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Research paper

Evaluation the Effect of Different Soil Moisture Conservation Techniques on Maize Yield and Yield Components in Adami Tulu Jido Kombolcha Woreda, East Shoa Zone, Central Ethiopia

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The use of in-situ moisture conservation techniques helps to reduce the runoff rate, nutrient losses from soil and improve the soil moisture and nutrient availability for plant growth, which in turn improve the productivity of lands. A field experiment was undertaken from 2017 to 2019 during Balg (from May to October) cropping season to study the effects of in situ moisture conservation on yield and yield components of maize at semiarid lowland of East Shoa (Adami Tulu district), central Ethiopia. The aim of this experiment was to determine the effect of soil moisture conservation on maize yield and to choice the best soil moisture conservation structures under moisture stressed areas. The experiment was laid out in randomized complete block design (RCBD) with using four treatments (Tie ridge, Compartmental bunding, closed ended and farmer practice/control) with three replications. Maize varieties BH 540 used as test crops, to evaluate the effect of different moisture conservation on yield and yield components. The experiment was conducted on farmer's field, on the plot size of 4m × 3m (12 m2). The results revealed that out of the different soil moisture conservation techniques tie ridge obtained 12.88% grain yield advantage over the control ,particularly in 2018, even if there is no significance difference between treatments in the remaining two cropping seasons, this might be due to the climatic condition of this year was better than the other two consecutive cropping season. Therefore in order to have conclusive recommendation this experiment has to be repeated in similar agro-ecologies across the locations.

Keywords: Soil moisture, Maize, Yield and yield component

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INTRODUCTION

Maize (Zea Mays L.) is one of the most important food crops grown worldwide. It is proven that current food demand of Sub-Saharan countries is increasing mainly driven by population increase [8], While most of sub Saharan Africa, maize production is based on rainfed systems [2] and [3]. The average annual grain production of 7 million tons is too low to support national food demands [1].Agriculture in Ethiopia is dominated by rain fed farming with low productivity. One of the biophysical and socioeconomic factors for yield reduction was soil

water management has crucial contribution on the expected agricultural production. The study by [6] noted that moisture stress was being the major limitation to crops yield in cereal based cropping systems in Eastern and Southern Ethiopia. Yet, the climate variability is a main factor that influences the annual crop productivity in this region (Thornton et al. 2006; E. Boelee et al.2013), despite many efforts which have been carried out to reduce consequences of these effects and resulted with significant outputs such as increasing crop productivity through intensive agricultural management practices smallholder farmers whose economy depends on agriculture have to improve the management of current climate variability (Muller et al., 2011; Tseganeh et al., 2013).Low agricultural productivity in semi-arid region is not only due to land degradation, but also due to moisture deficit [2]. Soil moisture conservation and nutrient management are the most important option for plant growth in semiarid areas. The appropriate use of different soil conservation measures helps to reduce runoff rate, nutrient loss and improve nutrient availability. The use of in situ moisture conservation techniques should get sufficient attention. In many parts of the country particularly, eastern Ethiopian highlands with uses crop residue in combinations of tied ridges and closed ended furrow planting to conserve soil moisture. Thus, the efficiency of the soil physic chemical properties and water conservation techniques depends on the soil type, climate, crop grown and the cropping methods followed. Therefore, planting crops using in situ moisture conservation reduces problems of soil moisture stress by reducing runoff through increased infiltration capacity of the soil and storage of water in the soil profile. In moisture scarce environment like Central Rift valley in generally, particularly like Adami Tulu Jido Kombolcha Woreda crop would face shortage of moisture available in the soil throughout the growing season.

Therefore, the present study was performed to evaluate different soil moisture conservation structures on maize grain yield under dry areas with the following objectives.

OBJECTIVES

- To determine the effect of soil moisture conservation techniques on maize yield
- To choice the best moisture conservation practices under soil moisture stressed areas

MATERIAL AND METHODS

Description of the study area

The study was conducted in the Central Rift Valley part of Ethiopia in Oromia Region, Adami Tulu-Jido Kombolcha woreda. Geographically the area is located between 38°25'E and 38° 55'E and 7°35'N and 8°05'N and is bordered by Southern Nations, Nationalities and Peoples' Region (SNNPR) in the north west, Dugda-Bora woreda in the north, Arsi zone in the East and Arsi Negele woreda in the south. The capital city of the district was found at distance of about 160 km from Addis Ababa which was capital city of country Ethiopia. The district has semi-arid and arid agro-climatic zones and lies between 1500-2300 m a.s.l. and it receives a bimodal unevenly distributed average annual rainfall of 760.9 mm per annum. The long-term mean minimum and the mean maximum temperature is 12.6 and 27 ^{o}C respectively. Vitric Andosols and Mollic Andosols are the dominant soil group in the district.

Treatments and Experimental Design

The experiment was consists of four treatments (Closed ended, Tie ridge, Compartmental bund and flatbed/farmer practice/.These treatments were arranged in RCBD replicated three times per treatments. Maize was sown using the spacing of 75 and 20 cm inter and intra row, respectively.

Experimental procedures

Experimental fields were prepared by Oxen plough followed by manual seed-bed preparation and conservation structures were constructed. After construction of the structures sowing was performed using BH540 maize variety as test crops, with 100kg/ha urea and DAP as source of NP fertilizers. Half of urea applied at sowing and the remaining before emergency. Three hand weeding was done equally and at the same time for the entire experimental unit.

Data collection and analysis

The present study was undertaken with the plot were picked and counted to calculate the number of cobs per m^2, grain yield, 1000 average kernels weight/cobs. Five individual plants were randomly chosen from the middle rows in each plot on which the observations of yield and yield components of corn were recorded to calculate the average number of kernels/cob and average cob length. All measured variables were subjected to analysis of variance using SAS statistical package (SAS Institute Inc., 1990) and significantly different of the means were separated by the least significant difference (LSD) method ($P \leq 0.05$).

RESULTS AND DISCUSSION

Effect of different soil moisture conservation techniques on maize yield and yield components

Grain Yield (kun/ha)

Statistical analysis result of the three years climate data and their interaction with maize grain yield was presented in (Figure 1). The combined analysis of the three years result indicated that the maximum maize grain yield was obtained in 2018 cropping season; this might be due to their better rainfall distribution during this season than the other years.

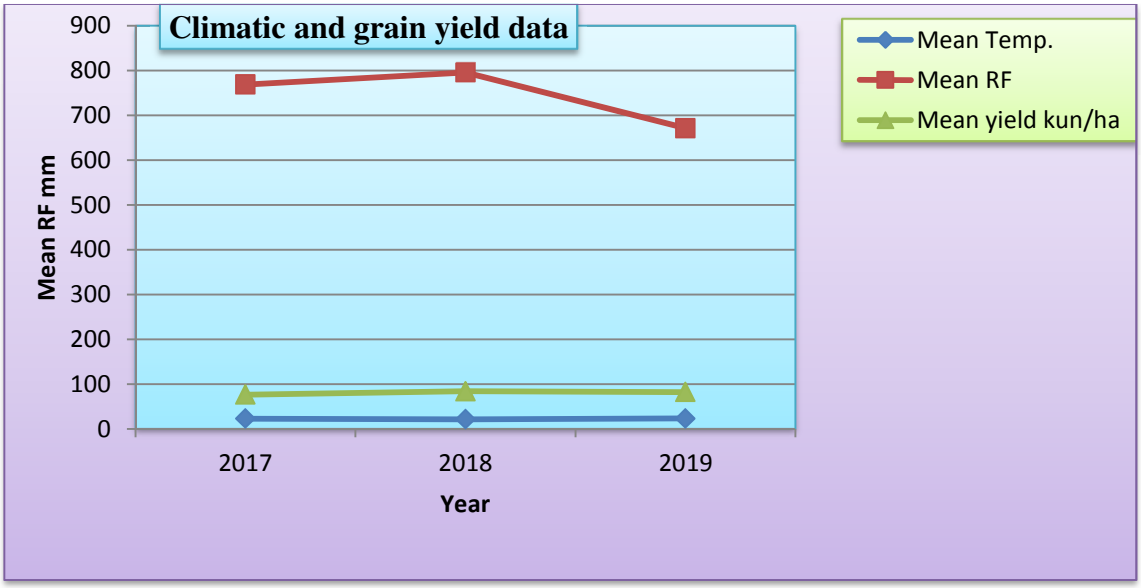

Figure 1. Mean annual RF, temperature and grain yield of experimental site

In this experiment there was no significance difference between the treatments on maize grain yield. This might be due to adequate amount and well distributed rainfall in the district during the three consecutive crop growing seasons (Figure 1). But tie ridge shows 12.88% grain yield advantage over the control plots in 2018 (Table 1). This might be due to the climatic condition of the experimental area in this cropping season was better than 2017 and 2019.This finding was disagreed with [5],[4]and [10] who reported that the importance of tied ridge was increasing crop yield by increasing the time for the water to penetrate into the soil. Similarly [8]who reported that the grain yield of early maturing maize varieties was significantly affected by in situ moisture conservation practices.

Table 1. Effect of different soil moisture conservation techniques on maize grain yield

Treatments	Year			
	2017	2018	2019	Mean
Tie ridge	77.26	90.88	75.47	81.2
Compartmental bund	72.21	83.64	83.28	79.71
Closed ended	76.25	83.64	84.17	81.3
Farmer practice	79.17	76.93	84.96	80.3
	NS	NS	NS	NS
$LSD_{0.05}$				
CV (%)		12.98		

Means within column followed by the same letters are not significantly different at P ≤ 0.05; LSD=Least significant difference; CV= Coefficient variation

Cobs per plant

Analysis of variance shows that there was no significance difference between treatments on the number of cobs per plant at (P ≤ 0.05)in 2017 and 2019 cropping seasons (Table 2). The highest number of cobs per plant was obtained in 2018 from tie ridge and the lower cobs per plant were recorded from the closed ended moisture conservation structure in 2019.This might be the direct relationship between rain fall distribution and cobs per plant within the years.

Table 2. Effect of different soil moisture conservation techniques on cobs per plants

Treatments	Year			
	2017	2018	2019	Mean
Tie ridge	1.13	2[a]	1.33	1.48
Compartmental bund	1.2	1.4[b]	1.33	1.31
Closed ended	1.13	1.3[b]	1	1.14
Farmer practice	1.06	1.06[b]	1.33	1.15
$LSD_{0.05}$	NS	0.58	NS	NS
CV (%)		27.2		

Means within column followed by the same letters are not significantly different at P ≤ 0.05; LSD=Least significant difference; CV= Coefficient variation

Thousand Seed Weight (g)

The thousand seed weight were another yield component parameters which was not show significant different at (p <0.005) between the treatments, but the maximum thousand seed weight was obtained in 2018 from tie ridge (Table 3). This implied that in situ moisture conservation structures improve thousands seed weight by retaining surface runoff and increase infiltration capacity within the catchment, even if not significant. This result in contrary to the idea of [4] who reports that the effect of in situ soil moisture conservation on thousand seed weight were significant difference in thousands seed weight between the tied ridge and closed furrow.

Table 3. Effect of different soil moisture conservation techniques on 1000 seed weight

Treatments	Year			
	2017	2018	2019	Mean
Tie ridge	0.41	0.47	0.35[d]	0.43
Compartmental bund	0.38	0.47	0.40[abcd]	0.42
Closed ended	0.39	0.46	0.42[abc]	0.42
Farmer practice	0.42	0.42	0.42[abc]	0.42
$LSD_{0.05}$	NS	NS	0.03	NS
CV (%)		10.26		

Means within column followed by the same letters are not significantly different at P ≤ 0.05; LSD=Least significant difference; CV= Coefficient variation

CONCLUSION AND RECOMMENDATION

Soil moisture stress has been described as the most important constraint for crop production in the arid and semi-arid area. As a result, in situ soil moisture conservation techniques at farm level was an important alternative for the moisture deficit area of Adami Tulu Jido Kombolcha Woreda, east Shoa Zone of Oromia National Regional State, Central Ethiopia with the following objectives: To evaluate the effects of different soil moisture conservation techniques on maize yield and to select the best soil moisture structures under moisture stressed areas. The experiment was performed for three consecutive years (2017-2019) on farmer's field. The experiment consists of four treatments: Tie ridge, closed ended, compartmental bund and farmer practice as a control. The experiment was laid out in a randomized complete block design replicated three times per treatment. Analysis of variance results after maize harvest revealed that there were no significant different between treatments on grain yield and thousand grain weight. This might be due to the climatic condition of this three consecutive cropping season is enough rainfall.On the other hand, cobs per plant shows significant difference between treatments in 2018. Likewise, tie ridge was better than other treatments and 12.88% yield advantage than the control in 2018, This shows that grain yield was climate dependent parameter.Therefore, this current result from a single location highlighted that; tie ridge was better than other treatments, thus this experiment has to be repeated in similar agro ecologies to have conclusive recommendation,by increasing the number of experimental site.

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