THE EFFECT OF TRIPLE SUPER PHOSPHATE, UREA AND LIME ON SOYBEAN (Glycine max) GROWTH RATE AND YIELD IN FERRASOLS OF KOMBEWA, KISUMU COUNTY

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ABSTRACT

Legumes play an important role in sustainable farming because of its ability to increase soil fertility. Legumes have a mutual symbiotic relationship with some bacteria in the soil that can improve levels on nitrogen in the atmosphere. Nitrogen fixation is a process of changing atmospheric nitrogen to ammonia or other molecules needed by living organisms.

Phosphorus plays a vital role in the growth and development of plants. It is needed in the molecular structure of plants and its facilitates transformation of energy and regulation

of several enzymatic activities as well. A high phosphorus supply is needed for nodulation. When legumes like soybeans dependant on symbiotic nitrogen receive inadequate supply of phosphorus they may suffer from nitrogen deficiency.

In ferrasols e.g Maseno, Kisumu county, the production of soybean has declined due to the chemical characteristics of the soil whereby they have a high iron and aluminium content which fixes phosphorus present in the soil making it inadequate for plant utilization.

The aim of this research was to assess the effect of Tri-super phosphate rates on soybean growth rate,nodulation and yield s in ferralsols.This research was laid out in complete randomized block design with two replicates and twelve treatments.The collected data was analysed using analysis of variance (ANOVA) and means separated by LSD at 5% significance level.

This study provided useful information to soybean farmers that might play a vital role in increasing the yield of soybean to meet the rising demand of soybean in Kenya.

ACKNOWLEDGEMENT

I thank the mighty LORD for this far. Through Him I have obtained access by faith into this grace in which I stand, and I rejoice in hope of the glory of God. More than that, I rejoice in my soil science undertakings, knowing that hard work and perseverance produce endurance, and endurance produces character, and character produces hope, and hope does not put us to shame.

Iam hugely indebted to Prof. Peter opala as my field supervisor and Prof. D.O Sigunga,senior Edaphologist for their generous support, and for allowing me to do my research concern.Iam particularly grateful and appreciate the very candid critical insights they gave me while undertaking this research.

Many thanks to the entire soil science Maseno University fraternity: Madam Dorcus Osanya and Linet Atieno for their laboratory support.

If at all I was in a position to better my research work, it is because I stood on the shoulders of soldiers. To you all in the aforemention, you are my soldiers, on your shoulders I stood strong.

DEDICATION

To:

Prof. D.O .Sigunga and Prof.Peter Opala,

Like all really nice people, you have a weakness for inspiring, mentoring and transforming ordinary people into great soil scientists. So after all that you have done for me, the least that I can do is to write. Here it is; with more gratitude and affection than I can well put down here. You heroes I dedicate this piece of writing, because I have to.

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CHAPTER ONE

INTRODUCTION

1:1 BACKGROUND OF THE STUDY

Soybean is a principle source of protein and micronutrients since the majority of rural population can’t afford to get protein from animals. This has led to a demand in soybean production. In western Kenya soybean production has declined due to phosphorus deficiency in ferrasols. Phosphorus is a vital nutrient element in soybean production as it assists in biological nitrogen fixation as an important energy source.

Various published research articles have discouraged N- fertilization. This is because soybeans fixes their own nitrogen through biological nitrogen fixation. Although soybean fixes their own nitrogen it is not sufficient for it to realize its full yield potential because production of soya beans is not enough to satisfy the demand for it.

Since N- fertilization is discouraged there is need to enhance the process of biological nitrogen fixation to fix enough nitrogen to satisfy the requirement needed by the soybean to realize its full potential yield. With this need to enhance the biological nitrogen fixation, phosphorus is added as a nutrient element which provides energy to be used in BNF.

1:2 PROBLEM STATEMENT

Western Kenya is the leading soybean producing regions in Kenya as it contributes to about 80% of total national production.However,over the years,soybean production in Western Kenya has continued to widen.This can be attributed to high Alluminium and Iron content leading to phosphorous fixation in ferralsols .Phosphorous is a limiting nutrient in soyabean production as it is a source of energy for nodule formation.In ferralsols,the amount of available phosphorous is largely insufficient to meet demands of soybean.

1.3 OBJECTIVES OF THE STUDY

1.3.1 GENERAL OBJECTIVE

To assess the effect of Tripple-super phosphate,lime and urea rates on soybean in ferralsols of Kombewa,Kisumu county

1.3.2 SPECIFIC OBJECTIVES

To determine the effect of TSP rates on soil pH
To determine the effect of lime on growth rate components of soybean.
To assess the effect of urea on growth rate of soybean.

1:4 HYPOTHESIS

Varying phosphorous rates had a significant effect on soybean plant height.

Varying lime rate had a significant change on soil pH.

Application of urea had significant effect on soybean growth rates.

1.5 JUSTIFICATION

Soybean is an ideal crop for improving nutrition, food security sustainable crop and livestock production system(Mahasi et al 2011). Despite its importance, soybean yields remain low in western Kenya.

Kenya has a substantial demand of approximately 150000 mt/yr (mauyo et al 2010). Despite this high demand soybean production in kenya is estimated at 8000 mt/yr, with 80% of the volume being produced in Western Kenya. Productivity however, in remains low with average yields of 3000kg/ha. (Mahasi et al, 2011). Therefore there is great need to close the gap that exists between the current yield and the yield potential to meet both local, national and international demand for soya bean.

This study provided useful information on effects of TSP,lime and urea rates on soybean growth rate(plant height and leaf number)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Characteristics of soybeans.

Soybean is a legume of the family Papilionacae,to which other well known plants belong,(Glycine max) is an annual plant upto 1.5m.Erect stems covered with thick brownish hairs.Leaves alternate,trifoliate with ovate leaflets and short penduncles.Flowers white-violet,5-6 cm long with in clusters.The fruits are pods of upto 7cm long with one to four seeds inside.They show different colours depending on the variety(mostly yellow,black or green)

2.2 Importance of soybeans

Soybeans stands out as the most popular grain legume in the world its popularity is attributed to a number of factors related to its composition and productivity. Soybean is a source of the most consumed edible oil and protein source for livestock feed.(Myaka et al,2005).

Many other soybean products are directly used for human consumption including soymilk, soya sauce, protein extracts and concentrates apart from nutritional qualities, soybean yield is higher than other common grain legumes since it has relatively few field and storage pests and diseases and it has a high nitrogen fixing ability. (vanlauwe et al 2003).

2.3 Nutrient requirements in soybean.

The demand for nutrients depend on the soybean growth stage. As the soybean plant accumulates biomass the amount of nutrients needed to support growth increases. The maximum nutrient demand occurs during seed fill since soybean seed has high levels of protein demand for nitrogen is extremely high during seed formation. Throughout the growing seasons nutrients are gathered from the soil and through nitrogen fixation, however late in the season many of the nutrients are remobilized from the older tissue to support seed development.

Nitrogen fixing plants have an increased requirement for P over those receiving direct nitrogen fertilization due to the need for nodule development and signal transduction and to p- lipids in the large of bacteriods (Graham et al, 2000).

Phosphorus is used in numerous molecular and biochemical plant processes particularly in energy acquisition storage and utilization (Epstein et al 2005).

2.4 Challenges in soybean production

2.4.1 Soil PH

Soil PH is an indication of the general chemical environment in a soil.It is a measure of the relative acidity and alkalinity.A soil of PH 7.0 is neutral,that with a PH of above 7 is alkaline .Acid soils are defined as soils with PH below 7.0 .Soil PH is the degree of hydrogen ions present in the soil and is represented by negative logarithm of hydrogen ions concentration (Haugh ,1983)

Availability of the nutrients vary with PH.Phosphorous is more available at slightly acidic and near neutral soil PH.Soil PH seldom affects soybean growth directly in ferralsols .Rather it affects the availability of phosphorous.Plant nutrients and microbial activity,incuding atmospheric N fixation by nodules.In ferralsols,the PH range from 5.0 to 6.0 and many other soil properties can affect nutrient availability.

2.4.1.1 Causes of soil acidity. (Robert D.Harter 2007)

i)Leaching of bases due to high rainfall-The bases on the cation exchange complex are replaced by acidic cations i.e Aluminium and Hydrogen

iii)Carbon(iv)oxide in the atmosphere

Rainfall combines with carbon (iv)oxide to form carbonic acid .Plants also produce carbon(iv)oxide due to their respiration processes during active growing periods,the roots can cause roots to be many times that in atmosphere.The result is an increase in carbon(iv)oxide dissolved in water hence high acidity.

ii)Application of Ammonium containing fertilisers

Modern fertilisers commonly contain ammonium as their nitrogen source,but the eventual conversion of ammonium to nitrate is accompanied by release of hydrogen ions.When urea is applied to soils,two hydrogen ions are consumed for each urea molecule decomposed.This tends to increase the PH in the surrounding soil but ammonium is converted to nitrate usable by plant.

iv)Organic matter

Decaying organic matter produces hydrogen ions that are responsible for acidity.Carbon(iv)oxide produced by decaying organic matter reacts with soil water to form weak carbonic acid.

2.4.2 Phosphorous fixation

Phosphorous availability in the soil is a major constraint to soybean production in the tropics(Allen etal…1997).In the tropics,the amount of available phosphorous in the soilsis largely insufficient to meet the demand of legumes and thus phosphorous deficiency is widespread in pulse crops (Rao etal…1998).Research shows that phosphorous is most readily available between PH 6 and 7 and its availability is governed by solubility and how readily it becomes fixed in the soil (Crocker etal… 1994)as a result of alluminium reacting with phosphorous to form insoluble phosphate precipitates.Acid soils in Kenya have low soil available phosphorous (less than 5mg P/kg)which is partly responsible for the plant yields(Okalebo etal…1997)

CHAPTER THREE

MATERIALS AND METHODS

3.1 SITE DESCRIPTION

The study was carried out at the Maseno university Research farm.It was conducted between august 20th and September 25th, 2021. Maseno lies at latitude 0 00’ 60.00” N longitude 34 35’ 59.99” E. Altitude 4934 feet. The annual rainfall is 1820 mm/yr and the soils are fairly acidic with PH of 4.5 to 6.5(B.K Waruru et.al,1994)

3.2 EXPERIMENTAL DESIGN AND MANAGEMENT

The experiment was a randomized complete block design with two replicates and twelve treatments. The twelve treatments consisting of; 30PL0N
0P60NL 10P60N0L

30P0L0N	10P0NOL	0P0L0N
0P60NL	10PL0N	30P60N0L
10P60NL	0PL0N	30P60NL

P expressed as Kgs P_2O_5 ha $^{-1}$,N as Kg Nha^{-1}

Four seeds per pot were sown .Thinning of two seedlings per pot was carried out after sowing.

Urea was used as a source of Nitrogen.

TSP wad used as a source of phosphorus .Two replicates were used

Other agronomic practices eg irrigation and weeding were kept uniform for all the treatments.

Lime was thoroughly mixed with the soil that required the treatment a day before planting. The pots were then watered to field capacity.

Replicate 1		Replicate two	
2	6	8	4
3	10	1	11
12	1	10	9
11	5	12	7
7	9	3	5
4	8	6	2

FI

Key;

1-10P0N0L

2-10P60NL

3-0P60N0L

4-0P0NL

5-0P60NL

6-0P0N0L

7-10PL0N

8-30PL0N

9-30P60N0L

10-30P60NL

11-30P0N0L

12-10P60N0L

FIGURE ONE(1)

3.3 SOIL SAMPLING AND ANALYSIS

Soil samples were collected from representative spots of the experimental location using zigzag sampling method.A representative sample was taken for initial pH reading.

3.3.1 soil pH analysis procedure used.

The soil PH procedure used was that provided by J.Robert Okalebo(1993).

3.4 DATA COLLECTION AND RESULTS

Data on plant height,number of leaves per plant was determined.

The plant height was measured from the base of the plant to the apical bud of plant and expressed to the nearest centimeters.

The number of leaves per plant was recorded.

Table 3.1:Arrangement of treatments and corresponding measurement in height(to the nearest 1.decimal point)

TREATMENT	REPLICATE ONE		REPLICATE TWO	
	WEEK ONE(cm)	WEEK TWO(cm)	WEEK ONE(cm)	WEEK TWO(cm)
10P0N0L	18.3	24.1	19.3	25.0
10P60NL	19.4	23.4	20.3	24.0
0P60N0L	15.6	17.0	15.8	16.5
0P0NL	13.1	16.7	13.8	17.7
0P60NL	14.7	16.8	13.1	15.2
0P0L0N	12.4	13.9	12.9	14.6
10PL0N	13.4	15.1	13.5	14.2
30PL0N	14.1	17.6	14.7	16.8
30P60N0L	17.6	20.2	18.9	21.1
30P60NL	11.5	12.1	11.9	13.3
30P0N0L	19.0	20.6	14.5	16.8
10P60N0L	17.6	19.1	14.9	16.2

3.5 STATISTICAL ANALYSIS

Data was analyzed using analysis of variance (ANOVA).Separation of means was done using Least significant difference (LSD at 5% sigficance level).

Table 3.2:Shows the means obtained by height of replicate 1(PHEIGHT1),Number of leaves in replicate 1(NOLEAVES1),Number of leaves in replicate 2(NOLEAVES2) and plant height in replicate 2(PHEIGHT2).

Table 3.3.Shows the comparison of selected treatments in respect to other treatments within a given replicate,and the significant levels.

ANOVA

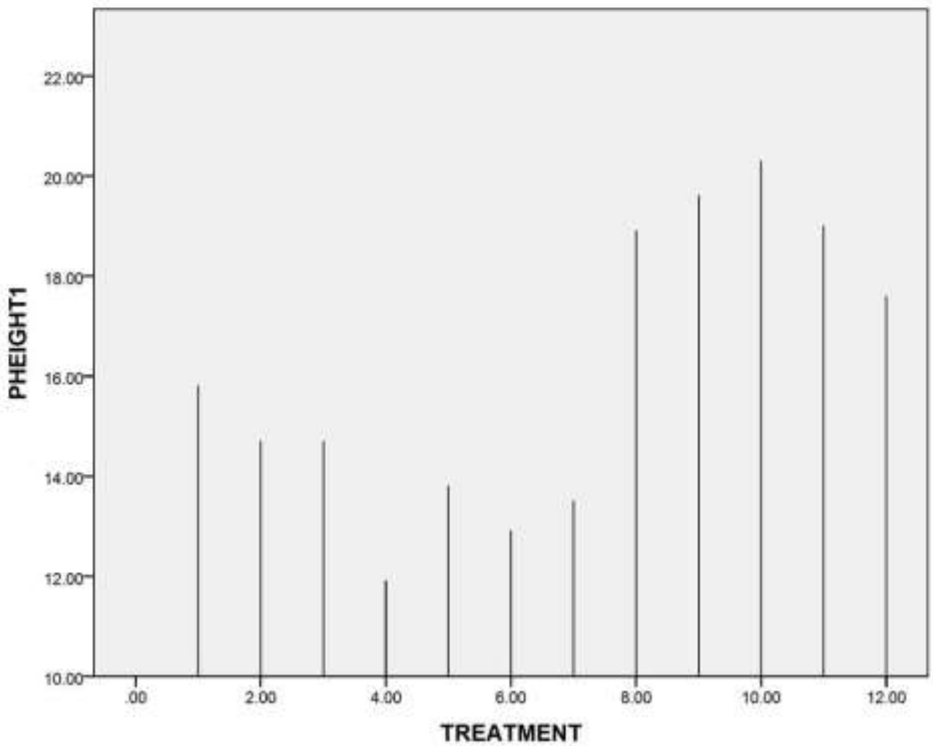
		Sum of Squares	df	Mean Square	F	Sig.
PHEIGHT1	Between Groups	150.498	11	13.682	9.224	.000
	Within Groups	17.800	12	1.483		
	Total	168.298	23			
NOOFLEAVES1	Between Groups	22.500	11	2.045	1.364	.301
	Within Groups	18.000	12	1.500		
	Total	40.500	23			
PHEIGHT2	Between Groups	285.823	11	25.984	19.476	.000
	Within Groups	16.010	12	1.334		
	Total	301.833	23			
NOOFLEAVES2	Between Groups	254.833	11	23.167	3.915	.013
	Within Groups	71.000	12	5.917		
	Total	325.833	23			

Post Hoc Tests

Multiple Comparisons

LSD

Dependent Variable	(I) TREATMENT	(J) TREATMENT	Mean Difference (I-J)	Std. Error	Sig.
PHEIGHT1	0P60NL	0P60N0L	1.80000	1.21792	.165
		0PL0N	1.30000	1.21792	.307
		0P0L0N	4.00000*	1.21792	.007
		10P60NL	2.25000	1.21792	.089
		10P0N0L	3.05000*	1.21792	.028
		10PL0N	2.25000	1.21792	.089
		10P60N0L	-2.55000	1.21792	.058
		30PL0N	-3.25000*	1.21792	.020
		30P0L0N	-4.15000*	1.21792	.005
		30P60N0L	-1.05000	1.21792	.406
		30P60NL	-.55000	1.21792	.660
	0P60N0L	0P60NL	-1.80000	1.21792	.165
		0PL0N	-.50000	1.21792	.689
		0P0L0N	2.20000	1.21792	.096
		10P60NL	.45000	1.21792	.718
		10P0N0L	1.25000	1.21792	.325
		10PL0N	.45000	1.21792	.718
		10P60N0L	-4.35000*	1.21792	.004
		30PL0N	-5.05000*	1.21792	.001

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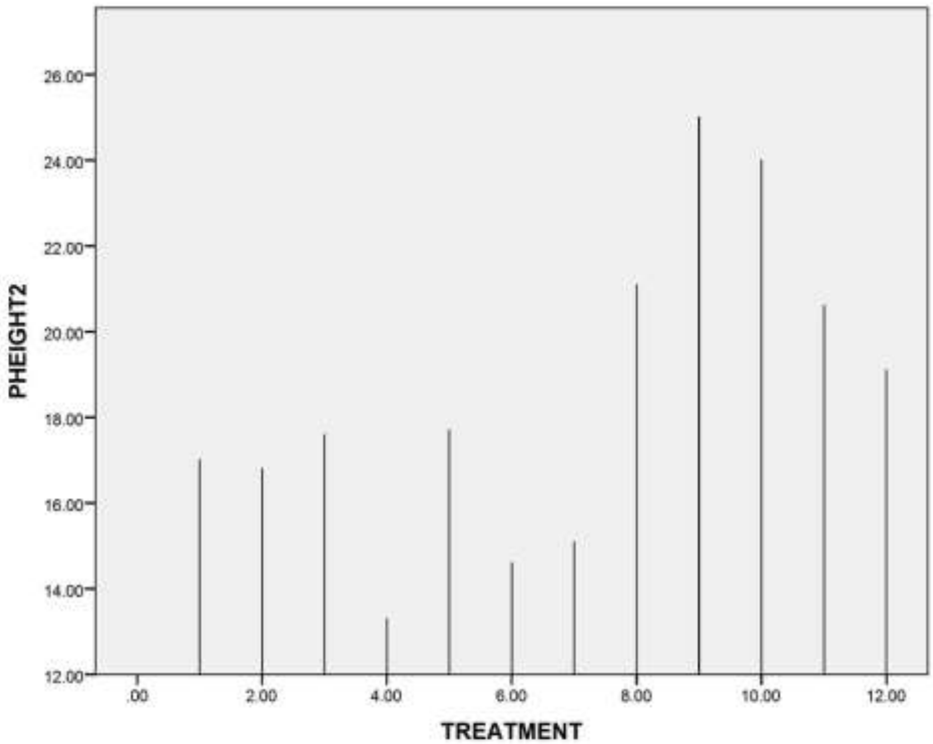


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are))
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3.2 2The graphs labeled 3.2.2. and 3.2.3 shows the graphical represantion of analysed date using ANOVA for the plant height in replicate 2(PHEIGHT2) and replicate 1(PHEIGHT1) respectively.

3.6 DISCUSSION

Note:This discussion is based on the results as per the data collected as per the time of termination of the experiment.

The level of phosphorus has been reported to have an effect on growth attributes of *Glycine max (Sharma et al 2002).S*Phosphorus application at a rate of $30P_2O_5$ significantly enhanced growth determinants and improved the plant height and leaf number.Addition of phosphorus at a rate of $10P_2O_5$ did not show much variation in the attributes but appeared inferior to P application at a rate of $30P_2O_5$.Bar et al (2010) reported that different levels of phosphorus is a key factor in governing performance of growth , yield attributes and productivity of soybean crop.Phosphorus fixation results in low P use efficiency in acid soils . Increase in soil pH through Urea hydrolysis may improve P availability and use efficiency *(Bremmer et al 1982*).Phosphorus uptake increases with added N, P uptake and use efficiency (*Barrow N, 1987)*In our experiment soybean growth rate increased with N addition which increased soil pH. In order to regulate the soil pH addition of lime was done.The addition of lime in treatments containing different rates of P and N had a significant interactions in terms of plant height in both replicates.This is in agreement with the findings of Olsen et.al 1972. Changes in soil properties due to the application of fertilizer N and P might have been of importance in understanding fertilization effects on soil nutrient availabilities. Temporary increases in soil pH caused by urea hydrolysis (Overrein and Moe, 1967; Reynolds et al., :1984; Kissel et al., 1988) could have increased molybdenum (Mo) solubility.On the other hand,pots that received only urea did not record a significant increase in yield. Acidification of soil as a result of nitrification could have led to reduced Mo solubility. Phosphoric acid that might have been produced from monocalcium phosphate dissolution could have acidified nearby soil and dissolved Al, Fe, Ca, and Mn (Lindsay and Stephenson, 1959a, 1959b; Lindsay et al., 1959). In contrast, replacement of OH from Fe or Al-oxides by phosphate anions during adsorption may have resulted in an increase of soil pH (Parfitt et al., 1975). Ion displacement could have occurred in the sorption sites if the charge of ions were the same. Among cations, NH4, Ca, Mg, K, and Al are known can replace each other (Sample et a~., 1979). Anions like OH, Cl, N03 , and S04 may also have competed for sorption sites. Interactions between Mo and other plant nutrients found in soil might have received considerable attention. Application of P fertilizer together with lime could have resulted in an increase of Mo uptake ,which has been reported (Barshad, 1951b; Stout et al., 1951; Olsen, 1972; Pasricha et al., 1977; Singh and Kumar, 1979; Gupta and Lipsett, 1981). This could be due to either enhanced physiological uptake of Mo at the root or increased soil Mo solubility. Interaction of P and Mo on Mo sorption has been reported (Barrow, 1970; Roy et al., 1986; Xie and MacKenzie, 1989, 1991). There have been several indications of Mo and fertilizer N interaction. Since Mo is required in nitrogenase and N03 reductase enzymes, N03 uptake could have been decreased in the soybean plants because of Mo deficiency resulting in a decrease in N uptake. Conversely, application of N as NH_4 could have resulted in a decrease in Mo absorbed by the soybean plants (Barshad, 1951b; Williams and Thornton, 1972; Sims et al., 1975). Molybdenum availability as weIl as the availability of other nutrients therefore may have been strongly affected by addition of urea and acidifying P fertilizer.

Initial soil was subjected to soil pH analysis where the initial pH was 4.87. After subjecting the soil to addition of P and Urea the pH was 4.5 . Acidification caused by N fertilizer from nitrification throuqh the following reaction, may have led to remobilization of nutrients in the soil itself, especially of trace elements.

$2NH_4 + 40_2 \rightarrow 2NO_3^- + 2H2 + 4H^+$.

Oconsequently, soil pH may have increased after urea application followed by pH decreases. and after addition of lime only the pH was 5.0. Addition of lime had significant influence on the soil pH. This was likely because lime increased calcium cations, displaced Al^{3+}, H^+, Fe^{3+} prevalent in acid soils.

SOURCES OF ERROR

The experiment underwent hitches in terms of time constraint whereby it did not run to completion hence other parameters were not accounted for example nodulation and yield.

The first seeds used did not germinate hence new seeds were sown therefore time was spent that would have been used for the plant germination.

5.0 CONCLUSION

From the results obtained,it can be deduced that combination of either of the factors led to a significant difference in growth parameters over the control.

The results also showed that all pots that received lime recorded an increase on soil PH(From 4.87 - 5.00).

The rise in Ph had a positive impact on growth parameters of soybean.

From the results the highest growth in height was obtained by application of (30P60NL) followed by 10P60NL.

Minimum growth in height was obtained by application of 0P0NOL.

In sum, the application of fertilizer TSP,urea and lime in the treatment enhanced plant uptake of nutrients and could have a major effect on Mo since both alter soil pH and soluble P, and may be have been involved in anion exchange.

6.0 RECOMMENDATION.

6.1:To the soil science department

This experiment was carried out under controlled greenhouse conditions. A recommendation is made that similar experiment be carried, following similar procedures, same crop and same experimental location ,to find out if there would be correlation between greenhouse and field conditions of ferrasols of Maseno.This will provide an imitation of the conditions upon which many farmers around Kombewa of Maseno produce their soybean crop.

The same time frame as indicated in this report should be considered.

6.2: To the University Research Division.

There should be future consideration to repair faulty equipments at the University soil science laboratory to avoid inconvenience. In testing some parameters such as soil p ,we had to seek the services of other departments outside the school of Agriculture and Food security. This led to inconvenience and time wasted due to logistical protocols.

There should be future plans to ensure students undertaking research are least affected by unpredicted interruptions so as to carry their research to completion.

6.3: To the Farmer

Based on the time constrained that limited our ability to carry this experiment to the end,no recommendations are made to the farmer.The future pattern of crop response to different treatment could not be predicted at the time when this report was written

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APPENDIX