**Haramaya University**

**College of Natural and Computational Sciences**

**School of Biological Sciences and Biotechnolgy**

**Biology/MBBT Program**

**Title of Senior Research project**

**THE EFFECT OF SALINITY AND FERTILIZER GROWTH OF MAIZE**

**A seiner Research Project Submitted to the Department of Biotechnology, College Of Natural and Computational Science Haramaya University in Partial Fulfillment of the Requirement for the Degree of Bachelor of Science in Biotechnology**

**Senior Research project (Biol.3102/Mobt4102)**

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**ID No:** 2039/09

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# ABSTRACT

*Salt stress is one of the most severs environmental factor that reduce and limit growth and development of plant , abiotic stress such as ,salinity , drought , temperature ,UV radiation ,heavy metal are cause drastic yield reduction in most of the crops, seed, zea may were germinated in pot contain with the treatment of NaCI solution(150mM NaCI) was the most affected than others. The result showed that salinity is most affected during germination than vegetative growth of plant maize. Salinity was inhibited germination and growth components due to ion toxicity, decreased osmotic potential and oxidative stress.*

*Maize (zea mays L, ) is one the most versatile emerging crops having wider adaptability under varied agro climatic condition and successful cultivation in adverse season and ecologies for various purpose. Globally maize is known as "Queen" of cereal because the highest genetic yield potential among the cereals .it is very important item of human consumption and also used as cattle and poultry feed beside being grown to horse and sheep .fertilizer has been a major component of improved maize production technologies being promoted by the extension package, different level of application rate of phosphorus and Nitrogen significant improved growth maize and yield. Nitrogen and phosphorus encourage plant growth which enhances early leaf initiation and development in order to assess the effect of p and N on the experiment was carried out with four treatments and three replication. Therefore, the experiment showed that growth was mostly supported with the application of rate of 7gram P and N per 4000g of soil which result in better growth performances.*

*therefore the proper amount of P and N fertilizer should be apply at critical stage and time of growth plant and in order to ensure the desirable characteristics*

# ACKNOWLEDGEMENT

First of all, I would like to thank my God who protected us in pace and healthy to come up with this work Next this I would like thank to give information for department of agricultural office for preparing such type of learning activity, our heartfelt thanks also hose to out advisor Jemal. (MSc) for this unreserved advice and being us in all ups and down while writing this senior research proposal.

# List of Acronyms

IFPRS………………………………International Food Police Resource Institute

LL………………………………….Leaf Length

g……………………………………gram

cm………………………………….Centimeter

Mm…………………………………Milimole

LL………………………………….Leaf length

N……………………………………Nitrogen

P……………………………………phosphorus

Np…………………………………. Nitro phosphate

NL…………………………………. Number of leaf

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# INTRODUCTION

## Background of the study

Salinity is a common abiotic stress factor seriously affecting crop production in different regions, particularly in arid and semi-arid regions of the world (Saleh and Maftoun, 2008). Salinity is becoming a serious problem in several parts of the world. The saline area is three times larger than land used for agriculture (Amirjani, 2010) salinity is one of the key environmental factor that limit crop growth and agricultural productivity. Total area under salinity is about 953 million ha. and covering about 8% of the land surface (Turanet al., 2010

Many social and economic problems are caused by salinity that affects the growth, productivity and distribution of plants. The most common effects of salted soil is on the delayed of germination, high rate of seedling mortality, stunted growth and reduced yield. Out of 20.2 million ha. The cultivated land in Ethiopia 4.5 million ha. Are affected with salinity (Anon, 2002). The increasing population of over 2% demands more foods shelters and resources. Of the many available approaches biological approaches appears to be long lasting and cheap solution that means to live with salinity. Introduction of salt tolerant plants on such soils will not only provide economic returns but also likely to improve these unproductive soil.

The morphological appearance presented by the plant response to salinity, may not be enough to determine its effect, so it was important to recognize other physiological and biological factors including toxic ions, osmotic potential, lack of element and other physiological and chemical disorder as well as the interaction between these various stresses (Munns, 2002). Among the cereal species, maize (Zea mays L.,) seems to be sensitive to salt stress (Maas et al; 1986).

Maize is also one of the most salt-sensitive field crops, showing obvious signs of stress, including wilting even when there is adequate soil moisture, dull leaves, and gray leaf tips (Hoque et al.,2015). However, maize is being increasingly cultivated in Ethiopia.

Present study was conducted to see the possible effects of NaCl salinity on the germination and seedling growths of crop plants, particularly maize. The findings might help enhancing the crop health of Ethiopian by utilizing the otherwise nonproductive saline habitats. According to many studies held the severity of salinity influence on plant parts also increase with an increase of its concentration (Jamil et al., 2005).

Many research carried out in relation to the effects of salinity on agricultural, forage and fuel wood species. However, little work has been done for exploring the possibility of using salted habitats for the cultivation of crop plants. The available literature includes the effects of salinity on the germination and seedling growth of Zea mays (Mutluand Buzcuk, 2007).

Hence, the present study has been carried out to assess the impact of salt stress on the primary growth of maize (Zea Mays L) Fertilizer has been amagor component of improved maize production technologies being promoted by the yield are declining soil fertility and insufficient use of fertilizer resulting depilation of soil (Buresh et al; 1997). It belong to crops which have high growth rate producing large biomass and in turn required more nutrients including Nitrogen and phosphorus (Mangle and Kirk by, 2001). Maize required adequate supply of nutrient nitrogen and phosphorus for good growth and high yield.

Nitrogen and phosphorus are very essential for good vegetative growth and grain development as well as yield in maize production. The response of maize to application of nitrogen and phosphorus fertilizer (Katsuoiro et al, 2003).adequate phosphorus results in rapid growth and earlier maturity and improve the quality vegetative growth .according to Rehman et al; (2011) nutrient P affects leaf growth and senescence dynamics in maize. Phosphorus is essential for cell division because it is a constitute elements of Nucleoproteins, which are involved in the cell reproduction processes it is important for seed and fruit formation and crop maturation.

## Statement of Problem

The production of maize was the most important attempt in yield increment. Although the production of maize in Ethiopia was played great role in economic development, however, the severity effect of salinity reduced the growth of such crops and collapse (decreased) the yield productivity (Diallo, 2002).

Particularly, the crop plants are more affected by the salinity effect. Such plants are; barely, wheat, maize, febia bean, pea, bean and other crops are affected by this severity of salinity (NaCl). Among such plants, this research was conducted on the effect of salinity (NaCl) on the growth of maize (Zea mays L.,). In growth of maize, the effect of salinity is playing a role in changing the morphological appearance and physiological, as well as decrease the yield productivity.

Matching fertilizer application rates and use of effective fertilizer materials to crop need is an essential component of optimizing crop production (Amuri et al., 2013). However limited availability of site specific fertilizer recommendation can undermine yield increment obtained fertilizer application. the need to recommended fertilizer according to the agro-ecological diversity and soil site specific conditions and climate have been reported by samling et al ,1992. in sub-tropical areas of Ethiopia, a site specific fertilizers recommendation of 75kg P and N fertilizers triple super fertilizer per hectare was reported (Mburu et al., 2011), therefore, in considering varied agro ecological condition of sub-tropical area of Ethiopia new site specific fertilizer recommendations for sub-tropical agro ecological zone are needed based on soil characteristics and crop response at Haramaya, Ethiopia in 2018.

## 1.3. Significance of the study

The significance of this study was found out the effect of salinity and fertilizer on the growth of maize and help to design intervention as distribution of salinity effect and fertilizer on the farmer and used as base line information for other studies on the same issues.

## 1.4. Objective of the study

### 1.4.1. General objective

* To determine the effect of salinity (NaCl) and fertilizer (P&N) on the growth of maize (Zea mays L.).

### 1.4.2. Specific objective

* To test the effect of different NaCl solution and fertilizer (P & N) level on the shoot length, plant height and numbers of leaf per plant.
* To test the effect of NaCl solution and fertilizer on the seed germination and length of maize

# Literature Review

## 2.1 2.1. Botany of maize

Zea mays was a genus of the family graminea (poacae), commonly known as the grass family. Maize (Zea mays L.) was a tall, monocots annual grass with overlapping sheaths and broad conspicuously distichous blades. Plant have staminate spikelet’s in long spike like racemes that form large spreading terminal panicles (tassel) and pistil late inflorescences in the leaf axils, in which the spikelet’s occur in 8 to16 roles, approximately 30 long, on a thickened, almost woody axis (cob). The whole structure was enclosed in numerous large foliaceous bracts and amass of long style (silk, protrude from the lipase a mass of silky threads (Byerlee *et al*., 2007)

### 2.1.1. Salt contamination

Water is taken up by the fine roots of plants through the process of osmosis, which involves the movement of water from region of low salt concentration (such as the soil) to regions of high salt concentration (such as the inside of root cells). When salt concentrations in soils are high, the movement of water from the soil to the root is slowed down. When salt concentrations in the soil are higher than inside the root cells, the soil will draw water from the root, and the plant will wilt and die. This is the basic way in which salinization affects plant production.

The damaging effects of salt on plants are caused not only by osmotic forces, but also by toxic levels of Na and Cl. Fruit crops and woody ornamentals are especially sensitive to high levels of these elements. Also, the high pH value (a measure of the acid or alkaline balance) caused by excess sodium may result in micronutrient deficiencies. Plants vary in their sensitivity to salt. This type of salinity is a common factor of many drought-induced humanitarian crises.

### 2.1.2 The effect of salt stress on the seed germination and plant growth

seed germination is the most in critical stage crop production on salt affected soil , generally salt stress during germination delay the start , reduce rate and enhance the dispersion of germination event (Ashraf and foolad, 2000, Fariani and Ghobadi, 2009).the early seedling growth are more sensitive to salinity than later development stage (Godsworhy, 1994). salt stress influence seed germination primarily by sufficiently lowering osmotic potential of the soil solution to retarded water absorption by seeds by causing sodium and chloride toxicity to the embryo or by altering protein synthesis in maize it sodium toxicity and not chloride toxicity that the major problem in the second phase of salt stress .salinity reduce shoot grow by suppressing leaf initiation and expansion , as well as inter node growth and accelerating leaf abscission (Rios \_Gonzalez *et al*., 2002, Akrametal 2010a, Quetal, 20012).salt stress rapidly reduce leaf growth rate (Munns 1993) due to reduction in the numbers of elongating cells and or the rate of cell elongation (Szalai and Hands 2009)

### 2.1.3. Physiological effect of Salinity

Salt stress was one of the most serious limiting factors for crop growth and production in the arid regions. About 23% of the world’s cultivated land was saline and 37% was sodium toxicity (Khan and Duke, 2001). Soils can be saline due to geo historical processes or can manmade. The water and salt tolerance, just like in oceans and seas determine the formation of salty soils, where more salts comes in than goes out. Here, the incoming water from the land brings salts that remain because there was no out let and the evaporation of water did not contain salts.

Soil salinity in agricultural refers to the presence of high concentration of soluble salts in the soil moisture of the root zone. These concentrations of soluble salts through their high osmotic pressure affect plant growth by restricting the uptake of water by roots. Salinity can also affect plant growth because the high concentration salts in the soil solution interferes with balanced absorption of essential nutritional ions by plants (Tester and Devenport, 2003).

Addition of salts to water lowers its osmotic potential resulting in decrease availability of water to root cells (Sairman *et al.,* 2002).

High salt concentration hampers vital processes such as seedling growth of maize, vegetative growth and flowering as well as fruit set. This ultimately reduces crop yield and quality of the produce (Sairman and Tyagi, 2004). The salt stresses restrict plant growth especially maize growth and hence, salt stress became an ever increasing threat to agriculture (Zhu, 2007).

According to Somani (2007), seed germination and seedling growth was a critical phase as the ability of a crop plant to germination and establishes seedling frequently becomes a limiting factor in crop production. There are many reports which indicated that seeds of most plants attain their maximum germination in water and sensitive to elevate levels of salinity at the germination and effect of NaCl salinity on the growth of plants.

Salinity appears to affect two processes: water relations and ionic relations. During initial exposure to salinity, plants experience water stress, which in turn reduces leaf expansion. During long term exposure to salinity, plants experience ionic stress, which can lead to premature senescence of adult leaves. The problem is compounded by mineral deficiencies (Zn, P) and toxicities (Fe, Al, and organic acids), submergence, deep water and drought (Gregorio, 2002). Thus the photosynthetic area available to support continued growth is reduced (Cramer and Nowak, 1992).Reduced photosynthesis with increasing salinity is attributed to either stomata closure, leading to a reduction in intracellular CO2 partial pressure, or non stomata factors (Bethke and Drew, 1992). In sum, several physiological pathways like photosynthesis, respiration, nitrogen fixation and carbohydrate metabolism have been observed to be affected by high salinity (Chen *et al*., 1986).

### 2.1.4 Effect of different level of phosphorus and nitrogen fertilizer on the growth of maize

Nitrogen and phosphorus are availability equal critical during the early stage of plant growth because the movement of Nitrogen and phosphorus to plant roots is reduced with cold soil temperature thus difference P and N are most often observed during the early part of growing season, However P and N move very little in soil and thus, available P and N as identified by soil testing indicates that no crop yield responses can be expected from additional P fertilizer (Sharpely, 1992).

The different NP combination significantly affects plant height , cob bearing plants , Number of grain per cob 100 grain weight and grain yield (Haque, *et al*., 2001) therefore , the proper management of this two nutrient elements is very important for good crop production

### 2.1.5 Effect of d/t level of phosphorus and Nitrogen fertilizer on the growth component of maize

Nitrogen and phosphorus uptake follows the same general Grande as plant growth , the maximum N uptake occurs during the month prior to tasseling and sinking , significant amount of Nitrogen are transferred from leaf tissue to grain during the grain fill processes. Phosphorus uptake is more constant throughout the season and generally parallels dry weight increase , the major objective an efficient fertilization program is to be certain that adequate P and N are available during the growing season so that supplies do not limit plant growth and yield

phosphorus improve the root growth which a great effect on the overall plant growth performance l. therefore , the regimes of P at the rate of 0kg per 4000g resulted in the shortest stature or height plant.

### 2.1.6 Effect of d/t level of phosphorus and Nitrogen fertilizer on plant height of maize.

Phosphorus play role in energy transfers chemico-physiological processes in plant (Wasilla, *et* *al*., 1984). Phosphorus is one of the most important nutrient for high yield in larger quantity (Che, *et al.,* 1995).and control mainly reproductive growth of plant (wojnowska *et al*.,1995)generally , availability of P and N to crops are soil pH, soil texture ,amount of P applied to soils presences of other elements like iron ,aluminum manganese and calcium in the soil, microbial activity and times P application (Yash, 1992) among this factor , times of P application is much important in soil either low or high PH.

### 2.1.7. Production of maize in Ethiopia

Ethiopia was the 5th largest producer of maize in Africa and small holder farmers make up 94% of the crop production. Maize was grown primarily, in the Oromia, SNNP and Amhara regions of Ethiopia. Maize plays a central role in Ethiopia’s food security. It was the lowest cost source of cereal calories providing 1 ½ times and two times the calories per dollar as compared with wheat and teff respectively. As the crop with the largest to small holder coverage at 8 million holde (Compared to5.8 million for teff and 4.2 million for wheat), maize was critical to small holder live holder in Ethiopia at 3.1 million tons and sorghum at 2.7 million tons (IFPRI, 2010).

# 3. MATERIALS AND METHODOLOGY

## 3.1. Study area and period

The study area of the general laboratory of biology department of Haramaya university was conducted from the period April 27 to May 19, 2010.Haramaya is a town in the Oromiya Regional State and it is the administrative capital city of the West Hararge Zone. The town is located approximately 360km south of Addis Ababa. The town is characterized by gentle slope from East to West. Geographically the town is located at 60 24l 30ll N latitude and 380 18l 30ll E longitude. The town covers 1123.47 hectares of land. The dominant soil type in this study area is characterized by 65% clay soil, 25% sand soil and 10% silt soil.

### 3.1.1. Study design

The study design will be cross sectional and laboratory based experiment which will be done in the general biology laboratory, department of biology, College of Natural and Computational sciences, Haramaya University.

### 3.1.2 Material and chemical used

**Material**   **Chemical**

-Pot -tap water

-soil. -distil water

-leveling paper and Ruler. -NaCI

-seed maize. P and N fertilizer

### 3.1.3. Experimental Procedure

The experiment was conducted in Haramaya university general laboratory, during the period from April 27 to May 19 in 2010

The experiment was conducted from eight seed zea mays are collected from Haramaya University of agricultural department of office. And then each seed zea mays was sterilized by chemical like sodium hypo chloride ( ) to avoided infection before seed soaking in the soil and each seed maize they were grow in the soil type ( loamy soil) which is taken from Haramaya university main campus and the whole experiment was divided into eight group including control group and then each seed maize was placed in plastic pot an each treatment was replicated three times per week .the first four group controlled in the different levels of salinity (NaCI solution )including controlling group and the rest three experimental group treated by in different levels of the application P and N fertilizer. the control group was received only water and the second, third and fourth experimental group treated with only 50mM, 100mM and 150mM NaCI salt concentration, respectively and the remain four experimental group; fifth, sixth and seventh group was treated with in different application of P and N fertilizer (1gram, 3gram, 5gram and 7gram) per 4000 grams of soil , respectively and 200mI of tap water was needed per plastic pot for every day until their finished the experiment.

Note the controlling group was used for as common for two experiment ( salinity and fertilize) effect

### 3.1.5. Data collection Method

For data was collected from seed germination up to the vegetative growth of maize parameters: plant height, leaf length, and numbers of Leaf per plant started from germination of seed after 7th days.

Plant height: was measured from as the height of plant from the soil surface to the base of tassel or newly growing shoot.

Leaf length: was measured from the leaf node up to leaf tip and the total numbers of green leaf per plant was counted included the drying leaf caused by the effect salt stress.

### 3.1.6. Data analysis

Data analysis all the result that is collected from each experiment was analyzed in the form of table and figure

# 4. Result and Discussions

The effect salinity and fertilizer on the germination time and vegetative growth of maize was observed from the experiment. The result showed that salinity is the most affected on the germination seed and growth parameters: plant height, length of leaves, and numbers of leaf per plant. But fertilizer mainly phosphorus and Nitrogen are the most important factors for growth of maize and high yield productions of crop.

## 4.1 The effect of salinity and fertilizer on the seed germination time and early seedling growth

The rate of seed germination was recorded in seven days after seed soaking in the pot contain 4000 gram of soil. Five seed was germinated obtained from the control group, and seed with in the application fertilizers at fiveth days after seed soaking. And seed with in the application of salinity 50mM, and 100mM of NaCl solution was germinated at six days and finally, last seed with high salt solution that is 150mM NaCl was germinated at eighth days. Salinity is the most affected that the during germination time of seed than early seedling growth ( Carpici *et al*, 2009) . But N and P fertilizer are not Influenced the germination of seed. The crop plant required N and P soon after germination to initiate the growth of stem, leaves and ear structure (Jones, 1995).

## 4.2 plant height

The result of plant height was measured by using centimeter from the soil surface to the tip newly growing shoot for every three days per week until the experiment finished .so, the shortest plant height (7.42 cm) was observed from the pot contained with application of 150mM NaCl solution and the medium plant height (22.35 cm) was observed obtained from the controlled group. But the highest plant height (36.82 cm) was observed obtained from the plant contained 7g of P fertilizer per 4000g of soil after seed germination at 14th days.

|  |  |  |
| --- | --- | --- |
| Treatment | Plant height (cm) | Plant height (cm) |
| Level of salinity and fertilizer | 7th days | 14 days |
| Control group | 14.57 | 22.35 |
| 50mM NaCl | 9.42 | 13.34 |
| 100mM NaCl | 8.43 | 10.54 |
| 150mM NaCl | 6.84 | 7.42 |
| 1 gram of P&N fertilizer | 18.74 | 23.56 |
| 3g of P&N fertilizer | 22.32 | 30.75 |
| 5g of P&N fertilizer | 23.85 | 33.78 |
| 7g of P&N fertilizer | 25.95 | 36.42 |

**Table 4.1** Effect of salinity (NaCI) and P and N fertilizer on plant height was recorded for 14 days after seed soaking on May 27/08/2010

## 4.3 Leaf length:

The leaf length was different in different application salinity and P and N fertilizer and the length was measured from the leaf node up to the tip of the leaf. The shortest leaf length ( 12.7cm) obtained from in the application of salinity (150mM NaCI) and the medium leaf length (26.58 cm) obtained from control group. Whereas the tallest leaf length (48.87cm) was obtained from in the application of fertilizer (5gramP and N) per 4000gram of soil at 21th days after seed soaking.

|  |  |  |
| --- | --- | --- |
| Treatment | Leaf length (cm) | |
| Level of salinity and fertilizer per 400g soil in pot | 7 days | 14 days |
| Control group | 23.5 | 26.58 |
| 50mM NaCl | 19.21 | 23.44 |
| 100mM NaCl | 16.74 | 20.58 |
| 150mM NaCl | 10.53 | 12.73 |
| 1 gram of P&N fertilizer | 29.1 | 32.95 |
| 5g of P&N fertilizer | 33.5 | 38.72 |
|  | 3 |  |
| 7g of P&N fertilizer | 38.57 | 48.87 |

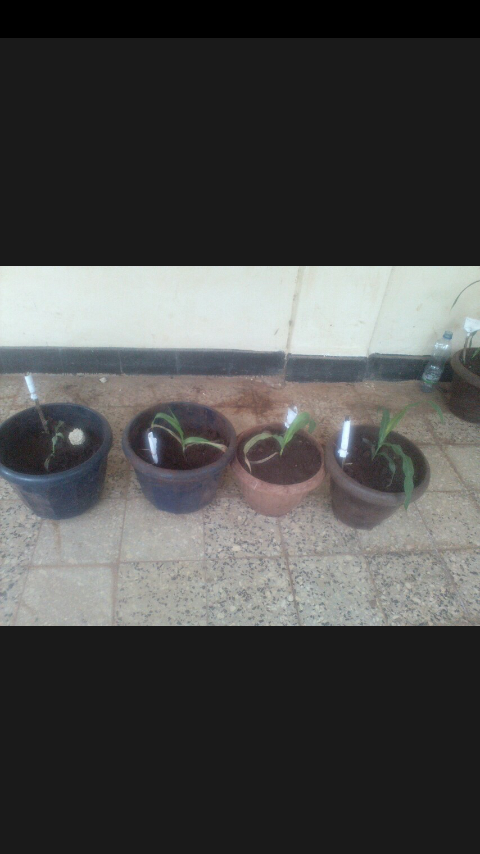
**Table 4.2:**the effect of salinity(NaCI) and fertilizer (P and N) on the length of leaf per plant growth was recoreded for 14th days after seed soaking on may 27, 08/2010

## 4.4 Number of leaf per plant growth

The total number of green leaves per plant growth and including dry leaf which is caused salt effect were counted from each plant growth per 4000gram of soil. at 21th day after seed soaking from the soil. So, low number leaf per plant growth was counted from high salt contamination (150mM NaCI) and the medium number of leaf per plant growth was counted obtained from the control group where as high numbers of leaf per plant growth was counted obtained from high amount of application fertilizer(5gram P and N ).

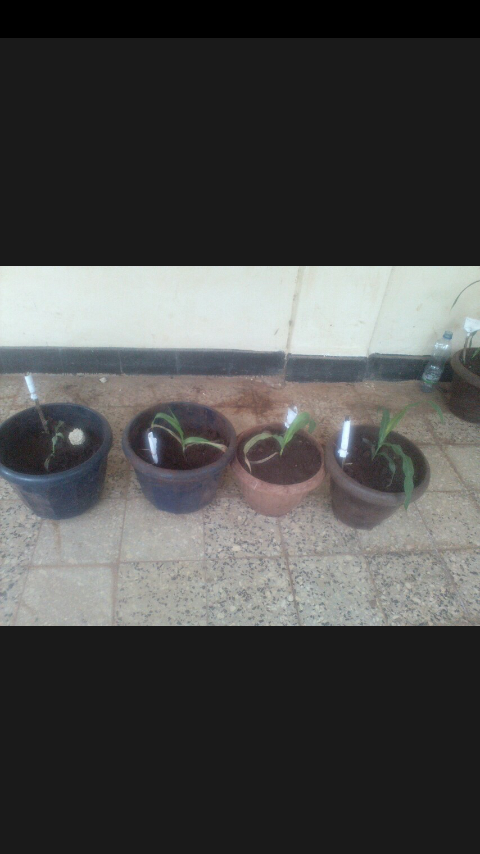
|  |  |
| --- | --- |
| Treatment | Number of leaf per plant |
| Level of salinity and fertilizer per 400g soil in pot | 14 days |
| Control group | 4 |
| 50mM NaC | 3 |
| 100mM NaCl | 3 |
| 150mM NaCl | 2 |
| 1 gram of P&N fertilizer | 5 |
| 3g of P&N fertilizer | 6 |
| 5g of P&N fertilizer | 6 |
| 7g of P&N fertilizer | 7 |

**Table 4.3:**The effect salinity and fertilizer (P and N) on the numbers of leaf per plant growth was counted at 14th days after seed germination.

4.4 Experimental observation

7g( N & P) fertilizer 5g (N & P) fertilizer 3g (N & P) fertilizer 1g (N & P) fertilizer

**Figure 4.1:**The effect of salinity on the growth of maize in 14 days after germination.



150mM NaCl 100mM NaCl 50mMNaCl control group

**Figure 4.2:**The effect of fertilizer on the growth of maize in 14 days after germination.

# 5. CONCLUSION AND RECOMENDATION

## 5.1 conclusion

The experimental study was indicates that the saline medium had an adverse affected on the germination of seed and vegetative growth of plant. The growth of NaCI medium was more pronounced in 150mM NaCI solutions compared to the control group and decreased speed of germination. Plant height, leaves, number of leaf and radical of maize in laboratory and pot experiment. Salinity effect under field condition may not be the same due to the variation in experimental and soil condition so, field experiment should be conducted to confirm the important factor for growth and yield production of crop. According to the result P and N fertilizer had highly significance effect on the growth parameter, plant height, length of leaf, numbers of leaf and grain yield.

The highest plant height, numbers of leaf, and length of leaf was recorded from the treatment in the 5gram of P and N fertilizer per 4000gram of soil in pot.

## 5.2 Recommendation

According to this experiment the society should be to apply to change the saline soil to fertile soil in order to ensure maximum growth of maize and high yield crop production. And also to maintain the soil fertility by using artificial fertilizer from animal dug and manure and use of alternative crop faming system. The farmer should be to apply 75kg of P and N fertilizer per hectare order to improve good yield product .but our work done only from growth components .therefore, the experiment should be done up to yield in different location at different time for the future to assess the detail effect of salinity and P and N fertilizer on maize further.

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