# Evaluation of Mulching Materials on Salinity Reduction for Onion Production at Kewot District of North Shewa

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## Abstract

*Salinity is a major problem affecting crop production all over the world: 20% of cultivated land in the world, and 33% of irrigated land, are salt-affected and degraded. This process can be stressed by climate change, excessive use of groundwater (mainly if close to the sea), increasing use of low-quality water in irrigation, and massive introduction of irrigation associated with intensive farming. The objective of this research was to show the effects of different mulching materials on salinity problems for onion production. The experimental treatments were four variables as no much (control), Green manure, incorporated Corotolaria junicea, organic mulch (grass Typhalatifolia"filla") and black plastic. The experimental design was randomized block design (RCBD) with four replications. The statistical analyses were performed using Analysis of Variance (ANOVA) procedure of the SAS 9.1 software. The experimental result indicated on the electrical conductivity increased over year in all treatments however, the result of electrical conductivity in each year lower concentration of the salt observed on filla (0.79, 0.917 and 1.548 EC ds/m) and black plastic mulching (0.89, 0.9417 and 1.578 EC ds/m) material treatment than green manure incorporation (1.61, 1.7425 and 2.925 EC ds/m) and no mulch treatment (1.52, 1.2858 and 1.925 EC ds/m). Similarly, the "filla" and black plastic mulch materials have shown highly significant difference on marketable yield as compared to control with 32.82% and 25.24 % yield advantage respectively. Therefore, "filla"organic mulching material and black plastic are recommended as mulching materials to get high onion yield with reduced effect of salinity level. And further investigation should be done on the minimizing the electrical conductivity.*

**Key words:** *electrical conductivity, green manure, mulching, onion, salinity*

## Introduction

Salinity is a major problem affecting crop production all over the world: 20% of cultivated land in the world, and 33% of irrigated land, are salt-affected and degraded. Soil salinity has been a major concern to global agriculture throughout human history (Lobell, *et al*., 2007). In recent times, it has become even more prevalent as the intensity of land use increases globally. Salinity of arable land is a problem that is becoming more and more important in many areas where irrigation is a regular agro-technical measure, and in semi-arid and arid regions in the world where atmospheric precipitations are not sufficient to flush the salts from the root zone.

In Australia, Africa, Latin America, and in the near and the Middle East these soils are widely present. About 951 million hectare of soil is affected worldwide and 80.4 million hectares of it is shared by Africa (Abrol *et al*., 1988). Ethiopia is not an exception to the problem although irrigation is not widely developed compared to the potentially irrigable area. In fact, it stands first in acreage of saline soil in Africa (Abrol *et al*., 1988). According to FAO (2005), Ethiopia has 10.61-million-hectare saline and 425,000 ha sodic land. The semi-arid and arid lowlands and valleys have major problems of salinity and alkalinity. Tamirie reported that 44 million ha
land area) is potentially susceptible to salt affected. Out of the 44 million ha, 75 % have dominantly salinity problems, 18 % have combined salinity and alkalinity problems and 7 % have dominantly alkalinity problems.

In the study area the maximum temperature reaches $32^{o}$c and annual evapotranspiration is 1517 mm and the annual rainfall is 1007.8 mm which is precipitation to evaporation ratio is 0.66 Soil salinity is a major environmental factor causes reduction in plant growth and productivity in arid and semiarid areas, where precipitation to evaporation ratios is 0.75 or less (Brady, N.C. and R.R. Weil, 1999). Salinity problem has manifested itself to the extent that farmers are experiencing tremendous yield losses, especially on vegetable crops, and some farms had to be abandoned or farmers had to switch to producing more salt tolerant crops. Adjacent to the study area Efratana Gidim Wereda at Negesso Kebele, about twenty farmers lost their fields due to saline sodic (Yonas and Gizaw 2007).

The use of mulching is one of the easy and effective mechanism to reduce the effect of salinity through the evaporation. Some reported by scholars mulching of soil surface with different materials used to reduce evaporation losses (Li et al., 1999; Deng *et al*., 2003; Qiao *et al*., 2006) and reduce salt build-up in the soil (Pang *et al*., 2009). Mulches may be inorganic (generally thin sheets of polyethylene) or organic (generally plant residues such as straw). Plastic mulches reduce the evaporation of water from the soil surface by 50-80% (Allen *et al*., 1998). Inorganic mulches are durable, but deteriorate with time and may generate disposal problems, whereas organic mulches are biodegradable, decompose more quickly and must be replaced more frequently than inorganic mulches. Deng *et al*. (2006) reported that mulching with crop residues improved water-use efficiency by 10 20% as a result of reduced soil evaporation and increased plant transpiration. As a consequence of reduced evaporation, soil mulching benefits the conservation of water, particularly in the topsoil, decreases the evapo-transpiration rate and lower the concentration of the salts present in the irrigation water and the soil solution (Zhang *et al.*, 2008), Therefore, these research focuses to investigate the effect of mulching on minimize the salinity effect on onion yield production.

## Materials and Methods

*Study Area Description:* The study area is located at 10$^{o}$ 5″32″N Latitude and 39$^{o}$ 54″51″E longitude at about 1197 m.a.s.l average elevation. The area is administered by Kewet District, Yellen Kebele. It is located at a distance of about 235 km to the North East of Addis Abeba on the way to the Northern part of the country (Figure1**)**. The district is classified under hot to warm moist agro-ecological zone. The annual average rainfall as 18 years data recorded at Yellen town is 1007.8 mm and the temperature ranges from 16.5$^{o}$C to 32$^{o}$C (Kewet district bureau of agriculture).

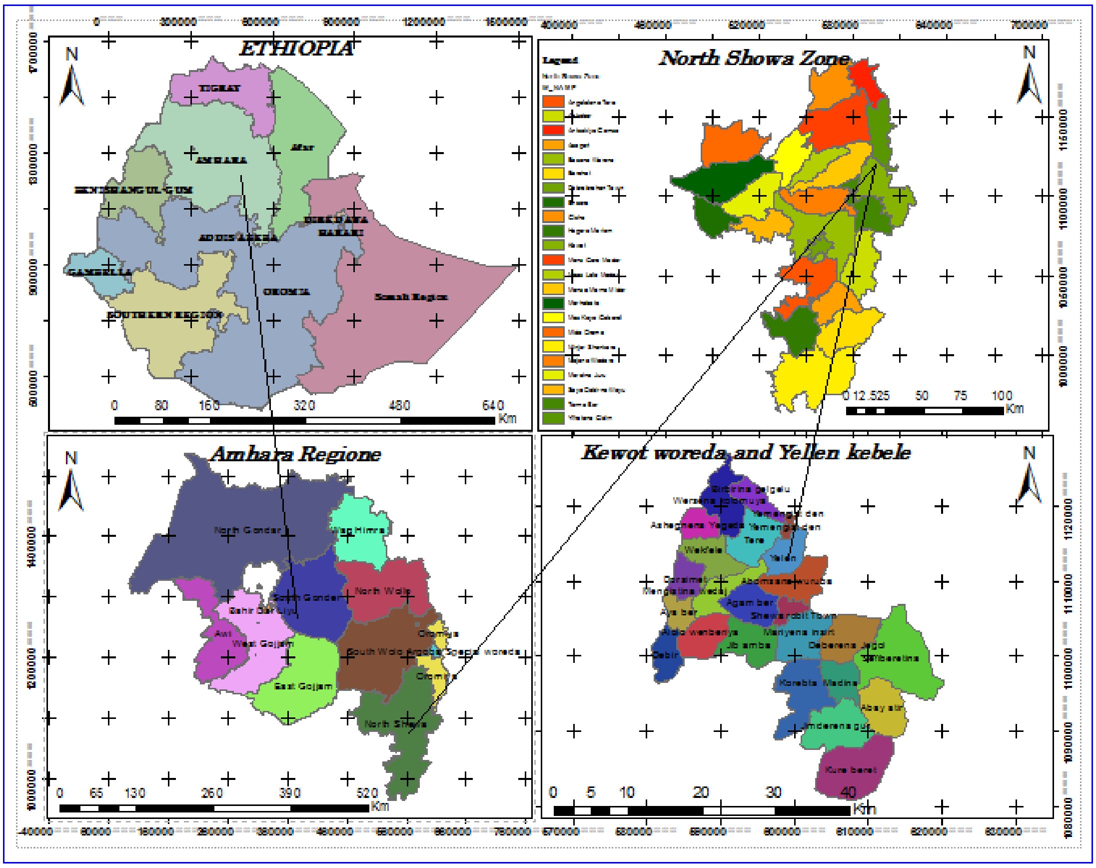


Figure1. Geographical location of study area

*Weather Data:* Rainfall temporal variability over the year the first year was higher than the second year this effect on the electrical conductivity value. The rainfall distribution during the experimental year was highly variable in amount and distribution. The total annual rainfall during the first year (2015/16) was 1065.5 mm while during the second year (2016/17) was 730.4mm. Similarly, in the irrigation season the rainfall distribution and amount was variable. For first year, the seasonal rainfall was 456.9mm and 70.4mm during the second-year irrigation season (Figure 2).

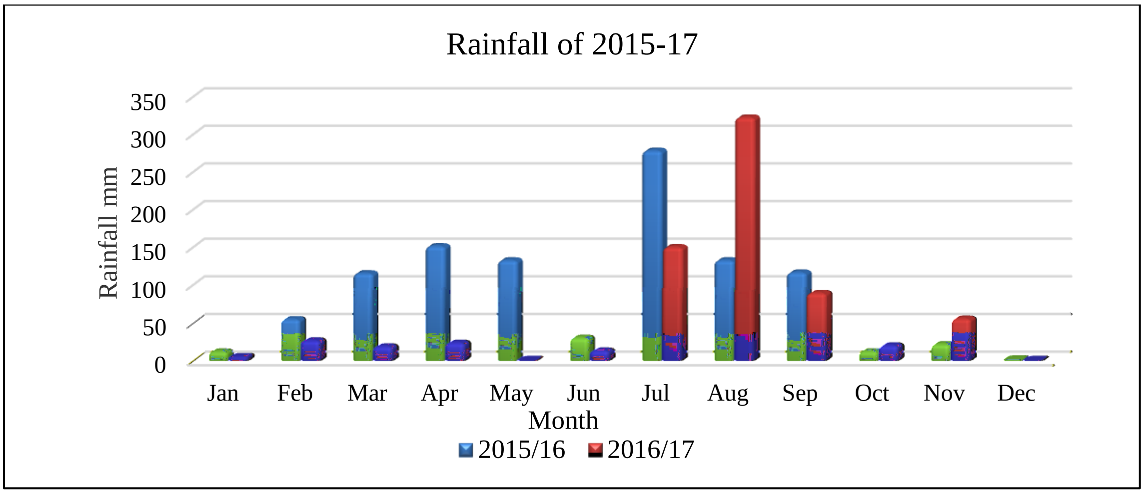


Figure 2. Distribution of rainfall during the experimental years (2015/16-16/17)

The maximum and minimum air temperature of the experimental area during the conducted year was variable from year to year. Maximum temperature was 30.5 and 31.7 $^{0}$C and minimum temperature was 13.3 and 14.1 $^{0}$C for first and second year respectively (Figure 3).

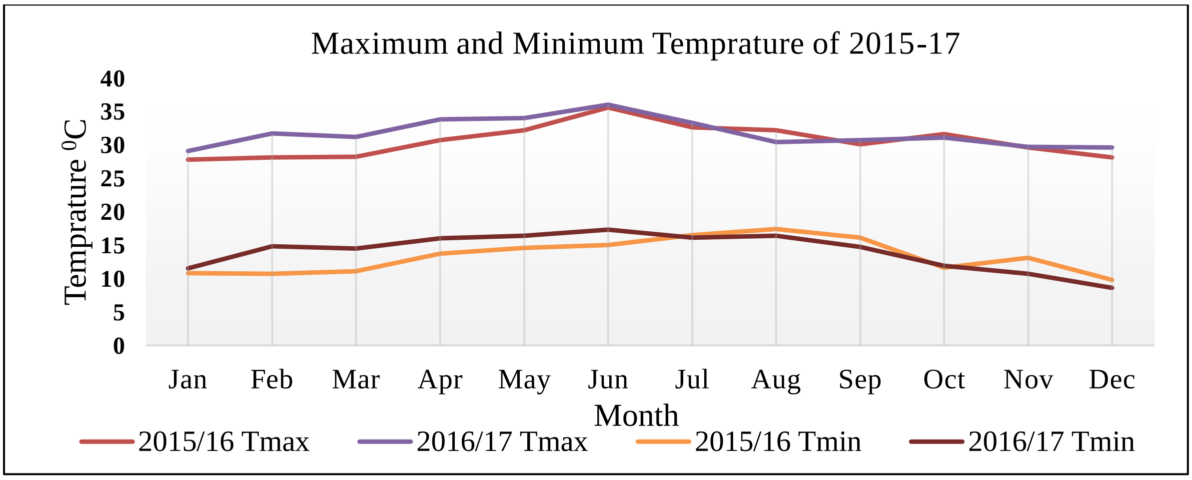


**Figure 3. Maximum and minimum temperature of experimental years (2015/16-16/17)**

The average potential evapo-transpiration of the study area is 5.47 mm/day. This value determined using CROPWAT 8.0 software (Table 1)

Table 1. Evapo-transpiration on the study site at Yellen

| Month | Min T °C | Max T °C | RH % | Wind km/d | Sunshine hours | Radiation MJ/m²/day | ETo mm/day |
|---|---|---|---|---|---|---|---|
| Jan. | 11.1 | 28.5 | 67 | 173 | 10.5 | 22.3 | 4.6 |
| Feb. | 12.7 | 29.9 | 67 | 173 | 10.6 | 24.1 | 5.12 |
| Mar. | 12.8 | 29.7 | 68 | 173 | 10.7 | 25.7 | 5.42 |
| Apr. | 14.8 | 32.2 | 68 | 173 | 11.2 | 26.9 | 5.99 |
| May | 15.5 | 33.1 | 67 | 173 | 11.6 | 26.9 | 6.1 |
| Jun. | 16.2 | 35.8 | 66 | 173 | 12.7 | 28 | 6.63 |
| Jul. | 16.3 | 32.9 | 69 | 173 | 11.1 | 25.8 | 5.89 |
| Aug. | 16.9 | 31.3 | 71 | 173 | 9.8 | 24.3 | 5.43 |
| Sept. | 15.4 | 30.4 | 70 | 173 | 9.8 | 24.3 | 5.31 |
| Oct. | 11.7 | 31.5 | 65 | 173 | 11.9 | 26.3 | 5.68 |
| Nov. | 11.9 | 29.6 | 67 | 173 | 10.7 | 22.9 | 4.83 |
| Dec. | 9.2 | 28.8 | 65 | 173 | 11.4 | 23 | 4.69 |
| Average | 13.7 | 31.1 | 67 | 173 | 11 | 25 | 5.47 |

*Irrigation scheduling:* The irrigation scheduled for onion crop was determined using fixed interval method with the help of CROPWAT 8.0 software. As shown the tables below the initial stage within 4 days interval and for other stage every 7 days interval were used for all treatments (Table 2 and 3). In the first-year, low irrigation water used due to more rainfall distribution with deducted the effective rainfall in growing season. While for the second year used irrigation water due to low to nil effective rainfall in growing season.

Table 2. Irrigation schedule during the first year 2015/16

| | | mm | % | fract. | % | mm | mm | mm | mm | l/s/ha |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | A | 0 | 58 | 0.68 | 70 | 28.8 | 0 | 0 | 41.2 | 1.19 |
| 8 | A | 0 | 20 | 1 | 100 | 10.8 | 0 | 0 | 15.5 | 0.45 |
| 12 | A | 0 | 29 | 1 | 100 | 17.7 | 0 | 0 | 25.2 | 0.73 |
| 16 | A | 0 | 26 | 1 | 100 | 17 | 0 | 0 | 24.3 | 0.7 |
| 20 | A | 0 | 23 | 1 | 100 | 15.9 | 0 | 0 | 22.7 | 0.66 |
| 27 | B | 12.3 | 10 | 1 | 100 | 8.3 | 0 | 0 | 11.8 | 0.2 |
| 34 | B | 0 | 21 | 1 | 100 | 18.7 | 0 | 0 | 26.8 | 0.44 |
| 41 | B | 19.9 | 15 | 1 | 100 | 14.7 | 0 | 0 | 21 | 0.35 |
| 48 | B | 0 | 20 | 1 | 100 | 21.2 | 0 | 0 | 30.4 | 0.5 |
| 55 | C | 21.7 | 7 | 1 | 100 | 7.4 | 0 | 0 | 10.6 | 0.18 |
| 62 | C | 24.2 | 16 | 1 | 100 | 17.4 | 0 | 0 | 24.9 | 0.41 |
| 69 | C | 0 | 23 | 1 | 100 | 24.4 | 0 | 0 | 34.8 | 0.58 |
| 76 | C | 26.6 | 6 | 1 | 100 | 6.3 | 0 | 0 | 9 | 0.15 |
| 83 | D | 0 | 17 | 1 | 100 | 18.3 | 0 | 0 | 26.1 | 0.43 |
| 90 | D | 0 | 28 | 1 | 100 | 30.5 | 0 | 0 | 43.5 | 0.72 |
| End | D | 0 | 0 | 1 | 0 | | | | | |

*A is initial stage, B is development stage, C is mid stage and D is late stage

Table 3. Iirrigation schedule during the second year 2016/17

| | | mm | % | fract. | % | mm | mm | mm | mm | l/s/ha |
|---|---|---|---|---|---|---|---|---|---|---|
| 4 | A | 0 | 67 | 0.53 | 62 | 33.3 | 0 | 0 | 47.6 | 1.38 |
| 8 | A | 0 | 29 | 1 | 100 | 16.1 | 0 | 0 | 23 | 0.67 |
| 12 | A | 0.5 | 26 | 1 | 100 | 15.9 | 0 | 0 | 22.6 | 0.66 |
| 16 | A | 0.5 | 24 | 1 | 100 | 15.8 | 0 | 0 | 22.6 | 0.65 |
| 20 | A | 0 | 24 | 1 | 100 | 16.7 | 0 | 0 | 23.9 | 0.69 |
| 27 | B | 0 | 35 | 1 | 100 | 27.5 | 0 | 0 | 39.3 | 0.65 |
| 34 | B | 0 | 34 | 1 | 100 | 30 | 0 | 0 | 42.9 | 0.71 |
| 41 | B | 0 | 34 | 1 | 100 | 32.6 | 0 | 0 | 46.5 | 0.77 |
| 48 | B | 0 | 28 | 1 | 100 | 30 | 0 | 0 | 42.8 | 0.71 |
| 55 | C | 0 | 31 | 1 | 100 | 33.8 | 0 | 0 | 48.2 | 0.8 |
| 62 | C | 0 | 29 | 1 | 100 | 30.8 | 0 | 0 | 44 | 0.73 |
| 69 | C | 0 | 33 | 1 | 100 | 35.8 | 0 | 0 | 51.1 | 0.84 |
| 76 | C | 0 | 31 | 1 | 100 | 34 | 0 | 0 | 48.6 | 0.8 |
| 83 | D | 0 | 34 | 1 | 100 | 36.7 | 0 | 0 | 52.4 | 0.87 |
| 90 | D | 0 | 34 | 1 | 100 | 36.7 | 0 | 0 | 52.4 | 0.87 |
| End | D | 0 | 18 | 1 | 0 | | | | | |

*A is initial stage, B is development stage, C is mid stage and D is late stage

*Initial soil and water status of the experimental site*

From the experimental site pre planting the composite soil sample were taken from 5 point diagonally and composite it, then after were taken 1 kg soil sample for lab analysis. While for water sample were taken 1 liter. The result presented in table below (Table4).

Table 4. Initial pre-planting composite soil and water result

| | | |
|---|---|---|
| | 8.16 | 1.98 |
| | 8.42 | 3.21 |

*Experimental Design and Treatment Setup*

The experimental treatments were no mulch as 1) control, 2) green manure i.e., incorporated Corotralia junciea, 3) organic mulch (grass Typha latifolia ″*filla*″) and 4) Black plastic mulch replicated four times. The experimental design was Randomized Compl

16 plots). Each plot area was 2.88 $m^2$ (1.8* 1.6 m). The farmland was leveled and chemical fertilizer was applied at the rate of 82 kgha-1 N, 92 kgha-1 $P_2O_5$. For black plastic treatment, the black polythene plastic sheet was laid over the entire bed and water was applied over it to make it stick.

The onion seedling was transplanted after seven weeks with 40 cm x 20cm x *10cm spacing between furrow, raw and plant respectively. For incorporated mulch, Carotralia junicea was chopped and incorporated in the soil one month before transplanting. Grass ″*filla*″ was as organic mulch was used. For all experimental treatments, urea fertilizer was applied at two split applications at planting and vegetative stage.

*Data Collection Method and Analysis*

Composite soil samples were collected before planting while, at mid stage and at harvesting from each plot were collected, weather data, soil data, planting date, harvesting date, plant height, stand count, bulb diameter, number of marketable and unmarketable bulb, marketable and unmarketable yield. The 0-30 cm depth soil samples were taken with a 4 cm diameter Edelman auger in four vines (*i.e.*, replications) of each plot. For simplicity and representativeness of root zone salinity, the results presented are the means of the values. The collected soil samples were brought to the laboratory and analyzed for soil pH and saturation extract electrical conductivity (ECe) in 2015/16 and 2016/17.

***Data Analysis:*** The statistical analyses were performed using Analysis of Variance (ANOVA) and General Linear Model (GLM) procedure of the SAS 9.1 software (SAS est

at $p$ = 0.05 (Gomez, A.K. and Gomez, A.A. 1984).

**Results and Discussion**

*Mulching Materials and Soil pH and Ece:* The analysis of variance revealed that the concentration of salt over years increased due to the rainfall variability , when the rainfall increased the salt is diluted and leached with rain water due to this the level of salt concentration minimized. The rain water is generally acidic in nature. The result of electrical conductivity in each year was lower concentration of salt observed on filla (0.79, 0.917 and 1.548 EC ds/m) and black plastic mulching (0.89, 0.9417 and 1.578 EC ds/m) material treatment than green manure incorporation (1.61, 1.7425 and 2.925 EC ds/m) and no mulch treatment (1.52, 1.2858 and 1.925 EC ds/m) (Table 5). The electrical conductivity showed increased over year in all treatments. Generally, the variation of the pH value was no significant variation among the treatment except the first year. While pH value lower in green manure incorporation treatment (7.42) than other treatments. As reported the scholars mulching reduce evapotranspiration and salt accumulation (Zhang et al., 2008), and maintain moisture content in the root zone, and also reduce soil temperature, evaporation and salt accumulation (Abou-Baker et al., 2011; Swarup, 2013; Alharbi, 2015).

Table 5. Soil pH and ECe for Evaluation of mulching materials on salinity reduction for onion at Shewarobit (2015/16) at harvesting

| Treatment | ECe ds/m 2015/16 at harvesting | ECe ds/m 2016/17 at mid stage | ECe ds/m 2016/17 at harvesting | pH 2015/16 at harvesting | pH 2016/17 at mid stage | pH 2016/17 at harvesting |
|---|---|---|---|---|---|---|
| No mulch | 1.52(0.39) [a] | 1.2858[b] | 1.925[b] | 7.48b(0.928) [ab] | 7.8096 | 7.764 |
| GM | 1.61(0.41) | 1.7425[a] | 2.925[a] | 7.42b(0.915) [b] | 7.7675 | 7.762 |
| Black plastic | 0.89(0.26) [b] | 0.9417[c] | 1.578[c] | 7.66a(0.94) [a] | 7.7879 | 7.695 |
| Typha latifolia | 0.79(0.24) [b] | 0.9171[c] | 1.548[c] | 7.73a(0.93) [ab] | 7.8825 | 7.666 |
| Cv (%) | 41.53(29.8) | 24.3 | 21.7 | 5.84(7.62) | 4.19 | 3.8 |
| LSD (0.05) | 0.14(0.0274) | 0.17 | 0.234 | 0.12 (0.0201) | ns | ns |

** The values in the parenthesis are transformed values

*Irrigation Water pH and ECw*

There was seasonal variation of salt concentration of irrigation water. On the average result showed that during initial- stage of the ECw was less than that of the mid-stage. But pH of the irrigation water was higher at the initial-stage and lower at the mid stage of the growing stage of onion (Table 6). The result may come from the rainfall and temperature effect. Soil mulching benefits the conservation of water, particularly in the topsoil, decreases the evapo-transpiration rate and lower the concentration of the salts present in the irrigation water and the soil solution (Zhang *et al.*, 2008). On average, the electrical conductivity of irrigation water was 3.16 ds/m and pH value were 7.935 these values are for most vegetables above the threshold dS/m ECw (Appendix Tables 1&2)). Even if the values above the threshold relatively better onion yield obtained on mulched treatments than no mulched treatments.

Table 6. Irrigation water pH and ECw at initial and mid stage of irrigation season

| Sample taken | ECw ds/m | pH |
|---|---|---|
| During initial- stage | 3.05 | 8.36 |
| During mid-stage | 3.27 | 7.51 |
| **Average** | **3.16** | **7.935** |

**Mulching material on soil moisture at mid and harvesting stages**

Soil moisture result showed that significant difference between treatments."*filla*" and black plastic mulch material were highly significant results as compared to without mulch and green manure incorporated at the mid stage in both years. At harvesting "*filla*" treatment was highly significant difference among the treatments in both years (Table 7).

Table 7. Response of soil moisture on mulching materials at mid and harvesting stages 2015/16 and 2016/17

| Mulch | Mid stage 2015/16 | Harvesting stage2015/16 | Mid stage 2016/17 | Harvesting stage 2016/17 |
|---|---|---|---|---|
| No | $23.529^{b}$ | $19.577^{c}$ | $19.179^{b}$ | $14.341^{c}$ |
| GM | $24.846^{b}$ | $21.024^{c}$ | $20.566^{b}$ | $15.862^{c}$ |
| Black plastic | $37.032^{a}$ | $31.514^{b}$ | $32.682^{a}$ | $26.278^{b}$ |
| | $37.998^{a}$ | $35.361^{a}$ | $33.648^{a}$ | $30.122^{a}$ |
| Grand Mean | 30.851 | 26.869 | 26.519 | 21.651 |
| CV(%) | 10.39 | 10.12 | 12.18 | 12.79 |
| LSD (0.05) | 3.5049 | 2.973 | 3.5321 | 3.0278 |

The first-year result showed that all parameters have significant difference between treatments, on the effect of mulch with assuming that constant depth and interval for all treatment (Table 8). ″Filla″and black plastic mulch have high results on marketable yield got 26.1% and 23.9 % yield advantage over control treatment (without mulch) respectively. Some reported by scholars mulching of soil surface with different materials used to reduce evaporation losses (Li, et al., 1999; Deng *et al*., 2003; Qiao *et al*., 2006) and reduce salt build-up in the soil (Pang *et al*., 2009).

The second-year results were similar trend with first year result. It showed that for all parameters of yield and yield components have significant difference between treatments, on the effect of mulch with assuming constant interval and depth for all treatments (Table 8). ″*filla*″ and black plastic mulch material have shown highly significant results on marketable yield compared to without mulch have 40.73% and 18.5 % yield advantage respectively.

Table 8. Yield and yield component of onion in the first year (2015/16)

| Mulch material | Marketable yield kgha-1 | Unmarketable yield kgha-1 | Total yield kgha-1 | Bulb diameter mm | plant height cm |
|---|---|---|---|---|---|
| No | 9679.0(3.96) $^{b}$ | 1794.0(3.2) $^{b}$ | 11473.0(4.03) $^{b}$ | 36.3b$^{c}$ | 33.0$^{b}$ |
| GM | 9217.09(3.95) $^{b}$ | 1972.1(2.97) $^{b}$ | 11190.0(4.04) $^{b}$ | 35.4$^{c}$ | 32.9$^{b}$ |
| Black plastic | 12719.0(4.093) $^{a}$ | 2170.3(3.1) $^{b}$ | 14889.0(4.16) $^{a}$ | 40.0$^{a}$ | 39.9$^{a}$ |
| | 13114.0(4.097) $^{a}$ | 3036.4(3.4) $^{a}$ | 16150.0(4.19) $^{a}$ | 39.2$^{ab}$ | 40.5$^{a}$ |
| CV(%) | 29.31(3.02) | 45.99(15.37) | 27.89(2.83) | 10.09 | 13.12 |
| LSD(0.05) | 2722.7(0.1) | 856.8(0.4) | 3109.6(0.09) | 3.16 | 3.98 |

** The value in the parenthesis is transformed value

Table 9. Yield and yield component of onion in the second year (2016/17)

| Treatments | Marketable yield kgha-1 | Unmarketable yield kgha-1 | Total yield kgha-1 | Bulb diameter mm | Plant height cm |
|---|---|---|---|---|---|
| No mulch | 6232(3.72) $^{b}$ | 550(2.73) $^{a}$ | 6782 (3.78) $^{b}$ | 35.38$^{b}$ | 33.95$^{b}$ |
| GM | 5111(3.70) $^{b}$ | 454(2.64) $^{ab}$ | 5566(3.73) $^{b}$ | 29.89$^{c}$ | 31.98$^{b}$ |
| Black plastic | 7648(3.81) $^{ab}$ | 333(2.50) $^{b}$ | 7981(3.84) $^{ab}$ | 36.61$^{ab}$ | 34.97$^{b}$ |
| | 10515(3.94) $^{a}$ | 486(2.66) $^{ab}$ | 11001(3.97) $^{a}$ | 40.17$^{a}$ | 44.32$^{a}$ |
| CV (%) | 48.58(6.33) | 55.32(8.14) | 43.08(5.28) | 13.66 | 16.32 |
| LSD (0.05) | 3130.1(0.245) | 220.23(0.226) | 3084.5(0.206) | 3.99 | 4.82 |

** The value in the parenthesis is transformed value

The combined result also showed similar trend with individual year result. It showed that for all parameters of yield and yield components have significant difference between treatments except unmarketable yield, on the effect of mulch with assuming constant interval and depth for all treatments."*filla*" and black plastic mulch material have shown highly significant results on marketable yield compared to without mulch have 32.82% and 25.24 % yield advantage respectively (Table ). Our results are similar to findings of Bu et al. (2002), who reported that surface-applied mulches provide benefits to crop production through improving water, heat energy and nutrient status in soil, preventing soil and water loss, preventing surface soil salinity and controlling weed. Also, straw mulch helps to retain soil moisture, reduce temperature, and conserve soil, control weeds and increase soil fertility.

Table 10. Yield and yield component for Evaluation of mulching materials on salinity reduction for onion at Shewarobit (combined)

| Treatments | Marketable yield kgha-1 | Unmarketable yield kgha-1 | Total yield kgha-1 | Bulb diameter mm | Plant height cm |
|---|---|---|---|---|---|
| No mulch | 8007(3.85) $^{b}$ | 1195.6(2.97) | 9166(3.91) $^{b}$ | 35.83$^{b}$ | 33.45$^{c}$ |
| GM | 7960(3.86) $^{b}$ | 1543.9(3.00) | 9417(3.93) $^{b}$ | 32.67$^{c}$ | 32.45$^{c}$ |
| Black plastic | 10710(3.97) $^{ab}$ | 1379.8(2.91) | 12041(4.02) $^{ab}$ | 38.32$^{ab}$ | 37.41$^{b}$ |
| | 11920(4.02) $^{a}$ | 1739.9(3.04) | 13656(4.08) $^{a}$ | 39.69$^{a}$ | 41.42$^{a}$ |
| CV(%) | 43.14(5.28) | 87.2(7.2) | 44.7(4.7) | 12.03 | 14.88 |
| LSD (0.05) | 2839(0.12) | 901(0.06) | 333.75(0.11) | 2.5 | 2.18 |

** The value in the parenthesis is transformed value

## Conclusion and Recommendation

Soil salinity is becoming a major constraint to vegetable crop production. Vegetable crop production requires a high input of fertilizers and water; these are possibly increasing soil salinity. Mulching management strategies must consider minimizing the effects of salinity on onion bulb production. Mulching with grass (*"filla"*) and with black black plastic increases onion bulb yield and keeps the moisture content to reduce the effect of soil salinity. The experimental result indicated on the electrical conductivity increased over year in all treatments due to rainfall variability. however, the result of electrical conductivity in each year lower the concentration of salt observed on filla (0.79, 0.917 and 1.548 EC ds/m) and black plastic mulching (0.89, 0.9417 and 1.578 EC ds/m) material treatment than green manure incorporation (1.61, 1.7425 and 2.925 EC ds/m) and no mulch treatment (1.52, 1.2858 and 1.925 EC ds/m). Considering the costs to use the mulching materials were used black plastic mulching material not recommended but for sustainable land use and minimizing the effect of salt *"filla"* mulching is better. As the results of (first, second and combined) year *"filla"*and black plastic mulch have high results on marketable yield got 26.1%, 40.73% 32.82% and 23.9 %, 18.5%, 25.24% yield advantage over control treatment (without mulch) respectively.

Therefore, we recommended that *"filla"*organic mulching material is the best mulching material to get high onion production with the lowest effect of salinity. And also, further research will be done with the variation of water amount and frequency and with different crops and vegetables in addition to onion. And also, should be done further water treatment

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## Annex

Appendix Table 1. Salt tolerance of vegetable crops as determined by soil salinity (ECe) and irrigation water salinity (ECW)

| Vegetable | Soil Threshold 1 | Irrigation Water Threshold 1 | Rating |
|---|---|---|---|
| Asparagus | 4.1 | 2.7 | T |
| Bean | 1 | 0.7 | S |
| Broccoli | 2.8 | 1.9 | MS |
| carrot | 1 | 0.7 | S |
| Cauliflower | - | 1.9 | MS |
| Celery | 1.8 | 1.2 | MS |
| Eggplant | 1.1 | 0.7 | MS |
| Lettuce | 2 | 0.9 | MS |
| Muskmelon | 1 | - | MS |
| Okra | 1.2 | - | S |
| Onion | 1.2 | 0.8 | S |
| Pea | 1.5 | - | MS |
| Pepper | 1.5 | 1 | MS |
| Potato | 1.7 | 1.1 | MS |
| Tomato | 2.5 | 1.7 | MS |
| Strawberry | 1 | 0.7 | S |

*ECe: electrical conductivity (EC) of saturated paste extract of soil, ECW: electrical conductivity (EC) of irrigation water, S: sensitive, MS: moderately sensitive, MT: moderately tolerant, T: tolerant

Appendix Table 2. Vegetable crops water salinity tolerance (ECw)

| Vegetable crop | No reduction (dS/m) | 10% reduction (dS/m) | 25% reduction (dS/m) |
|---|---|---|---|
| Tomato | 1.5 | 1.9 | 2.4 |
| Spinach | 1.3 | 2.2 | 3.5 |
| Cabbage | 1.2 | 1.9 | 2.9 |
| Celery | 1.2 | 2.3 | 3.8 |
| Broad bean | 1.1 | 1.7 | 2.8 |
| Potato | 1.1 | 1.7 | 2.5 |
| Sweet potato | 1 | 1.6 | 2.5 |
| Onion (3) | 0.8 | 1.2 | 1.8 |
| Radish (4) | 0.8 | 1.3 | 2.1 |
| Eggplant | 0.7 | 1.7 | 3.1 |
| Carrot | 0.7 | 1.1 | 1.8 |
| Bean | 0.7 | 1 | 1.5 |