of cations such as calcium (Ca^{2+}) and magnesium (Mg^{2+}) by plants, and the application of acidifying nitrogen fertilizers like diammonium phosphate (DAP) and urea.

Soil acidity negatively impacts soil productivity by influencing nutrient availability and causing toxicity from elements like aluminum (Al) and manganese (Mn). Most essential plant nutrients become less available, while certain micronutrients become more soluble and toxic. These problems are particularly severe in humid tropical regions with highly weathered soils [12]. As soil pH drops below 5.5, it becomes increasingly difficult to grow various crops. High acidity

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levels can lead to reduced root growth, decreased nutrient availability, impaired crop protection activities, and ultimately reduced crop yields or crop failure, as well as the deterioration of soil physical properties [10]. Soil acidity affects the biological, chemical, and physical properties of the soil, undermining the sustainability of crop production. Future agricultural production in the nation is greatly threatened by land degradation, particularly soil acidity, which is exacerbated by high rainfall, plant uptake of cations, and the use of acidifying fertilizers

Barley (Hordeum vulgare L.) is one of the most important cereal crops globally. In Ethiopia, it ranks as the fifth most significant cereal crop, following teff (Eragrostis tef), maize (Zea mays L.), sorghum (Sorghum bicolor L.), and wheat (Triticum aestivum L.) [20]. Barley serves as a staple food grain for Ethiopian highlanders, who cultivate the crop using indigenous technologies. Various parts of the barley plant are utilized to prepare traditional foods such as Kita, Kolo, Beso, Injera, and the local beverage called tela. Additionally, barley is an important raw material for many industries [9].

However, the major production of barley still largely depends on traditional varieties and farming practices, which contribute to its low yield. The cultivation of barley in marginal areas characterized by low soil fertility, high soil acidity, and challenges with diseases and pests further reduces the crop's yield levels. Consequently, current barley production in Ethiopia is insufficient to meet the demands of the rapidly growing population.

Yield losses exacerbated by soil acidity or aluminum (Al) toxicity and related factors range from 25% to 80% [11]. Low pH significantly affects nutrient fixation and availability within the soil, and the abundance of acidic cations in the colloidal soil solution can be cytotoxic to plant growth, resulting in reduced crop yields [23].

Liming of acidic soils has been suggested as an effective method to enhance crop cultivation in the highlands, as the application of lime improves the availability of essential nutrients (calcium, phosphorus, and molybdenum), enhances biological processes, and reduces the solubility of toxic elements like aluminum (Al^{3+}) and manganese (Mn^{2+}). This, in turn, promotes root development and improves water and nutrient uptake [13, 14].

However, lime is not easily obtained or free, and severely affected areas may require large quantities, making transportation challenging. Therefore, this study was conducted to evaluate the efficiency of split lime application in ameliorating acidic soils and improving wheat yield over three consecutive main growing seasons under rainfed conditions in the Gummer district of southern Ethiopia. [24], split application of lime is an effective approach for acid soil amelioration and improving crop yield, as it helps achieve and maintain suitable exchangeable acidity levels for various crops. The benefits of split lime application include improved nitrogen fixation, enhanced availability of essential nutrients such as calcium, phosphorus, and molybdenum, and reduced solubility of toxic elements like aluminum and manganese. [6], also highlights that the overall reactions involved in the split application of lime in acidic soils include the dissolution of alkaline materials, which consume protons, leading to the polymerization and precipitation of ionic aluminum and manganese. The initial reaction of calcium carbonate (CaCO3) results in a rapid increase in soil pH and ionic calcium (Ca), as the active acidity is neutralized. As soil pH and ionic Ca increase, the retention of calcium on the soil exchange complex is favored, leading to the expulsion of aluminum (Al^{3+}) into the soil solution. The expelled Al^{3+} undergoes hydrolysis, transforming into less available forms at higher pH. The protons generated during the hydrolysis of Al^{3+} are consumed as calcite continues to dissociate.

$$LR, CaCO_3\ (kg/ha) = \frac{cmolEA/kg\ of\ soil * 0.15\ m * 10^4\ m^2 * B.D.(Mg/m^3) * 1000}{2000} \quad (1)$$

In Ethiopia's highlands, where soil acidity is prevalent, barley (Hordeum vulgare L.) is the most commonly produced grain crop. Barley production occupies a total area of 1.2 million hectares, with a national average productivity of 2.35 t/ha [7]. Soil acidity is regarded as one of the most significant barriers to barley production in these regions, and the issue remains inadequately addressed. As a result of high soil acidity, many small-scale farmers have virtually abandoned barley farming. To mitigate soil acidity and promote fertility, farmers often employ a rotation system involving barley, simple fallow, and oats [16].

Under acidic conditions, iron (Fe) and aluminum (Al) oxides/hydroxides react with phosphorus (P) to form insoluble phosphates, reducing phosphorus availability to plants [5]. Consequently, phosphorus deficiency often coexists with aluminum toxicity in these soils. Efforts to alleviate the negative impacts of soil acidity must be paired with measures to enhance soil phosphorus availability. Although split lime application to acid soils has been widely used as an amelioration strategy to improve crop production for many years, it is rarely implemented in Ethiopia.

As Ethiopia's population rapidly increases, the demand for agricultural products also rises. However, food production growth has not kept pace with this population pressure. Strengthening the country's food production capability by utilizing its existing human and natural resources is crucial. Among the various strategies to boost agricultural development, addressing the degradation of areas that have become unproductive due to soil acidity is a top priority. Thus far, research has given insufficient attention to this pressing issue and the urgent need for remediation to mitigate its harmful effects and enhance contributions to food security and poverty eradication efforts.

The goal of this experiment was to determine the impacts of split lime application on barley yield and selected soil parameters in the study region, as well as to analyze the ameliorative capabilities of lime when applied in splits.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted at FTC of Hankomollicha district, Sidama region, Ethiopia. The district is located at a distance of 356km south of Addis Abeba. The study area is Geographically located on latitude of at 6^0-9' N and $35^0$3'E. The Former altitude of 3050 m.a.s.l and the later has altitude 2850 m.a.s.l. The major rainy seasons in the district from April-November. The mean annual temperature in (℃) and rainfall in (mm) in the area is 12.6-22.5 ℃ and 1401-1600 mm respectively. The dominant soil type of the woreda is nitisols, clay loam. These soils have relatively good agricultural potential. The major crops of the area where barley, Faba bean wheat, oilseeds, and pulses.in general and the study area in particular is Nitisols according to [8]. soil classification system.

The study was conducted for four consecutive years during (2015 to 2019) main cropping seasons at Hankomollicha in southern Ethiopia. Hankomollicha is the Southern Sidama Regional State. It is located 356 km south of Addis Ababa.Treatments and Experimental Design a factorial combination of five level of split lime at rate of (0, 25%,33%,50% and 100%) with totally twenty treatment combinations were laid out in a randomized complete block design (RCBD) with four replications. A high yielding variety named HB-1307 was used as test crop at seed rates of 125 kg/ha^{-1}. The plot size was used was 4*3.5m (14m^2) all treatments plots were hand weeded at 30 and 60 days after sowing. The amount of lime was applied at each level was calculated on the basis of the mass of soil 15 cm hectare- furrow- slice, soil sample density and exchangeable Al^{+3} and H^{+1} of each site. assuming that one mole of exchangeable acidity was neutralized by equivalent mole of $CaCO_3$. The recommended rate of NP was applied uniformly to all treatment. Lime was applied broadcasting uniformly by hand and incorporated in at each level of split form.

2.2. Soil Sample Preparation and Laboratory Analysis

Composite surface (0 to 20 cm) soil samples were collected from each plot and analyzed for soil physical and chemical properties during the initial year and subsequent alternate years. An auger was used to sample five randomly selected spots per plot. These sub-samples were thoroughly mixed, homogenized, air-dried under shade, ground, and passed through a 2 mm sieve.

Soil samples were randomly collected prior to experimentation and after harvesting for analysis of soil pH and exchangeable acidity. Soil pH was determined using a pH meter in a 1:2.5 soil/water suspension, and exchangeable acidity was extracted using 1M KCl [15].

The samples were then analyzed for soil pH, organic matter, total nitrogen (N), cation exchange capacity, available phosphorus (P), exchangeable acidity, exchangeable aluminum (Al), manganese (Mn), as well as zinc (Zn), copper (Cu), iron (Fe), and boron (B). Additionally, percentage acid saturation, aluminum saturation, and effective cation exchange capacity were calculated.

The collected soil samples were air-dried, crushed, and passed through a 2 mm sieve for analysis of selected soil physico-chemical properties, following the standard procedure outlined in the EIAR soil laboratory analysis guide. Soil bulk density of the top 0-20 cm layer was determined using the core sampler method [22]. Soil pH was measured by potentiometric methods at a 1:2.5 soil-to-water ratio [21]. Exchangeable acidity (Al and H) was assessed in 1 M KCl extracts titrated with 0.02 M NaOH [18]. Soil organic carbon (OC) was determined using the [23]. wet digestion method, with percent soil organic matter (OM) calculated by multiplying percent soil OC by a factor of 1.724, based on the assumption that OM is composed of 58% OC.

Total nitrogen was analyzed using the Kjeldahl digestion, distillation, and titration method [3]. Available phosphorus was measured using the standard Bray-II extraction method [4]. Exchangeable cations (calcium, magnesium, potassium, and sodium) were determined after extracting the soil samples with 1N ammonium acetate solution at pH 7.0. Exchangeable calcium and magnesium in the extract were measured by atomic absorption spectrophotometry (AAS), while potassium and sodium were determined using a flame photometer [18]. Cation exchange capacity was assessed from the same soil that was leached with ammonium acetate, through distillation and titration of ammonia [2]. The laboratory analysis was conducted at the Holeta Agricultural Research Center soil fertility laboratory.

Data were collected on barley grain yield and yield components. At crop maturity, the whole plot area (22.95 m^2) was hand harvested at ground level from each plot for determination of grain yield and biomass yield. Grain yield has adjusted to 12.5% moisture content. Soil samples were randomly collected prior to experimentation and after harvesting for analysis of soil pH and exchangeable acidity. Soil pH was determined by using a pH meter in a 1:2.5 soil/water suspension using pH meter, and exchangeable acidity was extracted by 1M KCl [17]. The collected data were statistically analyzed using SAS computer software version 9.4 E. For those parameters in which their ANOVA results found to be significant, further means separations were done using least significant difference (LSD) at 5% probability level.

The lime recommendation on this study was based on the amount of exchangeable acidity measured by the lime requirement of soil test. The amount of lime applied at each level was calculated based on the basis of exchangeable Al^{3+} and H^+ of the site. The experiment was laid out by RCBD with four replications. The treatments are arranged as follows. Control (without any input), Only blanket fertilizer recommendation, 25% of the dose applied in the first year, 25% in the second year, 25% in the third year and the rest 25% in the fourth year, 33% of the dose applied in the first year, 33% in the second year and the rest 33% in the third year, 50% of the dose applied in the first year and the rest 50% in the second year, and Full dose of lime applied at one time.

The blanket recommended fertilizer was applied uniformly to all treatments. Lime was uniformly applied to the plots as per treatment by hand and incorporated into the soil a month before planting. Application of Urea was in split. The plots were reserved permanently for the duration of the experiments to observe effects of split application of lime. Initial composite soil samples collected at the depth of 0-20 cm soil before lime application were analyzed for soil pH, available phosphorus and exchangeable acidity. Similarly, after harvest soil samples were also collected from each plot and analyzed for soil pH, available phosphorus and exchangeable acidity, exchangeable bases (Ca and Mg) and Cation exchangeable capacity (CEC). Barley (HB -1307 variety) which is the main staple crop in the area was used as the test crop. The agronomic recommendation of inorganic fertilizer rate for barley in the area was used as per treatment. Soil and agronomic data were collected and analyzed. Initial lime needed for the site was 5960 kg/ha and Splited to the plots based on plot size. Based on initial soil test data, the treatments were arranged as below in (Table 1).

Table 1. *Treatment arrangements.*

Treatment	Year			
	2015/2016	2016/2017	2017/2018	2018/2019
T1	Only Fertilizer	Only Fertilizer	Only Fertilizer	Only Fertilizer
T2	0.37kg	0.37kg	0.37kg	0.37kg
T3	0.5kg	0.5kg	0.5kg	-
T4	0.75kg	0.75kg	-	-
T5	1.5kg	-	-	-

2.3. Statistical Analysis

The collected data was entered into Microsoft excel and subjected to analysis of variance (ANOVA) using SAS software version 9.4.

3. Results and Discussion

Selected chemical properties of the soil prior to the application of the treatments are presented in (Table 2).

Table 2. *Initial selected soil chemical properties and Lime Requirement.*

pH (H_2O)	Exch. Acidity (Al^{3+}+H^+)	Lime Requirement (kg/ha)
4.73	1.098	5960

Exc. acidity= Exchangeable acidity.

3.1. Effects of Split Application of Lime on Some Soil Chemical Properties

Lime application significantly influenced soil chemistry, with both split and full dose applications resulting in comparable increases in pH. According to Dawit and Haiku G. [7], all split lime applications and full-rate applications significantly increased pH ($p < 0.05$), with no notable difference between the two methods. Remarkably, the 50% application significantly reduced the exchangeable acidity of the Hankomolicha soil compared to the 33% and full dose applications.

Additionally, findings from [19]. indicated that lime application increases pH and available phosphorus (P). Overall, liming can enhance soil pH and alter the physical, chemical, and biological properties of the soil (Table 3). Analysis of variance showed that soil pH and available phosphorus were significantly increased, while exchangeable acidity decreased due to the split application of lime compared to the control and inorganic fertilizer application treatments. The split lime application slightly increased soil pH from 4.73 to 5.07 (Table 3).

The increase in soil pH and the decrease in exchangeable acidity in response to the split application of lime at different rates was approximately 5.47% over the control (no lime applied) and 2.45% over the recommended blanket inorganic fertilizer. On the other hand, the split application of lime significantly reduced exchangeable acidity from 1.098 to 0.74 compared to the control plot.

In general, while there was no significant difference among the various rates of split lime application in terms of soil pH, available P, and exchangeable acidity, the split application of lime resulted in significantly higher values for these properties compared to the control and inorganic fertilizer treatments. Liming of acidic soils can increase exchangeable acidity, enhancing the release of phosphate ions that are fixed by aluminum and iron ions into the soil solution. Therefore, applying lime through different methods is important for the effective management of acid soils.

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Table 3. Mean effects of split application of lime on selected soil chemical properties.

TRT	pH (1:2.5 H_2O)	Exch. Acidity (cmol (+)/kg soil)	Av. P (ppm)
Control	4.74	1.02	3.94
25% lime each year	4.83	0.92	4.70
33% lime each year	5.07	0.73	5.58
50% lime each year	4.92	0.81	3.57
100% full dose at once	4.52	0.98	5.14
LSD @0.05	**	**	**
C.V	0.25	2.05	0.43

Exch. Acidity=Exchangeable acidity, Av. P= Available phosphorus.

3.2. Effects of Split Lime Application on pH and Exchangeable Acidity

The increase in soil pH and reduction of soil Exchangeable acidity following application of 33% of the full dose of lime as to compare to the control one and the other treatments which are to improve soil acidity from Exchange sites. Those preliminary results the use of application of split lime alongside and mineral fertilizers to increase productivity of Barley crop production at Sidama region, Hankomolicaha condition.

3.3. Effects of Split Application Lime on Plant Height and Spike Length

Analysis of variance revealed that, application of different level of limes brings significant variation on plant height. The heights pooled mean analysis plant height was found at 33% of the full dose of lime /ha^{-1} through the statistically as compare that the control treatment (Table 3). similarly plant height from application of 33% of the full dose of lime the heights and the lowest pooled mean analysis plant height was obtained from at 33% of the full dose lime/ha^{-1} is the control treatment similarly to the analysis of variance revealed that different level of lime application to bring significant variation on spike length and the highest pooled mean analysis showed from application of different level of limes that the best result such as 33% of the full dose is the highest result as compared the control treatment. So, in this finding for the sustainable barley crop production and highland of Ethiopia is should best split application of lime is the best way of for acidic properties of soil because for economic benefits and financial benefits recommended from these findings.

Table 4. Means for plant height and spike length of barley as affected by split application of lime at Hankomolicha during 2014/2015 to 2018/2019 cropping seasons.

TRT	PH (cm)					Spike length (cm)				
	Y1	Y2	Y3	Y4	Pool mean	Y1	Y2	Y3	Y4	Pool mean
Control	73.02[a]	63.20[b]	64.15[c]	49.40[b]	62.44[b]	7.47[a]	3.20[b]	3.80[d]	19.57[d]	7.73[d]

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TRT	PH (cm)					Spike length (cm)				
	Y1	Y2	Y3	Y4	Pool mean	Y1	Y2	Y3	Y4	Pool mean
25% of full dose	80.35^{a}	83.70^{a}	82.95^{b}	63.55^{a}	77.63^{a}	6.25^{bc}	3.85^{b}	4.60^{c}	28.81^{c}	9.63^{c}
33% of full dose	73.03^{a}	88.30^{a}	97.25^{a}	69.45^{a}	82.00^{a}	6.62^{bc}	4.90^{a}	5.82^{ba}	35.83^{b}	11.70^{b}
50% of full dose	76.51^{a}	86.35^{a}	83.75^{b}	69.90^{a}	79.12^{a}	6.94^{ba}	4.70^{a}	6.45^{a}	39.57^{b}	12.63^{b}
100% of full dose	73.42^{a}	87.85^{a}	79.80^{b}	73.20^{a}	78.58^{a}	5.97^{c}	4.85^{a}	4.95^{bc}	55.13^{a}	15.17^{a}
LSD@0.05	11.38	10.54	12.40	13.71	5.51	0.81	0.82	0.90	4.72	0.95
CV	10.03	8.54	10.08	13.97	10.25	8.12	12.68	11.69	8.76	11.87
Interaction with (TRT*YR)					**					**

3.4. Effects of Split Application Lime on Above Ground Biomass and Number of Tillers

The pooled mean analysis results with showed that application of lime levels aboveground biomass was significantly ($p>0.01$) influenced by application of different level of lime (Table 5). This indicates that the effects of different level of lime. So, the maximum and minimum aboveground biomass 5.29 ton/ha^{-1} and 4.06 ton/ha^{-1} obtained at 33% of full dose of application lime ton/ha^{-1} as compare to the control treatment. similarly, number of tillers of barley yield significantly influenced by application of different level of lime rates. The highest result was obtained at 33% of the full dose of lime is the best result the control and other treatments. However, number of tillers was significantly affected by application of different level of limes. so, the maximum and minimum number of tillers 14.92 and 10.59/ha^{-1} obtained from 33% of the full dose lime level per hectares. From this research findings sustainable barley crop production on acidic properties of soil and in the highlands of Ethiopia and it should be split lime application technologies is the best way of for acidic areas.

Table 5. *Means for above ground biomass and number of tillers of barley as affected by split application of lime at Hankomolicha during 2014/2015 to 2018/2019 cropping seasons.*

TRT	AGBM ton/ha^{-1}					No of tiller (cm)				
	Y1	Y2	Y3	Y4	Pool mean	Y1	Y2	Y3	Y4	Pool mean
Control	6.90^{a}	3.02^{b}	3.89^{b}	2.43^{b}	4.06^{b}	9.12^{a}	3.60^{b}	3.25^{d}	26.40^{bc}	10.59^{b}
25% of full dose	8.05^{a}	3.97b^{a}	4.95^{ba}	3.11^{ba}	5.02^{a}	9.00^{a}	5.5^{a}	5.32^{b}	24.20^{c}	11.00^{b}
33% of full dose	7.60^{a}	4.42^{a}	5.44^{a}	3.70^{a}	5.29^{a}	9.65^{a}	5.30^{a}	6.35^{a}	38.40^{a}	14.92^{a}
50% of full dose	8.05^{a}	3.85^{b}	5.20^{ba}	3.06^{ba}	5.04^{a}	9.00^{a}	5.00^{a}	5.32^{b}	35.90^{ba}	13.87^{a}
100% of full dose	8.87^{a}	3.72^{ba}	4.82^{ba}	3.16^{a}	5.14^{a}	9.59^{a}	5.15^{a}	4.55^{c}	44.85^{a}	16.03^{a}
LSD@0.05	2.16	1.26	1.53	0.73	0.66	2.2	1.08	0.76	9.65	2.40
CV	18.22	22.14	20.98	15.69	19.22	15.90	14.60	10.11	18.87	25.55
Interaction with (TRT*YR)										**

Table 6. *Means for Grain yield and 1000 seed weight of barley as affected by split application of lime and their interaction at Hankomolicha during 2014/2015 to 2018/2019 cropping seasons.*

TRT	Grain yield ton/ha^{-1}	1000 seed weight (g)

	Y1	Y2	Y3	Y4	Pool mean	Y1	Y2	Y3	Y4	Pool mean
Control	1.70[b]	1.17[c]	1.26[c]	1.20[c]	1.33[d]	5.71[ba]	29.14[a]	43.07[a]	39.59[a]	29.38[a]
25% of full dose	1.80[b]	2.22[b]	1.93[b]	1.25[c]	1.80[c]	6.03[ba]	30.93[a]	51.35[a]	35.15[ba]	31.61[a]
33% of full dose	2.25[ba]	2.65[a]	2.81[a]	2.53[a]	2.56[a]	6.55[a]	33.53[a]	54.47[a]	35.51[ba]	33.01[a]
50% of full dose	2.30[ba]	2.34[ba]	2.00[b]	1.89[b]	2.13[b]	5.43[b]	30.37[a]	50.07[a]	41.90[a]	31.94[a]
100% of full dose	2.60[a]	2.07[b]	1.87[b]	1.66[cb]	2.05[b]	5.93[ba]	30.22[a]	49.15[a]	31.55[b]	29.21[a]
LSD@0.05	0.60	0.39	0.51	0.50	0.21	1.11	8.04	14.56	7.9	4.37
CV	18.81	12.54	17.18	19.43	15.2	12.41	17.31	19.47	13.92	19.90
Interaction with (TRT*YR)					**					Ns

3.5. Effects of Split Application of Different Lime Level on Grain Yield and 1000 Seed Weight

The analysis of variance revealed that applications of different levels of lime by splitting form bring significant variation on grain yield and 1000 seed weight. The highest pooled mean grain yield was fund at 33% of the full dose by split application of lime. Statistically as compared with the control treatment (Table 6). Similarly, Grain yield is significantly influenced by application of 33% of full dose of lime. The highest grain yield was obtaining at 33% of the full dose of split application of limes from compered to the control treatment and the others treatments. In the research findings the acidic properties of soils must be splitting lime application is the best way for this reason sustainable barley crop production and productivity and for highlands of Ethiopia. It should be split lime application is the best way of for acid properties of soil because of for economic and financially recommended from this research finding.

4. Summary and Conclusions

Soil acidity is a major yield-limiting issue for crop production in Ethiopia, particularly in the Hankomolicha southern Sidama region, where high rainfall causes basic cations in the soils to leach down. Despite the fact that soil acidity is a major problem in the study area, no research was done on split lime application for soil acidity management. As a result, the purpose of this study was to determine the ameliorating ability of lime when administered in a split application and its impacts on Barley crop yield and selected soil properties in the study region.

The results of these research findings clearly showed that those soils are responsive to splitting lime applications. Generally, the results are briefly showed that there were significant results and improved acidic soil or change in plant height, spik length, number of tillers, above ground biomass, Grain yield and 1000 seed weight. Because of splitting lime application amendment through liming. Therefore, the application of 33% full dose of lime is drastically increments grain yield of barley (Table 6). hence for sustainable crop production and productivity. However, for sustainable and drastically increments of productivity of barley production in Hankomolicha southern Ethiopia. 33% of the full dose of split lime application had shown positive response on soil reaction and Exchangeable acidity.

The findings back with the theory that liming reduces soil acidity and enhances soil chemical properties, making it more conducive to crop growth. 33% of the full dose of Split lime treatment reduced exchangeable acidity from 1.09 to 0.74 cmolc/kg of soil and elevated soil pH from severely acidic to medium range (pH 4.73-5.07). Through its ameliorative properties, it favors the establishment of a more appropriate medium for nutrient uptake by the crop indirectly. This state offers a favorable soil environment that allows for efficient fertilizer usage, resulting in improved crop yield and yield components. Liming is a technique for lowering soil acidity. They can be used separately or all at once. Split lime treatment combined with the recommended rate of inorganic fertilizer had a similar effect on Barley grain yield as did lime application all at once. To enhance Barley grain yield on acid soils in Southern Sidama region/Hankomolicha, where soil acidity is a key production restriction, farmers could use lime in split applications or all at once. Lime suggestions must be as exact as feasible, considering soils, crops, time, and location. Other options, such as planting acid-tolerant crop varieties and using organic fertilizer, could minimize the quantity of lime needed and make farming more appealing.

Author Contributions

Abreham Yacob is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Agegnehu, G. Yirga, C. and Erkossa, T., 2019. EIAR Addis Ababa, Ethiopia. Soil Acidity Management, Ethiopian Institute of Agricultural Research, 2019.

[2] Ameyu, T. (2022). Split Application of Calcium Carbonate for Acid Soil Amelioration, Soybean and Maize Performance in Acid Prone Areas of South Western Ethiopia. American Journal of Environmental and Resource Economics, 7(2), 48-52.

[3] Blake, C. A. 1965. Methods of Soil Analysis. Part I, American Society of Agronomy. Madison, Wisconsin, USA. 1572p.

[4] Bray, R. H. and L.T. Kurtz. 1945. Determination of Total, Organic and Available Phosphorus in Soils. Soil Sci. J., 59(1): 39-45.

[5] Crawford Jr, T.W., Singh, U., & Breman, H. (2008). Solving agricultural problems related to soil acidity in Central Africa's Great Lakes region. CATALIST Project Report. International Center for Soil Fertility and Agricultural Development (IFDC), Kigali, Rwanda, 1–133.

[6] CSA (Central Statistical Agency). 2014. Agricultural Sample Surveys. CSA, Addis Ababa, Ethiopia.

[7] Dawid, J., & Hailu, G. (2017). Application of lime for acid soil amelioration and improved soybean performance in Southwestern Ethiopia. Journal of Biology, Agriculture and Healthcare (JBAH), 7(5), 95–100.

[8] FAO. (2014). A regional strategy for sustainable agricultural mechanization. Sustainable Mechanization across agri-food chains in Asia and the Pacific region. Rome.

[9] Getachew A., Chilot Y. and T. Erkossa. Soil acidity management. Ethiopian Institute of Agricultural Research (EIAR). Addis Ababa, Ethiopia, 2019; pp: 21.

[10] Harter, R. D. (2002). Acid soils of the tropics. University of New Hampshire. The Pennsylvania State University.

[11] Herrero-Estrella, L. (2003). How can life sciences contribute to production under marginal conditions? In Towards Sustainable Agriculture for Developing Countries: Options from Life Sciences and Biotechnology.

[12] Kamprath EJ (1984) Crop response to lime on soils in the tropics. Soil acidity and liming 12: 349-368.

[13] `Mamo, T., & Haque, I. (1991). Phosphorus status of some Ethiopian soils. II. Forms and distribution of inorganic phosphates and their relation to available phosphorus. Tropical Agriculture, 68, 2-8.

[14] Marschner, H. (2011). Marschner's mineral nutrition of higher plants (Editor). Academic Press.

[15] McLean, E. O. 1965. Aluminum. pp. 978-998. In: C.A. Black (Ed.). Methods of Soil Analysis. Agron. No.9. Part II. American Society of Agronomy, Madison, Wisconsin. USA.

[16] Negese, W., Mosisa, T., & Mulugeta, G. (2022). Split application of lime for acid soil amelioration and better maize yield at Yubdo Districts West Wollega Zone, Oromia, Ethiopia. population, 77.

[17] Omogbohu, A., & Akinwunmi, A.E. (2007). Lime effectiveness of some fertilizers in a tropical acid alfisol. Journal of Central European Agriculture, 8(1), 17–24.

[18] Rowell, D.L., 1994. Soil Science: Methods and Applications. Addison Wesley Longman Singapore Publishers (Pte) Ltd., England, UK. 350p.

[19] Sahlemedhin Sertsu and Taye Bekele. 2000. Procedures for Soil and Plant Analysis. National Soil Research Organization, Ethiopian Agricultural Research Organization, Addis Ababa. 110p.

[20] Tessema, G., Mekuria, A., & Enyew, A. (2008). Assessment of soil acidity in different land use types: The case of Ankesha Woreda, Awi Zone, northwest Ethiopia. A thesis submitted to the School of Graduate Studies of Addis Ababa University in partial fulfillment of the requirements for the degree of Master of Science in Environmental Science.

[21] Van Reeuwijk, L. P. 1992. Procedures for Soil Analysis, 3rd Ed. International Soil Reference and Information Center (ISRIC), Wageningen, the Netherlands. 34p.

[22] Van Schoonhoven, T., & Voysest, H. (1991). Common bean: Research for crop improvement. CIAT, Cali, Colombia.

[23] Walkley, A. and I.A. Black. 1934. An Examination of the Digestion method for Determining Soil Organic Matter and a Proposed Modification of the Chromic Acid Titration Method. Soil Sci., 37: 29-38.

[24] Asmare M. Phosphorus status, adsorption characteristics, kinetics and availability to wheat crop as influenced by applications of various amendments on acid soils of Farta District, Northwestern Highlands of Ethiopia. Doctoral dissertation. Ethiopia: Haramaya University; 2014.