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EFFECTS OF COMPOST APPLICATION RATES AND MULCH THICKNESS ON TOMATO (*Solanum lycopersicum* L.) YIELD, QUALITY AND SOIL PHYSICOCHEMICAL PROPERTIES UNDER SALT AFFECTED SOIL OF DUGDA DISTRICT OF ORAMIA REGEON

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DERARTU WODAJO

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EFFECTS OF COMPOST APPLICATION RATES AND MULCH THICKNESS ON TOMATO (*Solanum lycopersicum* L.) YIELD, QUALITY AND SOIL PHYSICOCHEMICAL PROPERTIES UNDER SALT AFFECTED SOIL OF DUGDA DISTRICT OF ORAMIA REGEON

Submitted to School of Graduate Studies College of Agriculture and Veterinary Medicine, Jimma University, in Partial Fulfillment of the Requirements of the Degree of Master of Science in Agriculture (Agronomy)

By Derartu Wodajo Sedeta

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Jimma Ethiopia

DEDICATION

I dedicated this thesis to late my beloved mother **Tayitu Kanea**.

STATEMENT OF THE AUTHOR

By signing below, I declare that this thesis is a result of my own genuine work. I have followed all ethical principles of scholarship in data collection, data analysis, and write-up of the thesis. All scholarly matter that is included in the thesis has been given recognition through citation. I affirm that I have cited and referenced all sources used in this document. Effort has been made to avoid any plagiarism in the preparation of the thesis.

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Name: Derartu Wodajo

Signature: ------------------

Place: Jimma University

Date of Submission: ____________

BIOGRAPHICAL SKETCH

The author was born in Oromia region west wollega zone of Oromia region, on November 1989 to her father Wodajo Sedeta and mother Tayitu Kenea. She attended her elementary education from 1995 to 1999, at Abdi Amuma elementary school, and her junior school from 2000 to June 2003 at Gefersa Guje elementary school. She attended her senior secondary school and preparatory education at Ambo comprehensive Senior Secondary School from September 2003 to June 2007. Then she joined Wollega University College of Agriculture and Rural development in 2007 and graduated with a Degree of Bachelor of Science in Plant Sciences and Crop Protection in June 2010. Then, in October 2010 she was employed by the Oromia office of Agriculture and stationed in west Showa zone, Meta Robi district where she served as an expert of agronomist until she joined Jimma University College of Agriculture and Veterinary Medicine in 2014 to pursue her Master's of Science (MSc) Degree in Agriculture (Agronomy).

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LIST OF ABREVATIONS

MT/ha	Metric ton per hectare
RSC	Residual sodium carbonate
CEC	Cation exchange capacity
CRV	Central Rift Valley
EC	Electrical conductivity
Ph	Hydrogen power
ECe	Electrical conductivity of saturation extracts
Na (ESP)	Exchangeable sodium percentage
SAR	Sodium adsorption ratio
DAP	Di ammonium phosphate
PAW	Plant available water
ANOVA	Analysis of variance
LSD	Least significance difference
CEa	**A**pparent electrical conductivity
OM	Organic matter
OC	Organic carbon
AV.P ppm	Available phosphorus in parts per million
RCBD	Randomized complete block design
HCO_3	Hydrogen Carbonate
CO_3	Carbonate
FAO	Food and Agriculture Organization
NaCl	Sodium chloride
BER	Blossom end rot
MoARD	Ministry of Agriculture and Rural Development
cm	Centimeter
Kg	Kilogram
AAS	Atomic Absorption Spectrophotometer
dS/m;	deci Siemens per meter
Mmho/cm	Millimho per centimeter

OWRDB	Oromia Water Resource Development Bureau
PGRC	Plant Genetic Resource Center
GHG	Green house gas
MARC	Malkasa Agricultural Research center
EGMOA	Ethiopian Government Ministry of Agriculture

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ABSTRACT

In response to rapid population growth and the need for more agricultural products, many countries in the world are engaged in an intensive irrigation development. As these efforts, in many cases, are following injudicious uses of water, environmental challenges such as widespread of soil salinity are emerging in many instances. The Ethiopian rift valley system, where this study was conducted, exhibits this problem. Research addressing these challenges, using locally accessible material such as compost and mulch are rarely available. Thus, this study was conducted at Dugda District, Girisa Kebele with the objective of evaluating effects of compost application rate (0, 2, 4 and 6 ton/ha) and mulch thickness (0cm/ha, 5cm/ha, 10cm/ha, and 15 cm/ha) on yield and yield quality of irrigated tomato. The experiment was conducted in factorial experiment arranged in a Randomized complete block design with three replications. The post-harvest soil result indicated that Mg, Om%, CEC, Ec (ds)/m, Na, and Available (Av .P) ppm were significantly ($p<0.01$) affected by the interaction effects of compost application rates and mulch thicknesses. However, pH, TN%, OC%, and Ca are significantly ($p<0.01$) affected by the main effects of compost application rate. The interaction effects of the treatments, on the other hand, did not affect days to 50% flowering and days to 50% maturity. These variables, however, were significantly ($p<0.01$) affected by the compost application rates. The growth variables were also not significantly affected by the interaction effects of compost and mulch thickness. Except single fruit weight per plant and fruit shape index, all yield and yield component variables were significantly affected by the interaction effects of mulch thickness and compost application rate. Yield obtained from the treatment combination of 6ton/ha compost rate and 10cm mulch thickness was agronomically and economically remunerative by 15.56% for farmers. Nevertheless, because of the slow releases of nutrient from compost and organic mulch, long term effect of this rate needs further investigation.

***Key words**: Organic fertilizer, Soil Fertility, Yield, Irrigation, Economic benefits*

1. INTRODUCTION

Soil fertility is fundamental in determining the productivity of all farming systems and is most commonly defined in terms of the ability of a soil to supply nutrients to crop (Wild, 1993). Salinization and low soil nutrient content are some of the major problem that hampers crop production on smallholder farmers field. About 20% of the world cultivated land and 50% of cropland generally affected by salinity (Lakhdar *et al.*, 2009). Salt affected soil in Ethiopia is reported to cover over 11 million hectares of unproductive naturally salt affected wastelands (Tadele, 1993)**.** The natural affected areas are normally found in the arid and semi arid lowlands and in rift valley and other areas that are characterized by higher evapotranspiration rates in relation to precipitation (PGRC, 1996).With the expansion of irrigated agriculture, man's activities contributing to the build-up and spread of salinity.

The social cost of salinization is not easy to quantify as it causes occupational and geographic shifting of the farm population and reduction in aggregate national income and expenditure. These events can have social and economic repercussions on the country as a whole.

Maintenance of high crop yields under intensive cultivation is possible only with external fertilizer inputs (organic and in organic sources fertilizer). Although inorganic fertilizers application is the quickest and easiest way of increasing yield per unit area, the problems associated with inorganic nutrient supplementation, if not judiciously handled, it can causes pollution of ground water and does not improve soil structure and may early contribute to greenhouse gases (GHG) (Gordon *et al.*, 1993).

Tomato (*Solanum lycopersicumL.*) is one of the most widely cultivated crops in the world. It is an important source of vitamin A (30%), vitamin C (38%), calcium (2%), iron (3%) and is an important cash crop for smallholders and medium-scale commercial farmers (Naika S *et al.,* 2005). Tomato is widely cultivated in Ethiopia: both under rain fed and irrigated systems. Though there are also other favorable growing pockets in different parts of the country, the bulk of tomato production in Ethiopia is concentrated in the Central Rift Valleys (MoARD, 2009),

In 2013 production year, tomato production in Ethiopia was on about 7000ha and the productivity was estimated at 78571Kg/ha (FAO, 2013).

Despite this economically important position there is growing concern that the region is affected by land degradation mainly due to the rapidly growing population and lack of proper soil fertility management practices (Jansen *et al*., 2007). Many reports indicate that, in Ethiopia, and in the rift valley areas, the low productivity of vegetables including tomato, is attributed to low or depleting soil fertility, poor agronomic practices such as imbalanced fertilization (Fekadu *et al*., 2006). Additionally increasing ground water table, in some part, and soil salinity and sodicity become some of the major concerns. Large sodium content exist in the lower part of the Central Rift Valley where soil pH present from 8.5 to 10.0 (OWRDB, 2009). Although salinity and sodicity are common phenomena for arid and semiarid regions of the world, salt-affected soils have been recorded in all climatic regions and in a wide range of altitudes in Ethiopia (Tena, 2002; and Paulos *et al*., 2002)

Salt affects tomato plant growth mainly through toxicity from excessive uptake of salt substances such as sodium, reduced water uptake, known as water stress and reduction in uptake of essential nutrients particularly potassium (FAO, 2005). Similar problems were observed in the central rift valley including Dugda Bora and generally, the production is low in terms of quantity and quality. This affects not only the productivity but also the quality and associated consumer's preferences (Aleligne *et al*., 1994).

Proper soil fertility management practices may alleviate the declining soil fertility and improve crop tolerance to salinity and thus enhances crop yield and quality (Ouedrago *et al*., 2001). Complementary use of organic with inorganic fertilizer is widely known to be reliable fertility management strategy in many countries of the world (Lombion *et al.,* 1991). This emphasized that high and sustained crop yields can be obtained with judicious and balanced NPK fertilizer application combined with organic fertilizer (Makinde *et al*., 2001). Compost addition increased water content at both field capacity and permanent wilting point, increased shoot and root growth under stressed condition and also can decreases the effects of salinity by increase soil water availability and nutrient uptake by plants (Nguye *et al.,* 2013). Organic mulches containing sawdust, dry grass (lawn clippings), maize cobs, rice and wheat straw have been very effective

for vegetable growth and yield through improving water content of the soil, heat energy and add some of the organic nitrogen and other mineral to improve nutrient status of the soil.
Surface mulching has shown to reduce evaporation and decrease salinity hazards to improve crop production (Yang *et al*., 2006). This means also combined application of organic fertilizer and mulching will address the twin problems of tomato production in the rift valley system

Dugda district is the area where many smallholder farmers are producing vegetable crop by irrigation. Among these vegetables tomato, one of the most widely grown, is severely affected by salinity (personal communication). The major salts at Meki-Ogolcha area are chloride, sulphate, bicarbonate, and to some extent, the availability of nitrate salts of Na, Mg and K and cation exchange capacity of soil varied within and between profiles (Kefyalew *et al*., 2008). Vegetable growers in the central rift valley (CRV) areas are trying to amend the soil fertility of irrigated lands through application of inorganic fertilizers, crop residues and animal wastes, and use crop rotations. But, this is not common for all farmers. They use variable rate of fertilizers and crop and soil specific recommendations are rare to find (Edossa *et al*., 2013)

Even though several attempts like integrated soil fertility management (use of fertilizer, organic inputs, and improved crop varieties have been made to manage soil salinity (Vanlauwe *et al*., 2010), there are limited empirical evidences whether or not the farmers used technology such as mulch and compost to decrease the effects of salinity on vegetable product and the impact of these practices on quality and productivity. With this premises this study was initiated with the following objectives.

General objectives

- ❖ To evaluate tomato yield and quality under salt affected soil by using different rates of compost and mulch thickness

Specific objectives

- ❖ To evaluate effects of compost and mulch on soil physicochemical properties under salt affected soil

- To evaluate effect of mulch and compost on tomato yield and quality under salt affected soil
- To identify optimum compost application rate and mulch thickness for tomato production in the area.
- To identify the best economically suitable compost rate and much thickness for tomato production.

2. LITERATURE REVIEW

2.1. Causes and Signs of Soil Salinity

Salinity is the amount of salt in the soil or water. Cultivation of naturally saline lands is one of the major causes of secondary salinity. Related processes are also the inflow of mineralized groundwater (with intensive irrigation) and increase in the salt content of irrigation water particularly when drainage water disposed into irrigation canals (Shirokova *et al*., 2000). The dominant salt type in most saline soil is common salt or sodium chloride (NaCl), varying amounts of calcium, magnesium and potassium chlorides and sodium sulfates (Thomas and Morini, 2005). The ions responsible for salinization are Na^+, K^+, $Ca2^+$, $Mg2^+$ and Cl^-. When Na^+ (sodium) predominates, salt affected soil is called sodic soil (Krause and Whitfield, 2010). The types of salinity based on soil and groundwater processes are groundwater-associated salinity (dry land salinity), transient salinity (dry saline land) and irrigation salinity (water) (Rengasamy, 2010).

There are three types of soil salinity: saline-sodic soils, sodic soils and saline soils. Saline-sodic soils are like saline soils, except that they have significantly higher concentrations of sodium salts compared to calcium and magnesium salts. They have an EC of less than 4 mmho cm^{-1}, and the pH is generally below 8.5. The exchangeable sodium percentage is more than 15. Sodic soils are unsuitable for many crop production as they tend to imbalance the nutrient availability and reduce water holding capacity of soils http://AgriLifebookstore.org.

Table1. Classification of salt affected soils based on their chemical properties

Salt affected soil type	Electrical conductivity of saturation extracts (ECe) at 25 ^oC dS/m = mmho/cm	Saturation (%) of cation exchange capacity with Na (ESP)	Reaction Value (pH)	SAR	Former name
Saline	> 4	< 15	<8.5	<13	White Alkali
Saline sodic	> 4	> 15	<8.5	>13	Either of the two(black or white)
Sodic (Alkali)	< 4	> 15	8.5-10	>13	Black Alkali
Non-saline non-sodic	< 4	< 15	About neutral	<13	Normal Soils

Source US Salinity Laboratory Staff (1954)

Soil salinity measurement expected to be varied under in different soil depth (Rhoades and Ingvalson, (1971) suggested that, the depth of insertion of electrode should be not more than 25 mm for measurements within the 0-0.3 m soil depth and not more than 50 mm for measurements within the 0-0.6 m soil depth. For deeper soil, the electrodes may be inserted up to depths of 75 mm with no discernible effect.

2.2. Effect of Salinity on Tomato Production and Fruit Quality

Agricultural land salinization is becoming a major source of concern as an excess salt that hinders the growth of crops by limiting their ability to take up water (Krause and Whitfield, 2010). The problem of low productivity of saline soils may be ascribed not only to their salt toxicity or damage caused by excess amounts of soluble salts but also arising from the imbalance of organic matter and available mineral nutrients especially N, P, and K (Lakhdar *et al*., 2009).

Crop growth responds to salinity in two phases: a continuous osmotic phase that inhibits the water uptake by plants due to osmotic pressure of saline soil solution lowering its potential energy (water always moving from a higher to lower potential energy levels); and a slower ionic phase when the accumulation of specific ions in the plant over a period of time leads to ion

toxicity or ion imbalance (Munns and Tester, 2008). Most commercial cultivars of tomato are sensitive to moderate levels of salinity up to 2.5dSm^{-1}(Parida and Das, 2005).

Increasing soil and water salinity affects growth, yield and fruit quality of tomatoes (Mizrahi *et al.*, 1988). Time of fruit development is shortened by 4-15% and fruit size and juice pH is reduced by salinity (Mizrahi, 1982). Saeed and Ahmad (2009) reported a significant decrease in plant growth in chlorophyll content, plant height and vegetative biomass of tomato with increasing salinity levels in irrigation system. Hajer *et al.* (2006) have also reported reduction in plant height, fresh and dry vegetative biomass and decrease in fruit yield per plant in tomato cultivars grown under sea saline water. Similar results were observed by Mitchell *et al.* (1991) and Rahman *et al.* (2006) in tomato under saline soil, Awang *et al.* (1995) and Saied *et al.* (2005) in strawberry.

Fruits coming from plants grown in saline conditions should be handling with special care as damages due to picking, packing and transport cause higher CO2 and ethylene production than in non-salinised fruits (Hobson, 1988). Quality of tomato fruits produced under saline conditions is often adversely affected by the appearance of blossom end rot (BER).BER symptoms begin with slight browning at the distal placental tissue, which progressively invades the pericarp; besides the necrosis of the affected tissue, the fruit stops growing and starts ripening too early. Internal and external blossom end rot are caused by Ca^{+2}.deficiency at the distal placental fruit tissue. Salinity, high temperatures and low humidity causes low uptake of Ca^{+2} thus increase BER (Adams and Ho 1992).

Salt stress increased the uptake of Na, Mg and chloride ions in tomato plants. Sodium reduced the uptake of potassium due to ion antagonism. Salt stress reduces the free energy of water in soils available to plants (Flowers and Yeo, 1986), and results in negative water potential in soils (Wood and Gaff, 1989). This drop in water potential is accompanied by specific ion toxicities, deficiencies, retardation of water uptake and nutritional imbalances in plants (Greenway and Munns, 1980

Both fruit weight and fruit number showed a threshold response with a subsequent linear decrease at higher EC values. Fruit weight is more sensitive to increasing salinity. The decrease in the size of marketable fruit with increasing salinity is consistent with the reduction in fruit weight. The percentage of the smallest size fruit increased exponentially with salinity (Magan *et al*., 2008). Ghiaal (2011) reported that, salinity stressed decreased the fresh weight in Roma V.F tomato.

2.3. Benefits of Mulch and Compost Use in Saline Soil Restoration

Fertilization types and materials used such as mulches are considered key soil management practices for crops production. Mulch is any material applied to the soil surface for protection or improvement of the area covered. The potential of mulches to improve soil structure, increase organic matter, and establish patterns of nutrient cycling more similar to natural ecosystems has been recognized (Abubaker, 2013). Rahman *et al.* (2006) found lower salinity level under various organic mulched (rice straw, water hyacinth and rice straw) plot than plots without mulch. Yang *et al.* (2006) found decreased salt content in soil layer under various kinds of mulches. Tejedor *et al. (*2003) has reported that mulches help to prevent soil salinity from capillary rise to soil surface through reducing evaporation. Fan *et al.* (1993) observed that decrease in soil salinity in the plots mulched with wheat straw persisted for two years. It increase in the photosynthesis due to CO2 releases via disintegration of straw also increases soil temperature (Splittoesser, 1990).

Surface mulches improved soil water retention and reduce wind velocity impacts at the surface of the soil (Kay, 1998). Groundnut mulch has been found to reduce day time temperature and conserve moisture, increase growth and yield attributes (Adetunji, 1990). Organic mulches helped to maintain moisture content longer than bare soil (Ghosh *et al*., 2006)

The release of nutrients from decomposing mulches (rapidly and slowly decomposing) might have positive effect on the soil (Cherr *et al*., 2006). Sonsteby *et al.* (2004) and Cadavid *et al.* (1998) suggested that application of straw and grass mulch significantly increased available phosphorus and potassium in the soil. Research findings showed that soil enzyme activities were generally higher in the mulched plots (Yang *et al*., 2003)

Composts are used in agriculture to improve soil fertility and quality because they can increase organic matter content, especially in sandy soils, which have low water and nutrient holding capacity. Soil fertility can be further increased by the addition of nutrients from compost (Lakhdar *et al*., 2009). According to Romheld and Neumann (2006), the improvement of nutrient uptake particularly of micronutrients was important to increasing plant resistance to biotic and a biotic stresses including soil salinity.

Compost amendments most frequently are used to provide essential nutrients (such as N, P and K) to rebuild soil physic-chemical properties, and re-establish microbial populations and activities (Lakhdara *et al.,* 2009). By increasing the organic content of the soil, biological activity can be enhanced and water and nutrient holding capacity can be improved in soils (Darlington 2003). Organic matter application and, consequently, the humus soil distribution decreased soil Na, EC and pH which can be accounted for by high supplies of Ca, Mg and K. These mineral elements kept the cation-exchange sites on soil particles, minimizing adsorption of Na, and so enhancing Na leaching losses during precipitation (Ouni *et al.,* 2014). Biologically, compost increases soil microbial populations and can be used to suppress plant disease (Wallace *et al.,* 2008).

2.4. Effect of Compost on Tomato Production Under Salt Affected Soil

Soil fertility management practices (including fertilizer application) practice under salt affected condition has the potential to influence tomato yield and quality in numerous ways. Provision of an optimum supply of every plant nutrient is essential to producing high quality fruit and good yield levels. Potassium (K), sulfur (S), and boron (Br) are three of the essential nutrients that need special mention with regards to production of quality vegetables. One way to reduce K leaching is to add organic matter such as compost to the soil (Giller, 2002). Sulfur is especially important because this nutrient forms organic compounds in the plant. It can be used to decrease the pH level if soils are too alkaline and good sources of sulfur include compost (Heckman, 2009).

The growth and development of vegetables depend on soil biological activity which in turn depends on soil properties such as, soil texture and structure, pH, organic matter and nutrient contents, cultural practices (soil fertilization, crop rotation, tillage and irrigation) and environmental factors (for example, soil temperature and moisture content). The slow turnover of organic amendments may become a limiting factor for optimal crop productivity (Heuvelink and Dorais, 2005, Mourao *et al.* 2010). Tomatoes grow best in well-drained soil that is rich in organic matter. They prefer soil with a pH between 6.0 and 7.0 (*www.andysgarden.com* accessed on July 3/2015).

Ogbomo and E.K., (2011) found that, soil compost amendments had a significant effect on plant height, number of branches, number of leaves and days to 50% flowering. According to these authors the average fruit weight was highest from organic fertilizer application. (Dauda (2005a) also suggested that fruit circumference, may increase with increase in compost application.

The enhancement in the number of leaves by fertilizer application was a precursor to greater amount of assimilate and thus allowing more translocation to the berry (Azarmi *et al.,* 2008). Increase in number of leave leads to better utilization of solar radiation (Law-Ogbomo and Remison, 2008). The soil amendment materials like compost and organic manure used for the soil fertilization had great potentials in improving degraded soil fertility. It is therefore recommended to be used to improve infertile soils and increase productivity of vegetable production for a sustain soil fertility and crop yield (Ogbomo, and E., 2011).

The effects of compost application, either as extracts to the foliage or as soil amendments, on plant disease control may be due to direct anti pathogen or resistance-inducing/plant-strengthening effects (Ghorbani *et al*., 2006). The improvements in plant growth and increases in fruit yields due to organic amendments could also related to production of hormones or humates in the composts which may acting as plant-growth regulators in addition to the nutrient supply (Arancon *et al*., 2003; Tu, *et al*., 2006). Barker and Bryson (2006) suggested fertilization with composts might be more beneficial for increasing plant growth when the compost is enriched with nutrients.

2.5. Effects of Mulch on Tomato Production Under Salt Affected Soil

Mulching with many types of organic materials, including chopped grass and clover material has been demonstrated to positively contribute to improved plant growth, development (Russo *et al.*, 1997; Hanson *et al.*, 2001). Tejedor *et al.* (2003) has reported that mulches help to prevent soil salinity from capillary rise to soil surface through reducing evaporation. Rahman *et al.* (2006) found lower salinity level under various organic mulched (rice straw, water hyacinth and wastage of rice straw) plot than un-mulched plots while studying tomato growth under various types of mulch treatments. Fan *et al.* (1993) observed that decrease in soil salinity in the plots mulched with wheat straw.

Ghosh *et al.* (2006) found more moisture content in wheat straw mulch than without mulch under field condition while observing growth and yield response of ground nuts .Thakur *et al.* (2000) reported increased photosynthesis in chilies with application of mulch, and Bhadauria and Kumar (2006) in okra leaves under control and saline irrigation due to higher retention of soil moisture for longer period that increased rate of transpiration. Also Rahman *et al.* (2006) reported increase in plant height of tomato mulched with rice straw. Baye Berihun (2011) reported that the highest fruit yield was obtained from wheat straw mulch followed by transparent and black polyethylene mulch, respectively. Mulching is not only important to reduce weed incidence, but also, it improves the soil micro-environment which indicated that organic mulches help to cool the soil, conserve soil moisture, reduced annual weed production and return nutrients to the soil through decomposition (Dickerson, 1996).

Increase in yield has been reported by Khayyat *et al.* (2007) in strawberry, Aiyellagbe *et al.* (1986) in pepper, Rahman *et al* (2004) in potato while using mulches of different composition at soil of various salinity regimes. Liasu and Achakzai (2007) noticed that leaf mulch of wild sunflower alone and with fertilizer (NPK) enhances the growth and development of tomato plant with reference to number of leaf, height and fruit yield. Some authors reported that mulching improves tomato quality (Sharma and Sharma, 2003; Singh *et al.*, 2007; Gill *et al.* (1996) stated greater yield increase with mulching for the early season crop. Geber *et al.* (1988) found that, applications of mulch increase the soil temperature so that vegetative development and fruit yield of tomato increased.

2.6. Economic Importance of Using Mulch and Compost

Farmers are suffering from declining soil fertility and are complaining about weak responses of their soil fertility management (Tonfack *et al*., 2013). Investigations have shown that farmers mostly rely on a single option of conventional nutrient replenishment, without taking into account the soil mineral balance (Tonfack *et al*., 2009).

To reduce and eliminate the adverse effects of in organic fertilizers and pesticides on human health and environment, new agricultural practices have been developed in the use of organic fertilizer (Chowdhury, 2004). The organic fertilizers take the place of inorganic fertilizers in sustainable agriculture and the main sources of the organic fertilizers can be composted livestock manures, plant residues and industrial wastes (Aksoy, 2001 and Chowdhury, 2004).

With the increasing fertilizer price and limited recourses reserves, organic amendment such as composts, manure and plant residues as source of plant nutrient and organic matter are considered an economic and environmentally-friendly alternative (Lazarovits, 2002). Application of organic fertilizers has been a noble and traditional practice of maintaining soil health and fertility. The use of organic fertilizers results in higher growth, yield and quality of crops (Sreenivasa *et al*., 2010). Most people are aware that using composts is an effective way to increase healthy plant production, help save money, reduce the use of chemical fertilizers, and conserve natural resources (Black and Miller 1998). Tomato production by using organic fertilizer has become a current practice as it contributes to poverty alleviation of smallholders' households by enhancing their income (World Vegetable Centre, 2007). Using with wheat straw mulch is economically more profitable than the other mulch treatment (Baye, 2011).

2.8. Effects of Organic Compost and Mulch on Tomato Seed Yield and Quality

High quality seed is a major factor in obtaining a good crop stand and rapid plant development even under adverse conditions although other factors such as rainfall, agronomic practices, soil fertility, and pest control are also crucial (FAO, 2005) . Tomato seed develops in a mucilaginous gel that has germination inhibitors. Environmental factors affects growth and development of vegetables in terms of seed germination, seed production, seed storage, seed dormancy and occurrence of disease and pests (Sing, 1997).

Compost has been found to influence on all yield parameters such as -improved seed, germination, enhanced rate of seedling growth for crops such as tomato, potato, brinjal, okra, spinach (Subler *et al*., 1998). Salam *et al.* (2010) found that, the higher number of filled seeds per fruit was due to increase in photosynthetic rate and translocation of food material to seed. Anisuzzaman *et al.* (2009) reported higher germination percentage of onion seed observed from mulched treatment.

Tomato seed germinates in the range of 10^oC to 35^oC. The optimum range is 16^oC to 29^oC, and optimum germination occurs at 29^oC. Fruits which are bruised, or fruits which have small cracks are useable for seed, but plants which have a lot of cracked fruit should be rouged before fruit is harvested, otherwise you may end up selecting for cracking (Jeffrey, 2004).

Tomato plants growing in mulched and fertilized soil had the biggest sizes of fruit each with round blossom end shape while those un-mulched and fertilized soils had moderately sized fruit though not as big as that of mulched fertilized tomato plants. Un-mulched and unfertilized tomato plant had fruits with the smallest sizes and shape that result small seed yield (Liasu O.M. and Achakzai, 2007).

3. MATERIAL AND METHODS

3.1. Description of the Experimental Site

An on farm experiment was conducted at East Showa, Zone Dugda district Girisa kebele during 2014 cropping season using irrigation. The experimental site is located at 130 km to south of Addis Ababa and (specific location is at 6^0 91' and 8^0 12' N and38^0 46'and 38^0 59' E and an elevation of 1641-1680 m.a.s.l.). Dugda is part of the central rift valley of Ethiopia (CRVE) and the area has a semi-arid and arid climate (Mengistu, 2008). More broadly, the soil of the area is calcarious derived from mix of parent material including: basalt, ignite, lava, genesis, volcanic ash, pumice, reverine and lacustrine alluvium parent materials (EGMOA, 1975). Generally, the texture of the soils range was from sandy loam to sandy clay loam. The average annual rainfall in the study area is about 677.84 mm with a maximum and minimum temperature of 27.8^{o}C and 14.4^{o}C, respectively (NMAE, 2005). Farmers in the study area grow annual and perennial crops and rear livestock, practices fishery, charcoal production (Opdedez, 2003). Both rain fed and irrigated farming are practiced in the area. In recent years, irrigation has substantially increased, mainly because of rapid population growth and increase in demand for vegetable crops (Haimanot, 2002). Onion, potato, pepper and tomato are major crops cultivated under irrigation.

3.2. Treatments and Experimental Design

The experiment involved four treatments in a factorial combination. These were four-mulch thickness (0cm/ha, 5cm /ha, 10cm/ha and 15cm/ha) and four levels of compost (0 tons, 2 tons, 4 tons and 6 tons/ha) and one tomato variety (Roma VF). The experiment was laid out in a factorial experiment arranged in Randomized Complete Block Design (RCBD) with three replications.

3.3. Experimental Procedures and Crop Mmanagement

Initially representative Kebele was selected in discussion with local development agent. Selection of five farmers and soil sampling were done randomly in September 2014. Then, levels of soil salinity were identified from laboratory work and those that shown high salinity level was used as experimental field. The compost was prepared at Genesis farm from the mixture of

animal manure, poultry manure and crop residue under plastic shade from August 2014 to December 2014 by putting materials as the following layer. First, 10 cm of material, which is difficult to decompose (twigs and stalks), Second, 10 cm of material which is easy to decompose (green and fresh), third, 2 cm of animal and poultry manure Fourth, A thin layer of soil from the surface of land to obtain the micro-organisms needed for the composting process and these layers were repeated until the heap reached 1.5m high, then pit was Covered with grass and banana leaves to prevent water loss. After 2 weeks, all the contents of the pit was turned over into the second pit and 2 later this was turned into the third pit .Land preparation was done in mid of November 2014 and ploughed with a tractor and hand leveled before planting. The seedling of the tomato (Roma VF) was raised in January 16/2015. At initial stages, water was applied with a watering can in the morning and afternoon. Application was changed to furrow irrigation once a day when seedlings were about 5 to 8 cm height. The compost was applied on January 23/2015 to the prepared plots and was incorporated in to the soil before transplanting (20 days before transplanting). The well-prepared rows in the plot were irrigated in the mid of the day of transplanting and 46 P_2O5 was applied before transplanting (Mengistu, 2008). Healthy, vigorous, stocky and succulent seedlings were selected and transplanted with two plants per hill by hand at about 10 cm depth in the field on February 13/2015to the gross plot size of 10.5m^2 at70cm inter and 50cm intra-row spacing. Then wheat straw was applied to the transplanted field by hand per treatment on the same date of transplanting (by measuring the thickness with shtick at (0, 5, 10 and 15 cm). The outermost rows at both sides of plots were considered as borders. A 1.5m wide-open strip separated the blocks; whereas the plots within a block were 1m apart from each other. In accordance with specifications of the design, each treatment was assigned randomly to experimental units within a block. The transplanted tomato seedlings were irrigated with furrow irrigation. The stand was thinned (at first true leaf stage) to a population of 16783 plants/ha (two week after transplanting which during the second hoeing). From 35.5 (N), half was side dressed at second hoeing and the remaining half was applied at last hoeing. Stalk was stand during fruit setting time and tomato branches tied with the stalk. Disease (Bloosom end rot and powdery mildew) and insects (Aphid) and management weeds were managed as per the recommendation of Adami Tulu Research Center. Harvesting was done by hand form May 16/2015 to June 01/2015.

3.3.1 Farmers Feedback

Twenty four (24) Farmers were invited to visit the experimental field at first harvest. Then the following questions were raised and disused in four groups and the idea repeatedly raised and similarly between the groups was taken as general ideas

- ✓ What is the major limiting factor in their production activity and how important is the salinity in the area?
- ✓ What does the salinity affect (productivity, quality) and how does this affect their marketable product?
- ✓ What technology they use (crop rotation, improved irrigation or others) to overcome the constraints?
- ✓ What is their perception from the results of this (experiment productivity, tomato quality marketability)?
- ✓ What do you think will be the major limitation to use these techniques to improve the productivity and the quality of tomato you produce?
- ✓ If there is any problem that limits the use of these technologies please rank them.

3.4. Data Collection

3.4.1. Soil Sample

Soil samples were collected at random from Girisa kebele on five farm fields at 0-30 cm depth before planting. These samples were then composited and two duplicate samples per collected soil samples were prepared for determination of soil chemicals and physical properties involving soil texture, organic matter, bulk density, organic carbon, (EC), pH, and amounts of phosphorus (P), nitrogen (N), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na) and cation exchange capacity as showed in Table 2. The soil samples were cleaned from root and other dusts, air dried thoroughly, mixed and ground to pass a 2 mm size sieve before laboratory analysis. Soil samples were also taken after harvesting from each plot of the experiment and soil chemicals and physical properties after harvest was determined

The soil samples such as pH, OM, %OC, %TN, AVP, EC (ds)/m were analyzed at Jimma University College of Agriculture and Veterinary Medicine soil laboratory. Parameters such as Cation Exchange Capacity (CEC(c mol kg-^{1}), Mg, Na and Ca were analysed at the soil laboratory of Oromia water works design and supervision enterprise. For texture, hydrometer method (Gee & or, 2002) was applied. OC was estimated by Walkley and Black method (Nelson and Summers, 1996) and with a factor of 1.724 as suggested by (Ryan *et al.*, 2001), OM percentage was estimated multiplying OC by this factor. EC was determined by conductivity meter in 1: 5 soils to water ratio, pH by using pH meter; amounts of available phosphorus (P) was estimated by using Olsen procedure as described by Olsen *et al.*, (1954). Nitrogen by micro-Kjeldahl digestion procedure (Bremmer, 1996), Ca and Mg were analysed by AAS (Thomas, 1982), K and Na are determined by flame photometer and cation exchange capacity (CEC) was determined by using ammonium saturation method (Jackson, 1968).

3.4.2. Crop Penology

- **Days to 50% flowering (day)**: -Data was taken on five plant within a plot at 50 % of the plant population in a plot reached the respective phonological stages.
- **Days to 50% maturity (day): -**This was taken on plot basis at 50 % of the plant population in a plot reached the appropriate physiological maturity.

3.4.3. Growth Parameters

- **Plant height (cm)**: -Data were taken from five plants on plot basis when 50 % of the plants in a plot reach maturity stage by using tape meter from collar region to the apex and the mean value was determined as mean plant height.
- **Number of primary branches:-**were taken from the same five plants on a plot basis when 50 % the plant in a plot reach maturity.
- **Number of clusters per plant**: -were counted and recorded from the same five plants on plot at 50% maturity.

3.4.4. Yield Components and Fruit Yield

3.4.4.1. Yield Components

- **Number of fruits per cluster: -**Number of fruit per clusters were counted on five plants per plot when 50 % of the plant in a plot reach maturity and average was taken

- **Number of fruits per plant: -**Total numbers of fruits harvested from five plants were counted individually and the mean values expressed as whole number of fruit per plant.

  Single fruit weight per plant (g): -Five ripen fruits were randomly selected from each five plant in plots and weighted individually using sensitive balance and the mean was recorded.

- **Fruit weight per plant (kg):** -All the ripen fruits from five plants per plots were collected, weighed individually and the mean was taken to get fruit yield per plant which was expressed in kilograms/ plant.

- **Fruit polar diameter (cm)**: -The diameter of five randomly selected tomato fruits per plant were measured by using instrument called digital caliper (CD-20PPX) and the mean was recorded as mean fruit diameter and the value was expressed in cm.

- **Fruit equatorial diameter (cm)**: -The same sample used in the fruit diameter was measured for its equatorial using the same instrument and the mean was determined as average fruit equatorial diameter and the mean value was expressed in cm.

- **Fruit shape index: -**The mean fruit shape index was calculated by dividing the mean polar diameter by the mean equatorial diameter of the fruit.

- **Fruit quality parameters:** -Some quality indicator like color, shape and size were observed.

- **Marketable fruit yield(ton/ha): -**Fruit which was cracked, damaged by insects, diseases, birds and those with sun burn were considered as unmarketable while those which were free of any feasible defect and damage was considered as marketable fruits.

- **Total fruit yield (ton/ha):** -The summation of marketable and unmarketable fruit yield per hectare was taken as total yield per hectare.

- **Number of seeds per fruit**: -Five plants were randomly selected in each plot and five fruit on each plants were harvested and a seed of each fruit extracted separately by

fermentation method and dried for six days under shade; then number of seeds per fruit was counted manually and the mean of the seed from five fruit taken as the seed per fruit

- **Seed yield per plant (g)**: -The seeds were extracted from ripen fruits of five plants in each plot by following fermentation method and dried under shade. Then the total seed weight was recorded in grams.
- **Seed yield (kg/ha):** -The seed yield per hectare was calculated based on seed yield per plant indicated earlier.
- **Thousand seed weight (g)**: -Three replications of 1000-seeds from each plot were weighed individually with sensitive balance and the mean weight of 1000-seeds will be expressed in grams.
- **Seed germination percentage (%)**: -The tomato seed taken from each plot were evaluated for the germination characteristics at JUCAVM laboratory. Germination test was conducted on sterile plastic by using four replicates of 100 seeds each in paper towel in the germination room. The germination room was maintained at 25^{0}C temperature and 95 % relative humidity. Data was recorded for nine days up to germination stopped. At the end of 10^{th} day of germination test, the number of normal seedlings in each replication was counted and the germination was calculated and expressed in percentage.

3.5. Profitability Analysis

Profitability analysis (Adeniyi, 2001) was used to estimate the net return of each of the treatment used and filter this financially remunerative .This was based on the formula:

NP = TR – TC

Where; NP= Net profit

TR= Total Revenue

TC = Total Cost

Benefit-cost ratio was calculated as the ratio of crop total value to total cost of production.

BCR= TR/TC

Where, BCR= Benefit-cost ratio

TR= Total Revenue (crop total value)

TC = Total Cost of production

3.7. Data Analysis

Data were subjected to analysis of variance (ANOVA) using the GLM procedure of data statistical software package (Genstat Version 13). Significance differences of treatments were separated by LSD (Least Significance Difference) test of significance. Correlation analysis was determined using Pearson's simple correlation coefficients for some intended tomato parameters Laboratory seed germination result was determined by SAS soft ware version 9.2 (1987)

4. RESULTS AND DISCUSSION

4.1. Soil Sample Analysis

The pre planting and post harvesting results of soil laboratory test indicated that the soil in the study site is Sodic (Alkali), texturally loam, low in organic carbon and phosphorus content. The sample analysis further indicated that the experimental soils have medium in total nitrogen, calcium and cation exchange capacity. High in pH, organic matter, potassium and magnesium were some of the additional features of the soil as illustrated by the analysis of sample (Table 2). The chemical properties of compost showed, high amounts of organic carbon, organic matter, total nitrogen, available phosphorus and other exchangeable cations like Mg, K and Ca those can boost agricultural productivity on the soil through gradual release of nutrients.

Table 2. Initial chemical and physical properties of soil and compost

	Chemical properties							Cmol (+) Kg^{-1}				Physical properties of soil			
Tested item	pH	% OC	% OM	% TN	Av.P ppm	EC (ds) /m	CEC	Na	K	Mg	Ca	% sand	% Clay	% Silt	Trl class
Soil	9.7	2.8	5.7	0.3	5.1	3.3	17.3	2.2	1.3	3.2	8.8	47	23	30	loam
Compost	7.8	25.6	44.3	2.2	18.2	1.8	43	2.1	6.3	9.6	16.6	Nd	Nd	Nd	Nd

Where Cmol = cent mole, pH= hydrogen power, %OC = percent of organic carbon %OM = percent of organic matter, %TN = percent of total nitrogen, Av.P. ppm = available phosphorus in parts per million, EC(ds) m = electrical conductivity in dessicemen, CEC = cation exchange capacity, Na = sodium, K = potassium, Mg = magnesium, Ca = calcium, % = percent, Trl class = textural class, Nd = not determined.

The post-harvest soil result indicated significant (P<0.01) differences on Om%, CEC, Ec (ds)/m, Na, and Available (Av.P) ppm due to the compost and mulch and also their interactions (Appendix table1). On Mg, the main effect of compost and its interaction with mulch thickness showed significant difference. The highest value of OM% was obtained from10cm and 6 ton, 15cm and 6ton, 10cm and 6ton, 5cm and 6ton 0cm and 6ton ,15 and 4 ton and 15cm mulch thickness and 4 ton compost rate. However the lowest %OM was from control plots. And the

highest Av.P was observed on 10cm mulch thickness and 6 ton compost rate as well as from 5cm mulch thickness and 6 ton compost rates. But the lowest was on 0cm and 0 ton, 5cm and 0 ton, 10cm and 0ton. 0cm mulch thickness and 2ton compost rate (table3). For CEC the highest values were observed on, 15cm and 6ton, 10cm and 6 ton, 5cm and 6ton, 0cm and 6ton, 15cmand 4ton, 5cm and 4ton and o cm mulch thickness and 2ton compost rate. The highest Mg value was observed on 5cm and 6ton, 10cm and 6ton, 5cm and 4 ton, and o cm mulch thickness and 4 ton compost rate. The lowest was from control plots as well as 5cm mulch thickness and 0ton compost application rates. The lowest EC was observed on 15cm 6 ton, 10cm and 6ton, 15 cm mulch thicknesses and 4 ton compost application rates. However, the highest was from 0cm and 0ton, 5cm and 0ton, 10cm and 0 ton 15cm mulch thickness and 0 ton compost application rate. And the lowest sodium concentration was found from a treatment combination of 0cm and 4 ton, 15cm and 4 ton, 15 cm and 6 ton, 5cm and 4 ton 5cm and 6 ton and 10cm mulch thickness and 6ton compost application rates .But the highest concentration was observed from the control plots. This finding showed that, compost and mulch applications were improve the soil physico chemical properties, reduce sodium concentration in the soil, Electro conductivities consequently soil salinity and increase plant nutrient. Ouni *et al*. (2014) reported similar result.

Table 3. Interaction effects of compost and mulch on the soil physicochemical properties (post-harvest)

Treatment number	Compost rate and mulch thickness interaction	Parameters						
		% OM	Av.P.ppm	EC(ds) m	CEC	Na	Mg	Textural class
1	0*0	4.13^{e}	8.07^{e}	2.20^{a}	17.83^{d}	2.64^{a}	2.75^{fg}	Loam
2	5 * 0	6.77^{d}	9.51^{de}	2.19^{a}	17.83^{d}	1.65^{b}	2.56^{g}	Loam
3	10 * 0	7.53$^{cd[}$	12.07^{bcde}	2.03^{a}	17.83^{d}	0.82^{cd}	3.01^{ef}	Loam
4	15 * 0	7.86^{bcd}	12.86^{bcd}	1.96^{ab}	19.94^{cd}	0.76^{cd}	3.11^{de}	Loam
5	0 * 2	7.86^{bcd}	11.68^{cde}	1.61^{c}	22.06^{ab}	1.11^{bc}	3.12^{de}	Loam
6	5 * 2	8.11^{bcd}	13.50^{bcd}	1.65^{bc}	19.94^{cd}	1.06^{c}	2.92^{ef}	Loam
7	10 * 2	8.19^{bc}	12.82^{bcd}	1.14^{d}	19.95^{cd}	0.91^{cd}	3.12^{de}	Loam
8	15 * 2	8.67^{abc}	10.09^{de}	1.10^{d}	22.07^{bc}	0.73^{cd}	3.40^{d}	Loam
9	0 * 4	8.18^{bc}	12.07^{bcde}	1.07^{de}	22.04^{bc}	0.12^{e}	4.31^{ab}	Loam
10	5 * 4	8.82^{abc}	13.57^{bcd}	1.10^{d}	24.1^{ab}	0.61^{cde}	4.32^{a}	Loam
11	10 * 4	8.18^{bc}	16.11^{b}	1.10^{d}	19.95^{cd}	0.71^{cd}	3.99^{bc}	Loam
12	15 * 4	8.87^{abc}	12.37^{bcd}	0.76^{ef}	24.23^{a}	0.37^{de}	3.77^{c}	Loam
13	0 * 6	8.95^{ab}	15.80^{bc}	1.62^{c}	22.07^{abc}	0.92^{c}	4.32^{a}	Loam
14	5 * 6	8.99^{ab}	22.17^{a}	1.28^{d}	24.06^{ab}	0.61^{cde}	4.23^{ab}	Loam
15	10* 6	9.62^{a}	24.88^{a}	0.71^{f}	24.23^{a}	0.57^{cde}	4.22^{ab}	Loam
16	15 * 6	8.47^{abc}	11.21^{de}	0.60^{f}	24.12^{ab}	0.37^{de}	3.99^{bc}	Loam
SEM(±)		0.47	1.44	0.11	0.76	0.10	0.11	
LSD(0.05)		1.36	4.16	0.32	2.19	0.28	0.32	
CV		10.00	18.20	14.10	6.10	19.10	5.4 0	

CV= Coefficient of variance, LSD = least significance difference, pH = Hydrogen power, % OC = percentage of organic carbon, % OM = percentage of Organic matter, % TN = percentage of total nitrogen, AV.P = Available phosphorus, EC = Electrical conductivity, CEC = cation exchange capacity, Na = sodium, K = Potassium, mg = magnesium.

The significant ($P<0.01$) differences were observed on OC%, pH, TN% and Ca due to the main effects of compost Appendix Table1). Per cent of silt, sand, clay and K were not affected by any of the treatments nor their interactions. The highest percentage of total nitrogen was recorded from 6ton compost application rate and the lowest was from unfertilized. The maximum present of Organic carbon was obtained on 4ton and 6ton compost rates but the minimum was from 0 and 2 ton compost rate and also the highest calcium amount recorded on 4and 6 ton compost rate but the lowest was on 0 rates. The lowest pH values were recorded at 6 and 4 ton compost rate comparing with other treatments. Implying that application of organic matter helps in alleviating some chemical properties of soils related to salinity. The fact that mulching did not show significant impact could be accounted for its low decomposition and longer time demanding to contribute to the chemistry of soil.

Generally, the chemical properties of the soil as illustrated by post harvest analysis, showed increased in percent of organic matter, organic carbon, total nitrogen, available phosphorus, CEC (magnesium, calcium and potassium) contents and decreased in sodium concentration, pH and electro conductivities (EC (ds)/m. The organic fertilizer application decreased soil Na, EC and pH likely due to high supplies of Ca, Mg and K. This was in agreement with Lakhdar *et al.* (2009), who reported that Ca, Mg and K mineral elements keep the cation-exchange sites on soil particles; minimized adsorption of Na and enhanced Na leaching losses. Brady and Weil (2005) also found cations such as Ca^{2+}, Mg^{2+} and K^{+} are produced during decomposition. Similarly, Wanerley and Mitton, (2004) also reported that, addition of organic manure to the soil enhanced microbial activity and increased their ability to conserve irrigation water and consequently increasing the fertility and productivity of soil.

Table 4. The main effect of compost and mulch on the soil chemical and physical properties after harvest.

Compost (ton)	pH	TN%	Oc%	Ca	K	% sand	% Silt	% Clay
0	9.56^{a}	0.29^{d}	4.13^{b}	8.86^{c}	1.31	50.00	39.00	18.00
2	9.41^{ab}	0.35^{c}	4.32^{b}	10.48^{b}	1.37	49.50	39.75	17.00
4	9.21^{bc}	0.43 ^{b}	4.81^{a}	11.72^{a}	1.39	50.50	39.50	17.75
6	8.99^{c}	0.49^{a}	5.15^{a}	12.37^{a}	1.49	49.25	40.25	18.75
SEM(±)	0.10	0.02	0.23	0.37	0.07	0.98	0.65	0.61
LSD(0.05)	0.29	0.06	0.46	1.08	NS	NS	NS	NS
Mulch (cm)								
0	9.50	0.36	4.31	10.49	1.36	49.50	39.00	18.50
5	9.28	0.37	4.46	10.95	1.38	50.50	39.50	18.00
10	9.17	0.44	4.90	10.95	1.41	50.00	40.25	18.50
15	9.23	0.39	4.75	11.04	1.42	49.25	39.75	16.50
SEM(±)	0.10	0.02	0.16	0.37	0.07	0.98	0.65	0.61
LSD(0.05)	NS	Ns	NS	NS	NS	NS	NS	NS
CV	3.70	19.00	12.00	11.90	18.30	6.80	5.70	11.80

TN% = percentage total nitrogen, pH=Hydrogen power, Ca = calcium, K=Potassium, % sand = percentage of sand, % silt =percentage of silt, % clay = percentage of clay, CV= SEM = standard error of mean CV=Coefficient of variance, LSD = least significance difference

4.2. Response of Phenology and Growth Parameters

4.2.1. Phenology

Days to 50% flowering (day): Analysis of variance indicated that the main effect of compost was significant (P<0.01) on days to 50% flowering (Appendix Table2)

Among the main effect of compost, the maximum (63.75) days to 50% flowering was recorded for zero ton compost and the minimum were recorded for 6t/ha (58.17), 4ton/ha (58.17) and 2ton/ha(60.08) compost rate (Table 5). The delayed days to 50% flowering on unfertilized plot might be from the low nitrogen fertilizer in the soil and the salinity effect that retard plant growth. Saeed and Ahmad (2009) reported a significant decrease in plant growth, in chlorophyll content and in terms of plant height and vegetative biomass of tomato on saline soil.

The earliest days to 50% flowering might be from the high organic nitrogen fertilizer in highest compost rate, which initiates plant growth and the presence of potassium in the compost that stimulates early flowering and setting of fruits. On the other hand, Phosphorus nutrient, which initiate root growth of tomato and aids in early establishment of the plant immediately after transplanting might also enhance the tomato plant to flower early. In agreement with this result, Ogbomo and K. (2011) found that all fertilized plots with organic fertilizer flowered earlier than the unfertilized plots. Kawthar *et al.* (2010) indicated that, the earlier number of days to 50% flowering observed in fertilizer treated plants could be attributed to acceleration of the vegetative phase through the stimulating effect of the absorbed nutrients on photosynthetic process. The effect was reflected on both vegetative growth and flowering initiation. In other experiment, Darlington (2003) revealed that compost dilute the accumulated soluble salt content in the soil.

Late flowering (63.75) observed in this study might be due to the soil salinity effect, which retards plant growth and cause water deficit at the root zone and the in sufficient macronutrient like N,P,K, Mg and Ca. Without these nutrients, tomato cannot grow properly or bear fruits. Sainju *et al,* (2003) reported that**,** tomato requires at least twelve nutrients, called “essential elements”, for normal growth and reproduction. Pessarakli and Tucker (1988) reported that tomato plants grown with saline water have significantly lower water uptake than those grown with fresh water. Pasternak *et al*, (1994) also reported that, salinity delays flowering of tomato.

Days to 50% maturity (day): -The present result revealed that days to 50% maturity was affected by the compost rates only. Tomato fruits grown in 6t/ha matured earlier (at 85.58) ,(87.9), (88.58) days after transplanting than in any other treatments. Tomato fruits grown in the treatments matured late at 92.92 days after transplanting compared to the other treatments

(Table5). The late matured tomato on unfertilized plot were from the late flowering of the plant on this plot and the early matured were also from the early flowering tomatoes. This finding was in agreement with Ogbomo and K (2011) who concluded that fruits of plants treated with fertilizers mature earlier than these untreated ones. However, non-significant differences were observed on 50% maturity due to different mulch thickness.

Table 5. Influence of the main effect of compost and mulch on phenology, growth parameters, yield and yield components of tomato

Compost (ton)	D.50%. F	D.to50% M	PH(cm)	Np bpp	N.cpp	F sh Index	SFWPP (g)
0	63.75[a]	92.92 [a]	50.75[c]	4.04[b]	10.25[b]	1.51	39.29[c]
2	60.08[b]	87.9[b]	56.68[b]	4.63[b]	12.37[b]	1.35	41.90[b]
4	58.17[b]	88.58[b]	59.07[ab]	4.78[b]	15.35[a]	1.37	44.19[a]
6	58.17[b]	85.58[b]	62.75[a]	5.68[a]	15.45[a]	1.39	45.89[a]
SEM(±)	1.24	4.90	2.74	0.41	1.30	0.06	1.12
LSD(0.05)	2.52	4.90	5.59	0.83	2.66	NS	2.28
Mulch (cm)							
0	62.08	91.33	56.77	3.99[b]	10.12[b]	1.475	42.61
5	59.67	89.67	58.88	5.15[a]	13.65[a]	1.40	42.15
10	58.67	90.00	58.04	5.2[a]	15.37[a]	1.32	43.70
15	59.75	86.83	55.57	4.80[ab]	14.28[a]	1.42	42.80
SEM(±)	1.24	2.40	2.74	0.41	1.30	0.062	1.12
LSD(0.05)	NS	NS	NS	0.83	2.66	NS	NS
CV	5.00	6.60	11.70	20.80	23.90	10.9	6.40

Means followed by the same letter within a column are not significantly different from each other at 5% level of significance. SEM = Standard Error of Mean, LSD=Least Significant Difference, CV= Coefficient of Variation.D50% F = Days to 50% flowering, D 50% M = Days to 50% maturity, PH = plant height, NBPP = number of branch per plant, N CPP = number of cluster per plant, FSHI = *fruit shape index, SFWPP = single fruit weight per plant.*

4.2.3. Growth Parameters

Plant height (cm): Compost showed significant (P<0.01) effect on plant height (Appendix Table 2). The highest plant height (62.75cm) and (59.07cm) were observed from the main effect of 6 and 4ton/ha compost application rates while the lowest (50.75cm) was observed from 0 ton/ha

compost application rate (Table 5). Highest compost application showed significant increase in plant height by providing optimum amount of nitrogen that is the most limiting nutrient for tomato growth and is required in large amount. Similarly Brown *et al*. (1995) observed that, plant growth was markedly influenced by application of poultry manure, inorganic N fertilizer and their combinations as observed from the highest plant height and number of leaves compared to the untreated.

On the other hand, the minimum plant height might be due to the result of low nutrient on the control treatment and the influence of soil salinity that decreases the rate of photosynthesis and plant growth. Salinity inhibits root elongation and influences soil - plant - water relationships and enhance the level of soluble salts within which plant growth. In agreement with this, Steppuhn (2005) reported that salinity induced reduction in crop growth, which the authors associate with reduction in water use.

Number of primary branches: The analysis of variance (Appendix Table 2) pointed out that the main effect of mulch and compost showed significant ($P<0.05$) effect on number of primary branches**.** Nevertheless, the interaction effects did not show significant differences. Maximum number of primary branch (5.68) was recorded from tomato plants grown in 6t/ha of compost. While the smallest number of primary branch (4.04), (4.63),(4.78) were observed from plots of zero ton/ha,2ton and 4ton compost (Table 5). This might be due to increased total N and other organic matter by increased compost application rate and also the tomato plant root growth was stimulated by P in better utilization of water and other nutrients in the soil and promotes a sturdy growth of stem and healthy foliage. Similar with this, Tsado (2014) found that, the result of differences in the number of branches produced in avian waste compost compared to that of agricultural waste.

On the other hand, the higher number of primary branch (5.2), (5.15) and(4.80) was found on 10cm, 5cm and 15cm mulch thickness respectively. But the lower number (3.99) of primary branch was recorded from plants grown in un-mulched plot. This might be due to the fact that optimum mulch increases vegetative growth of tomato by protecting water loss from soil and facilitate mineral uptake to the plant, provide favorable condition by optimizing the soil temperature that the plant was branched than un mulched plot. This agrees with the result

observed by Singh *et al*. (2007); who reported that optimum mulching improves plant growth, yield and yield quality.

Number of clusters per plants: -The interaction effects of mulch and compost showed non-significant differences on number of clusters per plants. However, number of clusters per plant varied from compost to compost and from mulch to mulch (P<0.01) (Appendix Table 2). The maximum number of cluster (15.45), (15.35) per plant were observed on tomato plants grown in (6 and 4 ton/ha) compost application rate respectively. Whereas, the minimum value (10.2 and 12.37) were from zero and 2ton/ha compost rate. The increased number of cluster was probably due to the ability of compost to enhance plant growth and initiate more number of flowers per branch that was become cluster per plant. This finding agrees with the findings of Curtis and Claassen (2005) and Nguyen *et al*. (2011), who reported, the positive effect of compost on plant growth by increasing nutrient availability.

Similarly, maximum number of cluster (15.37 14.28 and 13.65) were recorded form tomato plants grown in 10cm.15cm and 5cm mulch thickness. While the minimum number of cluster per plant (10.12) was observed from the unmulched plot (Table 5). This might be because, optimum mulch provides favorable temperature for vegetative growth, flowering, and fruit setting. It also contributed to increase number of cluster per plant that probably resulted from the increased number of primary branch per plant. Similarly, Gudugi *et al*, (2012) found that, mulched plots significantly produced more number of clusters per plant, number of branch per plant and flowers when compared to no mulching. Dickerson (1996) also indicated that organic mulches help to cool the soil, conserve soil moisture, reduced annual weed production. The small number of cluster per plant on the control plot might be due to the salt affected field which had low amount of organic nitrogen, in the soil. Hajer *et al*. (2006) reported reduction in fresh and dry vegetative biomass on tomato grown on saline soil. Amini and Ehsanpour (2006) also reported reduction in vegetative growth of tomato when grown on saline soil.

4.2.4. Yield Components and Fruit Yield

4.2.4.1. Yield Components

Number of fruit per cluster: Appendix Table 2 depicts results of ANOVA on number of fruit per cluster. Accordingly, number of fruit per cluster was affected significantly as result of the

interaction effects of compost and mulch (significant P<0.01). The highest number of fruit per cluster (5.07,5.00, 4.93,4.87, 4.87, 4.87,4.87,4.80, 4.67, 4.67, 4.60 , 4.6 and 4.53) were observed at (6ton with 10cm 5cm with 6ton, 15cm with 4ton, 15cm with 6ton,5cm with 4 ton, 10cm with 0, 0cm with 2ton,15cm with 2ton, 15cm with 0 ton, 0cm with 6ton, 10cm with 2ton,5cm with 0 ton and 0cm/ha mulch thickness with 4ton/ha compost application rates . On the other hand, the lower number of fruit per cluster (3.27) was found in the control plot (Table 6). The highest fruit per cluster might be from the higher amount of compost application with optimum mulch thickness that improves soil fertility of the salt affected field. The presence of magnesium fertilizer in compost increased tomato fruit production. Darlington, (2003) found that by increasing the organic content of the soil, biological activity can be enhanced and water and nutrient holding capacity can be improved in soil.

Besides the lowest yield on the control plot, in adequate plant nutrient mainly N and the presence of sodium concentration and high pH of the soil that influence nutrient uptake and plant water availability are probably the major factors. Needham (1973) found nitrogen deficiency in the soil causes stunted spindly growth of tomato plants. He also suggested that, younger leaves remain small and pale green, that caused reduction of photosynthesis in plants and die prematurely. It can decrease the production of number of fruits, fruit size, storage quality, and color of tomato fruit.

Number of fruit per plant: -As indicated on (Appendix Table2), significant (P<0.05) difference was observed due to the interaction effect of both mulch and compost. The maximum fruit number (46.53, 44.54, 42.93,45.35, 42.42 and 42.42) were found from a treatment combination of 6ton and 10cm ,5cm and 6ton ,15cm and 4ton, 10cm and 4ton and 10cm mulch thickness and 2ton compost application rates. The lowest fruit number (33.83 38.8,36.22,38.8537.10,39.07 and 35.53) were recorded from 0cm and 0 ton, 10cm and 0 ton,0cm and 2ton,5cm and 2ton0 cm and 4ton 0cm and 6ton 15cm and 6 ton. The increased number of fruit might be due to the highest application of compost with mulch to facilitate plant growth and fruit development through adding organic matter that provided enough amount of nutrient to the plant. Potassium nutrient improved fruits setting thereby increase the number and production of tomatoes per plant. Delate *et al.* (2008) found that, flower, fruit number, and yield were numerically greater in the fertilized plots as compared to the untreated soil. In addition, Turkmen *et al.* (2004) also reported compost

is an important in gradient in increasing the mineral nutrient uptake in tomato cultivated in saline medium. Mulch might have also a great role in soil moisture improvement and micro- organism decomposition enhancement. This agrees with the findings of Saeed (2005), who reported that the application of mulch resulted in significantly highest fruit yield per hectare that was mainly attributed to increased uptake of available nutrients present in the soil.

The result on the control plot might result from the deficiency of essential plant nutrients that limit plant growth, flower number, fruit setting and development and the salinity stresses which hamper water and nutrient up take. In similar case Parida and Das (2005) reported that, commercial cultivars of tomato are sensitive to moderate levels of salinity up to 2.5dsm-^{1}.

Single fruit weight per plant (g): -The analysis of variance indicated that the main effect of compost showed significant ($P<0.01$) effect on single fruit weight per plant. However, the variable was not affected by mulch and its interaction with compost application rates. The highest weight per plant (45.89) was recorded on (6t/ha) rate while the smallest weight (39.29) was recorded at zero compost. The increased in single fruit weight per plant with compost rate might be due to the positive effects of compost on improving soil nutrient content. High application of compost rates supplied high essential nutrients like nitrogen, phosphorus, potassium and calcium which enable fruit development and quality. And probably the high potassium concentration in applied compost help in vigorous growth of tomato and stimulate setting of fruits, thereby increased the fruit size, number and production of tomatoes per plant y inhibit sodium up take. Darlington (2003) reported that, soluble nutrients particularly K, Ca and N in compost are responsible for salinity. Varis *et al*, (1985) found similar result. Dauda (2005) also found similar result indicating that change in fruit weight correlates with compost application rates. Similar results were also observed in some previous researches (e.g. Ogbomo, and E.K.2011; Kawthar *et al.,* 2010).

Fruit weight per plant in (kg): - Significant ($P<0.01$) difference was observed due to the main effect of compost and mulch and the interaction effects. The maximum weight (2.22) was obtained from (6t/ha) of compost rate and (10cm) mulch thickness. Whereas the minimum weight (1.29) was from the control (Table 6). The maximum weight might be due to the highest amount of compost rates applied which supply high plant nutrient and increase soil organic

matter, reduce soil pH sodium concentration, increase nutrient and water uptake. And the applied mulch might improved the fruit yield by initiating soil organic matter decomposition and increase soil moisture content on these treated plot comparing with the untreated plot. Mourao *et al.* (2010) reported that, tomato yield increased with the application of manure compost under what condition, saline soil…please specify. Olaniyi and Ajibola (2008) also found the optimum marketable fruit yield can be obtained from application of poultry manure. The lowest yield from control plot indicated that, exposure of plants to salt stress which leads to changes in growth, morphology and physiology of the roots that will in turn change water and ion uptake that limit plant growth and fruit development. And also might be the in adequate amount of macronutrients such as N, P, K, Ca, Mg, and S, are needed in large amounts for optimum production because the concentration of these nutrients are higher than other nutrients in tomato.

Fruit polar diameter (cm): -The result indicated that Polar diameter was significantly ($P<0.05$) affected by the interaction effects of mulch and compost. The greatest fruit polar diameter (5.56 5.08 cm) was observed from a treatment combination of (6ton with 10cm and 10cm mulch thickness and 4ton compost rate). Whereas the lowest fruit polar diameters (4.03, 4.29 and 4.48 cm) were observed from those grown on 0cm and 0ton, 5cm and 2ton.This might be due to the higher nutrient concentrations added to these plots that bears greater fruit polar diameter than control plot. In this treatment, potassium, which was crucial for fruit development, might be increased since compost and mulch were applied. Also it enhances cation exchange capacity and acts as a buffering agent against undesirable soil fluctuations. In this relation Kalibbala (2011) suggested that, fruit diameter with compost was significantly higher than the control. Similarly Ngeze (1998) reported that organic manure helps to improve the physical condition of soil and provides the required plant nutrients. Ghorbani *et al.* (2008) observed that organic amendments showed significant impact on crop health and post-harvest quality of tomato. In addition, Singh *et al.* (2006) reported that mulching improves plant growth, yield and yield components Tonfack *et al.* (2009) indicated that correct soil nutrient balance is essential for healthy growth, high crop productivity and fruit production and are directly associated to the allocation of nutrients in sink organs. On the other hand, Umara *et al.* (2013) found that, the tomato diameter decreases in salt concentration under irrigation condition.

Fruit equatorial diameter (cm): -Significant ($P<0.05$) differences indicated due to the main effect of compost and mulch and interaction effects of the main effects on fruit equatorial diameter. Along with the interaction effects, the maximum result (4.34 cm and 4.03 cm) observed on treatments with (6 ton with 10cm and 10cm mulch thickness with 4ton compost rate. Whereas, the lowest fruit diameter (2.32 cm) was observed on the control plot (Table 6). The variation of the results might be from the different level of available nitrogen and other plant nutrients. Because soil moisture content and nutrient up take are important to improve fruit development that was high in mulched and fertilized plot

The lower fruit equatorial diameter on the control plot was probably resulted from the limited available nutrient in the soil. This might be related with a sink source relationship that limited in the control plot. Thus, low assimilate production might be leads to competition between vegetative and reproductive parts, that is, among the inflorescences and fruit sizes suffer severely on the same cluster. The similar result was obtained by Girmachew (2007) who found width of tomato fruits increased with increasing nitrogen rates and decreased with decreasing nitrogen. Furthermore, it is known that fruit size depends on assimilate distribution which is controlled by the activity of both source and sink. Dauda (2005) suggested that, fruit diameter may increase with increase in compost application. On the other hand, Cherr *et al.* (2006) reported that, the slow release of nitrogen from decomposing organic mulch is better synchronized with plant uptake than sources of inorganic nitrogen.

Fruit shape index: -The fruit-shape index (length/diameter) that indicated on (Table5) was showed non-significant difference due to the main effects of compost and mulch as well as interaction effects.

Table 6. Effect of compost and mulch interaction on yield, yield components and quality parameters of tomato production

Treatment number	Compost rate and mulch thickness interaction	Parameters				
		NFPC	N FPP	FWPP	FPDM	FEQDM
1	0* 0	3.27^{d}	33.83 ^{h}	1.29^{h}	4.03^{f}	2.32^{e}
2	5 * 0	4.60^{ab}	42.42^{abcde}	1.66^{cdefg}	4.60^{bcde}	3.44^{bc}
3	10 * 0	4.87^{a}	38.80^{defgh}	1.58^{fg}	4.76^{bcd}	3.54^{bc}
4	15 * 0	4.67^{ab}	41.07^{bcdef}	1.81^{bcdef}	4.70^{bcd}	3.51^{bc}
5	0 * 2	4.87^{a}	36.22^{fgh}	1.75^{bcdef}	4.64^{bcde}	3.23^{cd}
6	5 * 2	3.90^{c}	38.85^{defgh}	1.72^{cdefg}	4.29^{def}	3.37^{c}
7	10 * 2	4.60^{ab}	42.42^{abcde}	1.66^{cdefg}	4.60^{bcde}	3.44^{bc}
8	15 * 2	4.80^{ab}	41.00^{bcdef}	1.88^{bc}	4.60^{bcde}	3.36^{c}
9	0 * 4	4.53^{ab}	37.10^{efgh}	1.63^{defg}	4.74^{bcd}	3.32^{c}
10	5 * 4	4.87^{a}	39.33^{cdefg}	1.87^{bc}	4.88^{bc}	3.55^{bc}
11	10 * 4	5.00^{a}	45.35^{ab}	1.97^{b}	5.08^{ab}	4.03^{ab}
12	15 * 4	4.93^{a}	42.93^{abcd}	1.89^{bc}	4.48^{cdef}	3.27^{cd}
13	0 * 6	4.67^{ab}	39.07^{defgh}	1.82^{bcde}	4.57^{cde}	3.51^{bc}
14	5 * 6	5.00^{a}	44.54^{abc}	1.85^{bcd}	4.62^{bcde}	3.46^{bc}
15	10* 6	5.07^{a}	46.53^{a}	2.22^{a}	5.56a	4.34^{a}
16	15 * 6	4.87^{a}	35.53^{gh}	1.61^{efg}	4.87^{bc}	3.06^{cd}
SEM(±)		0.31	2.65	0.12	0.24	0.63
LSD(0.05)		0.63	5.40	0.24	0.50	0.63
CV		8.20	8.10	8.10	6.40	11.2

Means followed by the sat me letter within a column are not significantly different from each other at 5% level of significance. SEM = Standard Error of Mean, LSD=Least Significant Difference, CV= Coefficient of Variation.FPC = fruit per cluster, N.FPP = Number of fruit per plant = FWPP = fruit weight per plant, FPDM =fruit polar diameter, FEQD = fruit equatorial diameter.

Marketable fruit yield (ton/ha): - Marketable fruit yield is significantly affected by the level of compost and its interaction with mulch Appendix Table 2. The maximum fruit yield (37.23t/ha) was found on (6t/ha) compost and (10cm) mulch plot. However, the lower amount (21.67ton and 25.16) were recorded from 0 cm and 0 ton 5cm and 0 ton (Table 7).

The higher marketable fruit weight might be the result of soil amended with high compost rate which enhance fruit yield as discussed in some yield component parameters. Nutrient is a major entry point to increase yields that the marketable fruit yield per hectare increase on this treatment was because of enough nutrients in the soil that the size of fruit was big. The efficient use of both combinations of organic and inorganic fertilizers was optimized fruit yield through minimizing damaging of fruit that result from strong and health plant growth through proper nutrient uptake. The improvements in plant growth and increases in fruit yields in organic amendments could also be due partially to large increases in soil microbial biomass after organic fertilizer applications as N and K are absorbed by tomato in large amount. The availability of potassium nutrient in the compost was probably increased with increasing compost application rate that, potassium nutrition can affect the quality of tomato fruit.

On this treatment, firm, healthy, evenly colored, good appearance and good keeping physical quality fruits was also found. Similarly, Winsor (1973) observed that the percentage of unevenly ripened tomatoes and irregularly shaped and hollow fruits decreased with increased K rate. Wallace (2008) also observed that, organic matter application and, as a consequence, the humus soil distribution decreased soil Na, EC and pH likely due to supplies of Ca, Mg and K. These mineral elements kept the cation-exchange sites on soil particles, minimizing adsorption of Na, so enhancing Na leaching losses during precipitation events. In addition, compost applied had a great role in plant strength and reduce diseases in tomato production (Chellemi and Lazarovits, 2002). Related with this, Bulluck and Ristaino (2002); Abbasi *et al*. (2002) reported that, composts incorporated into soil or planting mixes can provide effective biological control of diseases caused by soil borne plant pathogens as well as foliar pathogens. Akanbi *et al*. (2005) suggested that, tomato can be supplied with combination of compost and mineral N fertilizers to improve fruit yield. Ogbomo (2011) found positive relationship between fruit yield enhancement and viability in tomato production by using organic mineral. On the other hand, the mulch applied with compost have a great role on saline soil restoration that increase soil organic matter,

improve soil moisture, commence nutrient availability and enhance plant growth and fruit yield and increase the fruit quality as per it protect fruit from soil contact and damaging that decrease the unmarketable fruit on this treatment. The increase marketable in yield of mulched plot was probably also associated with the conservation of moisture and improved microclimate both beneath and above the soil surface and great weed control. Hamid *et al.* (2012) reported that, mulch was significantly had higher marketable yield compared to bare soil.

Beside the lowest yield on the control plot, it might be due to the low amount of nutrient in the soil because of the continuous irrigation used throughout the year and removal of crop residue which caused low organic matter. Also the salt affected soil of the experimental site has low cation exchange capacity that influence nutrient up take and retard plant growth. Salinity might cause water deficit at the root zone similar to that produced by drought. This is with the agreement of Qian *et al.* (2000) who reported that the plant response to salinity consists of numerous processes because salinity decreases the rate of photosynthesis and plant growth to various degrees. Steppuhn (2005) also found that, accumulation of soluble salts has influence on soil - plant - water relationships and the level of soluble salts

Unmarketable fruit yield (ton/ha): -Analyzed data of unmarketable fruit yield revealed that unlike the main effects of compost and mulch, interaction effects of the main effects indicated significant ($P<0.01$) effect (Appendix Table 3). The maximum unmarketable fruit yield/ha (3.65t/ha, 3.61/ha, 3.61/ha, 2.85t/ha, 2.95t/ha, 3.55t/ha and 3.54t/ha) was recorded from 0cm and 0 ton, 5cm and 2 ton, 10cm and 2 ton ,5cm and 4 ton, 10cm and 4 ton 0cm and 6ton and 15cm mulch thickness and 6ton compost application rates and the minimum (2.66t/ha,2.41t/ha,2.18t/ha,2.63t/ha,2.72t/ha,2.48t/ha,2.85t/ha,2.95t/ha,2.18t/ha,2.69t/ha and2.42t/ha) were recorded for (5cm and0 ton,10cm and 0ton,15cm and 0 ton, 0cm and2 ton,15cm and 2 ton,0cm and 4 ton, 5cm and 4 ton, 10cm and 4on,15cm and4 ton, 5cm and 6ton and 10cm) much thickness and 6 ton compost application rates mulch thickness without compost (Table 7). The maximum unmarketable fruit yield might be from the salinity stress that limit nutrient up take, which influence fruit size; increase fruit crack and disease severity in control plot comparing with other treated plot. On the other hand, because of the salt the control plot persuaded by blossom-end rot. Similarly, Del Amor *et al.* (2001) found that, salinity reduced fruit size, the number of fruits per plant and the total marketable fruit yield and also suggested

the unmarketable fruit yield increased progressively up to 0.80kg/plant with salinity. Also, Tuzel *et al*. (2001) found in his work, increasing salinity increased the incidence of blossom-end rot with tomato. Mulch was also important factors on fruit quality that initiating fruit development, protecting the fruit from soil contacts. Yanar *et al*. (2011) achieved the highest unmarketable yield from non-mulched plot comparing with the mulched plot.

Total fruit yield per hectare (ton/ha): -The result on (Appendix table 3) showed significant (P<0.01) difference due to the main effect of compost and mulch and the interaction effects of the main effects on the total yield of tomato production. The maximum yield (39.64 t/ha and 35.98t /ha) obtained on the interaction effects of compost and mulch were obtained when (6t/ha) compost interact with (10cm) mulch thickness and also on 10cm mulch thickness and compost application rates. The minimum yield (25.33t/ha, 27.82t/ha and 28.84t /ha) were on the 0cm and 0 ton,5cm and 0ton and 10cm and 0ton) (Table 7). Compost and mulch combination gave the highest yield parameters compared to individual factors.

In general, the yield obtained from the present experiment was less than the average (40 ton ha^{-1}) potential yield of Roma Vf tomato variety (MARC, 2003). Because of the salinity effect of the experimental site and the inadequate available nutrient in the soil these limit plant growth and fruit yield. The other environmental factors such as wind speed during the production time, predators, temperature and the rainfall received at the maturity stage might be the reason of the yield reduction

Table 7. Effects of compost and mulch interaction on marketable fruit yield per hectare, un-marketable fruit yield per hectare and total fruit yield per hectare of tomato.

Treatment number	Compost rate and mulch thickness interaction	MFY(ton/ha):	UMF Y(ton/ha):	T FY(ton/ha):
1	0*0	21.67^{h}	3.65^{a}	25.33^{g}
2	5 * 0	25.16^{gh}	2.66^{c}	27.82^{fg}
3	10*0	26.43^{fg}	2.41^{c}	28.84^{efg}
4	15 * 0	30.29^{bcdef}	2.18^{c}	32.47^{bcde}
5	0 * 2	29.50^{bcdef}	2.63^{c}	32.13^{bcde}
6	5 * 2	28.87^{cdefg}	3.61^{a}	31.38^{cdef}
7	10 * 2	27.89^{cdefg}	3.61^{a}	31.51^{cdef}
8	15 * 2	31.62^{bc}	2.72^{bc}	34.34^{bc}
9	0 * 4	27.32^{defg}	2.48^{c}	29.80^{def}
10	5 * 4	31.40^{bc}	2.85^{abc}	34.25^{bc}
11	10 * 4	33.03^{b}	2.95^{abc}	35.98^{ab}
12	15 * 4	31.65^{bc}	2.18^{c}	33.83^{bc}
13	0 * 6	30.46^{bcde}	3.55^{a}	34.01^{bc}
14	5 * 6	30.98^{bcd}	2.69^{c}	33.67^{bcd}
15	10* 6	37.23^{a}	2.42^{c}	39.64^{a}
16	15 * 6	26.97^{efg}	3.54^{ab}	30.51^{cdef}
SEM(±)		1.94	0.02	1.97
LSD(0.05)		3.96	0.05	4.02
CV		8.10	17.50	7.50

Means followed by the same letter within a column are not significantly different from each other at 5% level of significance. SEM = Standard Error of Mean, LSD=Least Significant Difference, CV= Coefficient of Variation. MFY (ton/ha):= Marketable fruit yield per hectare in ton, UM F Y (ton/ha):= Unmarketable fruit yield per hectare in ton, T FY (ton/ha):= Total fruit yield per hectare in ton

Number of seed per fruit: -Regarding these parameters**,** Compost and mulch interaction showed significant (P<0.01) deference. However, the main effects of mulch and compost showed non observable difference on number of seed per fruit (Appendix Table 3). The maximum number (83.84, 81.80 and 79.10) were recorded from mulch (15cm) thickness with zero compost,0cm mulch thickness and 4ton compost application rates and 0cm mulch thickness and 6 ton compost application rates. But, the minimum number of seed per fruit (53.03,65.70, 67.22,61.18,57.28 and 58.77 and 60.66) were recorded from the 0cm and 0 cm15cm and 2 ton, 10cm 4ton, 10cm and 6 ton and 15cm mulch thickness and 6 ton compost rates. The maximum number recorded from the above treatment might be due to compost mulch presented favorable, moisture, and water up take and enhance development of economic parts such as pollination, fruit healthy and seed production. This agreement with Sing (1997) who reported that, available temperature is important for growth and development of vegetables in terms of seed germination, development of economic parts, flowering, pollination, fruit set, seed production. Also Anisuzzaman *et al*. (2009) reported that, significant variation was found due to the effect of mulching on both number of seeds and percent seed set per umbel that mulching markedly increased seed yield of onion.

The lower number of seed from control plot on the other hand might be due to the limited nutrient up take because of low organic matter and available nutrient in the soil. And salinity also affected the seed setting. Similarly, Debez *et al.* (2004) a drastic reduction of tomato   seed production was observed at higher salt concentration.

Seed yield per plant (g) :-Appendix Table 3 shows results of analysis of seed yield per plant. Accordingly the main effect of compost, mulch and their interaction effects was significant (P<0.01). The maximum seed yield per plant (11.04 g) was obtained from the combination of (4t/ha) compost and (15cm) mulch. The lowest yield (4.18g) was observed from the control plot. The highest yield from the above treatment might be due to the applied mulch that created a favorable microclimate for the activities of soil microorganisms, which improve and maintain the biological and physical qualities of the soil there by improved the growth performance of tomato plant and seed development. I n addition, this result revealed that increasing mulch thickness was more important than increasing compost rate for tomato seed production. Similarly Liasu and Achakzai (2007) reported the number of tomato seed per fruit were highest in mulched and

lowest in un mulched plants. On the other hand, the compost application might have improved the seed setting and development. In this relation result from Jagadeesha (2008) suggests that higher seed yield and quality of tomato under manures application.

1000-seed weight(g): -Due to the main effect of compost and mulch as well as due to the interaction effect (Appendix Table 3) A significant ($P<0.05$) different were observed on 1000 seed weight between treatments and control. The maximum (3.62gm) weight was observed on (4t/ha) compost and (15cm) mulch thickness interaction. The minimum weight (1.87gm)was observed on control plot (Table 8).The maximum seed weight might be from the application of compost and mulch that were improved the organic matter content of the soil that leads to increase the seed size and quality.. In this relation Liasu and Achakzai (2007) found that, tomato plant growing under mulched and fertilized soil had the biggest sizes of fruit each with round blossom end shape.

Seed yield (Kg/ha): -As indicated on appendix Table 3 the interaction effect of the main effects and the main effects of rate of compost application and mulching revealed significant ($P<0.01$) differences between the treatment and control on seed yield per hectare (Appendix Table 3). The greatest seed yield per hectare (185.3kg) was observed on (4t/ha) compost application rate and (15cm) mulch thickness combination. The minimum (70.2 Kg, 88.00Kg, 93.30 Kg,91.80Kg and 91.00Kg) were observed on 0cm with 0 ton,0cm with 2 ton, 5m with 2 ton, 10 cm with 6 ton and 15cm mulch thickness and 6ton compost application. In relation to this Liasu and Abdulkabir (2007) reported that the combination of fertilizer and mulch promote growth and yield of tomato better than fertilizer or mulch alone. Also, it improves fruit shapes, fruit number and number of seeds per fruit and therefore yields per ha. Oso *et al.* (2010) reported that, the cover of mulch created a favorable microclimate for the activities of soil micro-organisms which helps to improve and maintain the biological and physical qualities of the soil there by improves the growth performance of plants. Compost application probably increased seed yield through supplying macro (NPK) and micro nutrient like boron, zinc, molybdenum etc. that important for seed production. In similar case Kumari *et al.* (2006) found out that, the effects of boron, zinc, molybdenum, copper, iron and/or manganese, application increased the growth of fruit and seed yield of tomato. On the other hand, the decreasing seed yield was due to the salinity effects.

Rahimi (2012) found that, umbel number per plant and seed yield decreased with the increase in salinity level.

Germination percentage (%): -Analysis of germination percentage indicated that all the main effects of compost and mulch as well as interaction effect of the main effects were significant (P<0.01) effect (AppendixTabe3).The maximum germination percentage (79.50%,77%,75.00%,72%,72% and 71.50%) were observed when (15cm and 4ton ,0cm and 6 ton, 5cm and 2ton, 10cm and 6ton, 15cm and 6ton and 10cm and 2ton)t mulch thickness and compost rate were sown in combination. The minimum (45.00.00%) was indicated on control plot. The greater germination percentage might be from the optimum compost and mulch applied that enhance normal seed growth with good food storage at maturity time because seed yields and seed quality (germination and vigor) may be unpredictable due to growing conditions. In addition, the minimum percentage of germination might be caused from very small seed size caused from the low nutrient content of the control plot and it might be the effects of soil salinity. Salinity affects almost every aspect of the physiology and biochemistry of the plant. Alpaslan *et al.* (1999) suggested that Na^+ in salt-stressed plants is taken up by the roots and is accumulated in the whole plant depending on whether or not the cultivars are salt-tolerant or sensitive.

Table 8. Interaction effect of mulch and compost on seed yield and seed quality of tomato

Treatment number	Compost rate and mulch thickness interaction	NSPF	SYPP(g)	TH SW(g)	SYP ha (kg)	SG % tage
1	0* 0	53.03^{h}	4.18^{g}	2.10^{cdef}	70.20^{g}	56.00^{h}
2	5 * 0	65.70^{defg}	5.94^{def}	2.27^{bcde}	99.70^{def}	7..00^{bcdef}
3	10 * 0	73.2^{bcd}	6.07^{def}	1.96^{ef}	101.80^{def}	62.50^{gh}
4	15 * 0	83.84^{a}	8.26^{bc}	2.25^{bcde}	138.70^{bc}	45.00^{i}
5	0 * 2	67.22^{defg}	5.24^{fg}	1.99^{ef}	88.00^{fg}	63.00^{fgh}
6	5 * 2	68.82^{def}	5.56^{defg}	1.92^{ef}	93.30^{defg}	75.00^{abc}
7	10 * 2	73.51^{bcd}	7.11^{bcd}	2.01^{def}	119.40^{bcd}	71.50^{abcde}
8	15 * 2	61.18^{efgh}	6.51^{def}	2.38^{bcd}	109.20d^{ef}	71.00^{bcdef}
9	0 * 4	81.80^{ab}	8.45^{b}	2.56^{b}	141.80^{b}	66.50^{defg}
10	5 * 4	64.40^{defg}	6.69^{cdef}	2.41^{bc}	112.30^{cdef}	68.50^{cdefg}
11	10 * 4	57.28^{gh}	6.31^{def}	2.23^{bcdef}	105.80^{def}	64.50^{efg}
12	15 * 4	64.22^{defg}	11.04^{a}	3.62^{a}	185.30^{a}	79.50^{a}
13	0 * 6	79.10^{abc}	6.87^{bcde}	1.99^{ef}	115.30^{bcde}	77.00^{ab}
14	5 * 6	70.38^{cde}	6.63^{def}	1.95^{ef}	111.30^{def}	71.00^{bcdef}
15	10* 6	58.77^{fgh}	6.87^{bcde}	1.87^{f}	91.80e^{fg}	72.50^{abcde}
16	15 * 6	60.66^{efgh}	5.42^{efg}	2.18^{cdef}	91.00e^{fg}	72.50^{abcde}
SEM(±)		5.01	0.78	0.18	13.05	4.10
LSD(0.05)		10.23	1.59	0.37	26.65	8.37
CV		9.10	14.40	9.80	14.40	7.40

Means followed by the same letter within a column are not significantly different from each other at 5% level of significance. SEM = Standard Error of Mean, LSD=Least Significant Difference, CV= Coefficient of Variation. NSPF = number of seed per fruit, SYPP = Seed yield per plant, THSW = thousand seed weight, SYP/ha = seed yield per hectare and SG% tage = seed germination percentage.

4.3. Correlation Analysis aamong Crop Phenology, Growth, Yield and Yield Components

The correlation coefficient among crop phenology, growth, yields and yield components as well as quality parameters of tomato are provided on Table 9. Days to 50% flowering was highly significant and positively correlated with days to 50% maturity ($r=0.84^{**}$) this indicated that the plants which flower early were matured early and vice versa.

However it was significantly ($P<0.5$) and negatively correlated with number of cluster per plant ($r=-0.32^{*}$), seed yield per plant($r=-0.31^{*}$), thousand seed weight ($r=-0.34^{*}$) and seed yield per hectare ($r=-0.31^{*}$). Days to 50% maturity was highly significant and negatively correlated with plant height ($r=0-.34^{*}$), number of cluster per plant ($r=-0.44^{**}$), fruit polar diameter($r= -0.30^{*}$), seed yield per plant ($r=-0.30^{*}$), thousand seed weight ($r=-0.35^{*}$), seed yield per hectare ($r=-0.31^{*}$) and seed germination percentage ($r=-0.29^{*}$).

Plant height was significant ($P<0.5$) and positively correlated with number of cluster per plant ($r=0.53^{**}$), single fruit weight per plant ($r=0.55^{**}$), fruit polar diameter ($r=0.54^{**}$), fruit equatorial diameter ($r=0.34^{*}$) and seed germination percentage ($r=0.35^{*}$). The parameters that positively correlated with plant height were revealed that optimum fruit yield because of highly synthesize plant. Sharma (1990) reported that plant height had the direct effect on fruit yield. Mohanty (2002) also reported a negative correlation between yield and plant height which was not observed in present investigation but association was significant in present study. Number of branch per plant was also highly significant and positively correlated with number of cluster per plant ($r=0.37^{*}$), fruit per cluster ($r=0.29^{*}$), number of fruit per plant ($r=0.45^{**}$), single fruit weight per plant ($r=0.31^{*}$), fruit weight per plant ($r=0.34^{*}$), fruit polar diameter ($r=0.29^{*}$), marketable yield per hectare ($r=0.34^{*}$) and total yield per hectare ($r=0.31^{*}$).This showed that, as the number of branch per plant and Number cluster per plant increases, the fruit yield and yield component were increase. Premalakshmi (2001) reported that number of branch per plant was positively correlated with yield in tomato. In another development, fruit weight was found to be positively correlated with yield per plant according to Yadav and Singh, (1998). However, it was highly significant ($P<0.5$) and negatively correlated with unmarketable yield per hectare ($r=-0.35^{*}$). Number cluster per plant was highly significant ($P<0.5$) and positively correlated with number of fruit per plant ($r=0.48^{**}$), single fruit weight per plant ($r=0.63^{**}$), fruit weight per plant

(r=0.46**), fruit polar diameter (r=0.61**), fruit equatorial diameter (r=0.56**), marketable yield per hectare (r=0.46**), total yield per hectare (r=0.48**).

Fruit per cluster was highly significant (P<0.5) and positively correlated with number of fruit per plant (r=0.45**), equatorial diameter (r=0.30*), marketable yield per plant (r=0.58**), total yield per hectare (r=0.58**); whereas it was highly significant and negatively correlated with unmarketable fruit yield per hectare (r=-0.35*) and showed that increasing the fruit per cluster was enhance fruit per plant. Ghosh *et al.* (2010) and Tasisa *et al.* (2012) reported a significant positive correlation between yield and cluster per plant, fruits per cluster and fruits per plant which is in accordance to the present study. Hannan *et al.* (2007) and Hayder *et al.* (2007) also reported high and significant positive association between fruit yield and flower clusters/plant, leaves/plant and plant height in tomato. Number of fruit per plant was highly significant and positively correlated with fruit weight per plant (r=0.57**), fruit polar diameter (r=0.36*), fruit equatorial diameter (r=0.49**), marketable yield per hectare (r=0.57**), total yield per hectare (r=0.56**), seed yield per plant (r=0.43**), seed yield per hectare (r=0.43**). Conversely it was highly significant and negatively correlated with fruit shape index (r=-0.40**) and unmarketable yield per hectare (r=-0.33*). Single fruit weight per plant was highly significant and positively correlated with fruit weight per plant (r=0.39**), fruit polar diameter (r=0.66**), equatorial diameter (r=0.49**), marketable yield per hectare (r=0.39**), total yield per hectare (r=0.42**) and seed germination percentage (r=0.37*). Fruit weight per plant was highly significant (P<0.5) and positively correlated with fruit polar diameter (r-0.36*), fruit equatorial diameter (r=0.62**), marketable yield per hectare (r=0.62**), total yield per hectare (r=0.99**). Similarly, Ara *et al.* (2009) observed significant positive correlation for yield and fruit weight. Similar to the observations in the present study Singh *et al.* (1997) also observed strong positive correlation for number of fruits per plant and number of fruits per cluster with fruit yield. Das et al. (1998) also observed significant positive correlation for fruit yield per plant and fruits per plant and fruit weight. Fruit polar diameter was highly significant and positively correlated with fruit equatorial diameter (r=0.63**), marketable yield per hectare (r=0.36*) and total yield per hectare (r=0.37*). Fruit equatorial diameter was also indicated highly significant (P<0.5) and positively correlated with marketable yield per hectare (r=0.62**), total yield per hectare (r=0.64**). Also marketable yield per hectare result showed highly significant (P<0.5) and negatively correlated with unmarketable yield per hectare (r=-0.33*); but it indicated positively correlated with total yield

per hectare (r=0.99**). This result was indicated that, as fruit quality increase, cracking and damaging fruit is reduce. Unmarketable fruit yield per hectare indicated highly significant (P<0.5) and negatively correlated with seed germination percentage (r=0.35) and negatively correlated with seed yield per plant (r=-0.34*) and seed yield per hectare (r=-0.34*).

Number of seed per fruit was highly significant (P<0.5) and positively correlated with seed yield per plant (r=0.48**) and seed yield per hectare (r=0.48**). Seed yield per plant was highly significant and positively correlated with thousand seed weight (r=0.77**), seed yield per hectare (r=1.00**). Thousand seed weight revealed highly significant (P<0.5) and positively correlated with seed yield per hectare (r=0.77**).

Table 9. Correlation analysis among crop phenology, Growth, Yield, yield components and Quality of Tomato parameter

Parameters	DFF	DFM	PH	NPBPP	NCPP	NFPC	NFPP	SFWPP	FWTPP	FPDM	EQTD	FSHI	MYP (ton/ ha)	UNMRT YP (ton/ha)	TYP (ton/ ha)	NSPFRT	SYPP	1000 SW	S Y P ha (Kg)	SG% TAGE
D 50% F	1																			
DFM	.84**	1																		
PH	-.26	-.34*	1																	
N PBPP	.18	.07	.26	1																
NCPP	-.32*	-.44**	.53**	.37*	1															
FPC	-.17	-.28	.13	.29*	.16	1														
NFPP	-.07	-.17	.26	.45**	.48**	.45**	1													
SFWPP	-.14	-.23	.55**	.31*	.63**	.18	.24	1												
FWTPP	-.23	-.24	.20	.34*	.46**	.58**	.57**	.39**	1											
FPDM	-.10	-.30*	.54**	.29*	.61**	.23	.36*	.66**	.36*	1										
EQTD	-.23	-.23	.34*	.25	.56**	.30*	.49**	.49**	.62**	.63**	1									
FSHI	.21	.10	-.07	-.09	-.32*	-.24	-.40**	-.16	-.53**	-.90	-.81**	1								
MFYP (ton/ha)	-.23	-.24	.20	.34*	.46**	.58**	.57**	.39**	.090**	.36*	.62**	.99	1							
UNMRTYP (ton/ha)	-.07	-.14	.03	-.35*	-.09	-.35*	-.33*	-.01	-.33*	-.02	-.12	-.53**	-.33*	1						
TYP (ton/ha)	-.28	-.28	.22	.31*	.48**	.58**	.56**	.42**	.99**	.37*	.64**	.17	.99**	-.25	1					
NSPFRT	.00	.02	.19	.15	-.02	.05	.04	-.06	-.07	.08	.08	.17	-.07	-.17	-.08	1				
SYPP	-.31*	-.31*	.11	.12	.24	.26	.43**	.05	.20	.08	.10	-.55**	.20	-.34 *	.23	.48**	1			
1000 SW	-.34*	-.35*	-.05	-.03	.16	.21	.15	.09	.20	.02	-.02	-.16	.20	-.27	.24	-.07	.77**	1		
SYP ha (Kg)	-.31*	-.31*	.11	.12	.24	.26	.43**	.05	.20	.08	.10	-.16	.20	-.34*	.23	.48**	.99.00 **	.77**	1	
SG%TAGE	-.19	-.29*	.35*	-.01	.27	.07	.06	.37*	.15	.25	.20	.02	.-.32	.35	.21	-.23	-.22	-.12	-.22	1

Where, DFF= days to fifty percent flowering, DFM=days to fifty percent maturity, PH= plant highs NPBPP=number of primary branch per plant, NCPP =Number of cluster per plant FPC= Fruit per cluster, NFPP =Number of Fruit per plant, SFWPP=single fruit weight per plant, FPDM= Fruit polar diameter, FEQTD= Fruit equatorial diameter, **FSHI** ***= fruit shape index MFYP*** **(ton/ha)*****= marketable yield per hectare in ton, UMFYP*** **(ton/ha)** ***= unmarketable yield per hectare in ton, TYP*** **(ton/ha** ***=Total yield per hectare in ton, NSPFRT= number of seed per fruit, SYPP=seed yield per plant, 1000 SW=Thousand seed weight per plant, SYP ha=seed yield per hectare and SG%TAGE seed germination percentage , * =Correlation is significant at the 0.05 level and **= Correlation is significant at the 0.01 level***

4.4. Profitability Analysis of Mulch and Compost

The profitability analysis of this study showed positive relationship between fruit yield enhancement and viability in tomato production. Using compost and mulch is expensive. However, this study demonstrated that it is profitable and viable with reference to net profit and benefit-cost ratio. As indicated in (Table 10), the highest total cost of compost and mulch 76810 ETH Birr was recorded for the application of 6t/ha compost rate and 15cm mulch thickness and the cheapest cost of production 61933 ETH Birr was recorded on the control plot. The maximum compost rate and mulch thickness incurs the maximum cost of production, which was the most expensive. However the greater profit from the marketable yield was from 6t/ha compost rate with 10cm mulch thickness. The total revenue obtained was also directly proportional to the marketable yield; in that, the maximum 260610 ETH Birr was found when 6t/ha compost was applied with 10cm mulch thickness and the minimum 151690 ETH Birr was on the control plot. The net income and benefit cost ratio showed also a positive relation to the marketable yield and total revenue; in that the maximum and minimum net income was 184832 and 89756.78 ETH Birr respectively and the maximum and minimum benefit cost ratio were 3.44 and 2.45 respectively. Ogbomo and K. (2011) found that organomineral fertilizer application is the most effective for the optimum growth yield and profitability of tomato.

Table 10. Effect of compost and mulch on the economic benefit of tomato production.

Item	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Treatment	0* 0	5 * 0	10 *0	15*0	0 * 2	5 * 2	10 *2	15 * 2	0 * 4	5 * 4	10 *4	15 *4	0 * 6	5 * 6	10* 6	15* 6
Land preparation	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300	3300
Seed	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331	2331
DAP and UREA	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230	2230
Mulch and compost	0	1232.1	2364.3	3396.4	7253.5	8485.6	9617.8	10649.9	8977	10209	11341	12373	11481	12713	13845	14877
Seedling and transplanting	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350	2350
Field management	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150	12150
Stalk	17488	17488.5	17488.5	17488.5	17488.5	17488.5	17488.5	17488.5	17488.5	17489	17488.5	17488.5	17488.5	17489	17489	17488.5
Stalking	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600	1600
Chemicals	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4	7080.4
Fuel	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8	7575.8
Harvesting	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5	5827.5
Total Cost	61933	63165	64297.5	65330	69187	70418.9	71551	72583.1	70910	72142	73275	74307	73414	74646	75778	76810
Marketable yield	21670	25160	26430	30290	29500	28870	27890	31620	27320	31400	33030	31650	30460	30980	37230	26970
Total Revenue	151690	176120	185010	212030	206500	202090	195230	221340	191240	219800	231210	221550	213220	216860	260610	188790
Netfarm income	89757	112955	120713	146700	137313	131671.2	123679	148757	120330	147658	157936	147243	139806	142214	184832	111980
Benefit: Cost Ratio	2.45	2.79	2.88	3.25	2.98	2.87	2.73	3.03	2.70	3.05	3.16	2.98	2.90	2.91	3.44	2.46

4.5. Farmers Feedback

This section will provide details of discussion I had with farmers on their perception of problem related to tomato production. Accordingly they highlighted that the major factor limiting their production activity involves water quality and, disease and soil salinity problem. They emphasize that salinity is wide spreading. Secondly they complain also about increased cost of production which is mostly related to fertilizer inputs In this relation Taha (2007) conducted study in Dugda Bora District of East Showa and according to him, the average rate of fertilizer applied by sample households' onion and tomato during the 2005/06 year was 414.78 $kgha^{-1}$ with the maximum amount of fertilizer used was 800 $kgha^{-1}$ while the minimum was 200 $kgha^{-1}$. Probably this is related to increasing salinity and resultant imbalances in nutrient and weak responses from plant this is due to the low fertility of the farm land. By adding high amount of chemical fertilizer, insecticide, pesticide and other inputs, their profitability was not satisfactory. The other point they rose relates to marketing, in the study area farmers are whole seller with low costs that when output prices are high, they can earn substantial profits. Yet when market prices are low, they may fail to earn enough revenue to offset their costs of production. On the hand they are going to produce by rain fed instead of producing on and off season because of soil salinity problem. They used only crop rotation and high rate of fertilizer to overcome these constraints.

Framers welcome the results of this experiment and clearly mentioned that the treatment had effect but their adoption of this technology could be limited by the following major points.

- All crop residues are used for both feeding animal stock and household energy.
- Lack of awareness to prepare compost from raw materials in their hand.
- Constraint of the raw materials such as trees and leaves used for compost preparation.
- They also suggest that mulch may attract disease and pest.

In this relation, future research trend and capacity building need to focus on addressing these farmers concerns and longer-term experiment would give a clue on the contribution of mulch to the different agronomic parameters observed.

5. SUMMARY AND CONCLUSSION

This study indicated that the post-harvest soil result of Mg, Om%, CEC, Ec ds/m, Na, and Available (Av .P) ppm were significantly affected by the interaction effects of compost rates and mulch thicknesses. However, pH, TN%, OC%, and Ca are significantly affected by the main effects of compost application rate. All the phenological tomato parameters indicated significant effect due to the main effects of compost rate. However, the main effects of mulch and interaction of the main effects showed non-significant. All the growth parameters of tomato showed significant difference due to the main effects of compost and mulch, except plant height that showed non-significant effect due to mulch. However, the interaction effects of the main effects indicated the non-significant deferent.

Among the yield and yield components; number of fruit per plant, fruit weight per plant, fruit polar diameter, fruit equatorial diameter, marketable fruit yield per hectare and total fruit yield per hectare revealed significant differences due to the main effects and interaction effects. But single fruit weight per plant indicated significant effect only due to compost rate and unmarketable fruit yield per hectare due to interaction effect only. Result indicated that, the main effects of compost and mulch and their interactions were observed significantly effecting thousand seed weight, seed yield per hectare, seed number per fruit and seed germination percentage. In general 6t/ha compost and 10cm mulch thickness are recommended to make farmers benefited from the system. The calculated result also confirmed that the largest net farm income and benefit cost ratio was obtained from this treatment combination.

Organic fertilizers are used to maximize fruit yield and are more appropriate in terms of soil fertility improvement mainly in the off-season where irrigation is used to secure family food and salinity effects hinders the production. The present study indicated the yields obtained from the fertilized tomato are greater than the yield obtained from the control plot. However, it is difficult to conclude and give strong recommendation in one year experiment at one site, hence further investigation on the selection of best compatible compost rate and mulch thickness proportion for tomato production should be studied.

Future directions

- More research trend is needed on compost rate with these mulch thicknesses to understand their effectiveness on salinity effect.
- Different tomato varieties must be tested rigorously with different compost rate and mulch thickness.
- Plant tissue analysis must be done to evaluate the nutrient uptake of the plants
- Irrigation schedule and the mineral content of the ground water and the river used for irrigation must be tested by laboratory.
- The fruit chemical analysis must be done to identify effects of mulch and compost on quality of fruit.

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7. APPENDIX

Appendix Table1. Effect of Mulch and Compost on the Soil Chemical and Physical Properties after harvest

		Mean Square													
Source of variation	Df	Av.P	EC	CEC	Na	K	Mg	pH	TN%	OM	OC%	Ca	% sand	% Silt	% Clay
Replication	2	13.67	0.07	4.16	0.13	0.01	0.06	0.18	0.004	0.44	0.37	3.60	26.20	0.06	12.06
Compost(A)	3	141.81**	1.52**	63.09**	2.4**	3.99	5.42**	0.75**	0.09**	14.33**	2.61**	28.67**	3.69	3.25	6.25
Mulch(B)	3	64.59**	1.48**	9.69**	0.92**	0.37	0.03	0.25	0.02	4.29*	0.87	0.74	3.69	3.25	10.75
Compost and mulch (A x B)	9	27.23**	0.15**	4.64**	0.62**	0.12	0.18**	0.04	0.004	1.93*	0.25	0.44	3.69	1.08	6.92
Error	30	6.22	0.04	1.72	0.03	0.02	0.04	0.12	0.01	0.66	0.30	1.68	11.47	5.13	4.46

Df = degree of freedom, AV.P = Available phosphorus, EC = Electrical conductivity, Na = sodium, K = Potassium, mg = magnesium, Ca = calcium, % sand = percentage of sand, % silt =percentage of silt, % clay = percentage of clay

Appendix Table 2.Phenology and growth parameters of tomato as influenced by mulch and compost

		Mean Square												
Source of variation	Df	D50%F	D50%M	PH(cm)	N PBPP	N CPP	FPC	N FPP	SFWPP (g)	FWPP	FPDM	FEQDM	FSHI	MFY(ton/ ha):
Replication	2	38.896	82.58	418.87	0.11	41.18	2.43	32.56	36.22	0.14	0.54	0.10	0.01	38.79
Compost(A)	3	83.14**	117.64*	304.54**	5.53**	75.95**	1.09**	40.25*	98.39**	0.26**	0.63**	0.84**	0.06	73.94**
Mulch(B)	3	25.14	42.97	25.38	3.74*	61.93**	0.85**	90.77**	5.14	0.12**	0.70**	1.24**	0.05	33.37**
Compost and mulch (A xB)	9	11.38	21.34	39.58	2.14	11.24	0.54**	25.89*	7.32	0.10**	0.20*	0.38*	0.05	28.30**
Error	30	9.16	34.56	45.02	0.99	10.16	0.14	10.50	7.46	0.02	0.09	0.14	0.02	5.631

*DF F = Days to 50% flowering, D FM = days to 50% maturity, PH = plant height, NPBPP = number of primary branch per plant, N CPP = number of cluster per plant, N FPC = number of fruit per cluster, No FPP = number of fruit per plant, SFWPP (g) = single fruit weight per plant, FWPP = fruit weight per plant, FWPP = fruit weight per plant, FPDM = fruit polar diameter, FEQDM = fruit equatorial diameter, FSHI = fruit shape index, MFY(ton/ha):= marketable fruit yield per hectare in ton. * = significant at 5 % probability level**= highly significant at 1% probability level.*

Appendix Table 3.Yield and yield parameters of tomato as influenced by mulch and compost

Source of variation	Df	UMF Y(ton/ha)	T FY(ton/ha)	N S PF	SYPP	TH SWT	SY P ha	SG% tage
Replication	2	0.002	30.28	43.65	1.17	0.08	328.3	223.19
Compost(A)	3	0.002	78.30**	9.67	12.20**	1.20**	3436.3**	446.67**
Mulch(B)	3	0.002	29.12**	43.43	7.68**	0.77*	2162.8**	225.67**
Compost and mulch (A x B)	9	0.004**	22.25**	377.**	6.21**	0.23**	1750.4**	144.59**
Error	30	0.001	5.81	37.64	0.91	0.05	255.5	25.19

UMF Y(ton/ha):= unmarketable fruit yield per hectare, T FY(ton/ha):= total fruit yield per hectare in ton, N S PF = number of seed per fruit, SYPP = seed yield per plant, THSWT = thousand seed weight, SY P ha = seed yield per hectare, SGR = seed germination rate, SG% tage = seed germination percentage. = significant at 5 % probability level**= highly significant at 1% probability level.*

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Appendix Table 4. Rainfall, temperature distribution and wind speed at Dugda during production season of June2014-May2015

Month	Rain fall (mm)	Max (C^0)	Min (C^0)	Mean Temp (C^0)	Wind speed m/s
June	0.79	29.3	14.2	21.8	1.80
July	4.84	26.0	14.5	20.3	1.70
August	4.97	25.1	13.7	19.3	1.26
September	2,48	25.8	12.7	19.5	0.96
October	7.36	27.2	11.0	19.1	0.91
November	0.00	28.4	9.1	18.7	1.05
December	0.00	28.1	7.6	17.9	0.76
January	0.00	29.0	8.0	20.7	1.13
February	0.00	31.9	9.1	20.5	1.01
March	0.00	32.4	11.4	22.1	1.15
April	0.93	32.6	13.5	23.0	1,28
May	2.63	30.8	16.0	23.6	1.36
Total	23.48	440.48	152.53	267.04	14.28
Ave	2.06	28.88	11.53	20.44	1.14

Source: National Meteorological Agency of Ethiopia ATJK = Adami Tulu Jido Kombolcha

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