Advances in Crop Science and Technology

Negash F, Adv Crop Sci Tech 2022, 10:9

Research Article

Open Acces

# Influence of In-situ Moisture Conservation Techniques and N rates on Agronomic Traits of Sorghum in Raya Valley, Northern Ethiopia

**Kasaye Abera and Berhane Sibhatu**

*Department of Agronomy, Ethiopian Institute of Agricultural Research, Ethiopia*

## ABSTRACT

Soil erosion, low nitrogen availability and soil moisture stress during main season are among the major limitations to high crop production and sustainable land management in semiarid areas. In such area, in-situ moisture conservation techniques and right application of fertilizer are very important. The study was carried out to determine the appropriate in-situ moisture conservation technique and nitrogen rate for sorghum production in Raya Azebo (chercher) district of Tigray, Ethiopia in 2017 and 2018 cropping season on farmer field experiment. Adoption of soil moisture conservation techniques such as tie-ridges and mulching and appropriate use of fertilizer has shown improved soil moisture retention in a wide range of environments. The treatments includes four levels of moisture conservation techniques (planting on flat bed, closed end tied ridge , Flat bed + grass mulch (3 cm thick ), Closed end tied ridge + grass mulch);and three rates of nitrogen viz., 11.5, 23, and 46 kg N ha-1laid out in factorial arrangement of RCBD design. According pooled mean result plant height, panicle length and panicle weight were not significantly ($p>0.05$) in the main effect of rate of nitrogen, but leaf area, biomass yield and harvesting index were significantlyinfluenced by the two main effects. More over thousand kernel weight and grain yield have interaction effect. The maximum grain yield (3633 kg ha-1) and thousands seed weight (39.12 gram) was obtained from closed end tied ridge interact with 46 kg N ha-1. Also closed end tied ridge plus mulch have significant effect on most parameters. However closed end tied ridge interact with 46 kg N ha-1could be recommended for study area and related agro ecology.

**Key words:** Moisture Conservation; Nitrogen Fertilizer; Yield of Sorghum

## Introduction

The efficient use of water in agricultural systems is needed to improve crop production and resilience to environmental adversities that may be caused by climate change and extended droughts, especially in arid and semi-arid areas. Marginal and erratic rainfall aggravated by the loss of water by runoff and evaporation are the main causes of low crop production in these areas (Yosef and Asmamaw, 2015). Sorghum (Sorghum bicolor L. Moench) is one of the drought tolerant crops grown in arid and semi-arid areas and is the fifth important cereal crop in the world surpassed by maize, wheat, rice and barley (Akram et al., 2007). Sorghum is indigenous to Ethiopia and thus has tremendous range of genetic variability. It is one of the major traditional crops grown mainly in the dry semi-arid areas of the country. Especially sorghum is the most important crop in the Kobbo-Alamata plain, Shewa Robit area, Chercher and Humera.

Among the different soil water harvesting techniques tied ridges and mulch were found to be very effective in soil water conservation and yield increase in many field crops in most Sub-Saharan African countries. Tied ridges improve the availability of water in the soil profile to decrease the effects of dry periods caused by the seasonal variation of rainfall. Soils contemporarily hold water, so in-situ water harvesting prolongs the availability of water in the root zone by reducing runoff and evaporation losses. In soil with low organic matter, fine texture, compacted soil surface with low infiltration rates high runoff and soil loss tied-ridges (ridging with additional cross in the furrow at short intervals) has been found to efficient and effective method for conserving soil moisture. The main reasons for effective soil water conservation through tied ridges include high rates of water penetration into the stirred soil, the action of tied-ridges in preventing run-off from the rain and increasing the opportunity time for infiltration. Thus, it enhances rapid build-up of soil moisture needed for rapid seed germination, and early plant growth [1-5].

## Materials and Methods

Description of the Study Area

The experiment would be carried out under rain fed conditions at Chercher kebelle, Raya Azebo district, which was located 60 kms far from Maichew to wards east direction. The experimental materials for this experiment would be Urea fertilizers as a source of nitrogen and grass mulch and Meko sorghum variety. In these areas sorghum production is being limited by water stress due to low and variable rainfall between season and with the seasons. Sorghum yields vary considerably between years and show a close dependence on rainfall. Short duration sorghum varieties are the most important one. Meko-1 sorghum verity is one of the short growing crop and important to that area. The verity was released by Melikassa Agricultural Research Center in north. The Varity is early drought resistant, white seed

***Corresponding author:** Kasaye Abera, Department of Agronomy, Ethiopian Institute of Agricultural Research, Ethiopia, E-mail: kasayeab123@gmail.com; Tel: +251 973738766

**Received**: 02-Aug-2022, Manuscript No. ACST-22-561, **Editor assigned:** 04-Aug-2022, PreQC No. ACST-22-561(PQ), **Reviewed:** 18-Aug-2022, QC No. ACST-22-561, **Revised:** 25-August-2022, Manuscript No. ACST-22-561(R), **Published:** 02-Sep-2022, **DOI:** 10.4172/2329-8863.1000533

**Citation:** Abera K, Sibhatu B. (2022) Influence of In-situ Moisture Conservation Techniques and N rates on Agronomic Traits of Sorghum in Raya Valley, Northern Ethiopia. Adv Crop Sci Tech 10:533.

with injera making quality and relatively tall with higher biomass production. This variety fits well for dry semi-arid areas with short growing season.

Treatments and Experimental Procedures

The treatments were four levels of moisture conservation techniques (planting on flat bed, closed end tied ridge, Flat bed + grass mulch (3 cm thick), Closed end tied ridge + grass mulch); and three rates of nitrogen viz., 11.5, 23, and 46 kg N ha-1. The experiments laid out in factorial arrangement of RCBD design where the treatments would be replicated three times having a gross plot size of 3.75m * 3 m. Urea fertilizers as a source of nitrogen and grass would be used as a mulch and use after emergence. Based on treatment arrangement amount of Nitrogen fertilizer in the form of urea would be applied at planting and the remaining dose at knee stage. The other crop management practices like weeding, chemical spray and hoeing will be applied uniformly for all plots [6-9].

Data Collected and Measurement

Growth parameters: Plant height was measured at physiological maturity from the ground level to the tip of panicle from five randomly taken plants and was averaged on per plant basis. Panicle length, the length of the panicle from the node where the first panicle branches emerge to the tip of the panicle which was determined from an average of five randomly taken panicles per net plot.

Yield components and yield: Panicle weight (g), Samples of five panicles was weighed after harvesting and sun drying to determine weight per panicle. Thousand kernels weight (g) was determined by counting 500 grains in duplicates and weighting them on an electronic balance. The weights obtained were multiplied by two to get the 1000 kernels weight. The weight was adjusted to 12.5% moisture level. Grain yield (kg) was obtained from all plants of net plot area. It was determined using sensitive balance after the panicles were threshed, cleaned and sun dried and the yield was adjusted to 12.5% moisture level. Then, it was converted to kg ha-1 basis. Above ground dry biomass (kg) was measured after the plants from the net plot area were harvested and sun dried till constant weight.

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) using the Genstat 18 edition, and interpretations were made following the procedure described by Gomez. Whenever the effects of the treatments were found significant, the means were compared using least significance difference (LSD) test at 5% level of significance.

## Result and Discussion

Selected physico-chemical properties were analyzed for composite soil (0-30 cm depth) from the samples collected diagonally from five spots in every replication before planting. The result indicated that soils in the study area are dominantly clay loam in texture and soil pH was characterized as moderately alkaline (pH=8.28) based on ranges of soil–water pH interpretation 6.6-7.3, 7.4-7.8 and 7.9-8.4 are characterized as neutral, slightly alkaline and moderately alkaline respectively.

In-situ Moisture Conservation Techniques and Nitrogen Fertilizer

Moisture conservation: is actually the process of concentrating precipitation through runoff and storage for beneficial use. All sorts of water harvesting techniques are innovations in dry land farming. From soil moisture conservation techniques tie-ridges and mulching has shown improved soil moisture retention in a wide range of environments. Tied Ridges details and local experiences among the different soil water harvesting techniques tied ridges were found to be very effective in soil water conservation and yield increase in many field crops in most dry land area. Mulching also one proven technique for increasing rainwater infiltration is mulching. Mulch absorbs the energy of raindrops and prevents the soil surface from crusting. Thus surface mulching has been proven to be effective in soil water conservation, maintaining favorable temperature conditions and improving soil structure through enhanced biological activity. Mulching also increases soil organic matter by improving soil physical conditions as well as nutrient and moisture retention capacity. Soil water conservation should also be integrated with other improved agronomic practices so that the soil water retained could be used effectively. Weeds should be controlled as early as possible to avoid completion. Water harvesting techniques should also be used with improved crop management practices to use the harvested water more efficiently. Nitrogen use Nitrogen is often the critical resource regulating plant growth rates and limiting crop yields. Plant modifications to improve plant growth per unit of N fertilizer being applied could help increase crop yields, and avoid the negative environmental consequences of N losses and contamination of groundwater, to avoid this contamination it must follow the four key areas of nutrient management, right source, right rate, right time and right place. Adding fertilizer to meet crop needs can result in greater productivity per unit of water input.

Conserved rainwater through rainwater conservation techniques was efficiently utilized for higher grain production especially during a drought condition compared to normal rainfall. Higher grain yield with rainwater conservation techniques and appropriate use of nutrient was higher in growth and yield components of sorghum (Table 1 and 2).

| **Treatment** | **PH (cm)** | **PL** | **LA** | **PW** | **BY** | **HI** |
|---|---|---|---|---|---|---|
| | | **(cm)** | **(cm2)** | **(gm)** | **(kg ha-1)** | |
| Nitrogen rate Kg $ha^{-1}$ | | | | | | |
| 11.5 | 113.7 | 24.33 | 348.2c | 63.11 | 6254a | 0.366b |
| 23 | 116.3 | 24.48 | 356.8b | 67.34 | 5345b | 0.511b |
| 46 | 117.1 | 24.58 | 375.6a | 68.13 | 5222b | 0.552a |
| LSD | NS | NS | 8.16 | NS | 870.5 | 0.083 |
| **Moisture conservation mechanism** | | | | | | |
| Flat planting | 106.2c | 22.29b | 302.0c | 59.44c | 5301 | 0.437b |

| | | | | | | |
|---|---|---|---|---|---|---|
| Close end tied rig | 119ab | 25.76a | 390.3a | 77.03a | 5364 | 0.578a |
| Flatbed +Grass | 114.1b | 24.03ab | 366.3b | 60.48c | 5820 | 0.401b |
| Close end tied rig +Grass | 123.4a | 25.78a | 382.3a | 67.81b | 5844 | 0.420b |
| LSD | 5.94 | 2.12 | 9.42 | 6.62 | NS | 0.096 |
| CV% | 7.7 | 13 | 3.9 | 15 | 26.9 | 30.3 |
| Where: NS = non-significant, Means with the same letters in the same column are not significantly at P < 0.05, PH= plant height, PL= panicle length, LA= leaf area, PW= panicle weight, BY= biomass yield, HI= harvesting index and Fb= Flat bed, CET= Close end tied ridge and Gr= Grass, LSD= least significant difference CV=coefficient of variance | | | | | | |

**Table 1:** Plant height, panicle length, Panicle weight and harvesting index of sorghum as influenced by main effect of conservation mechanism and Nitrogen rate

| Treatment | | TKW (gm) | GY kg ha$^{-1}$ |
|---|---|---|---|
| **Nitrogen rate Kg ha$^{-1}$** | **Moisture conservation mechanism** | | |
| 11.5 | Flatbed planting | 30.32c | 1857g |
| | Closed end tied riding | 33.46bc | 2489d |
| | Flatbed planting +grass | 32.48c | 2245e |
| | Closed end tied riding +grass | 37.29ab | 2712c |
| and | Flatbed planting | 30.63c | 2007f |
| and | Closed end tied riding | 38.05a | 2856b |
| and | Flatbed planting +grass | 31.11c | 2403d |
| and | Closed end tied riding +grass | 33.15bc | 2649c |
| and | Flatbed planting | 37.15ab | 2145ef |
| and | Closed end tied riding | 39.12a | 3633a |
| and | Flatbed planting +grass | 33.17bc | 2499d |
| and | Flatbed planting +grass | 33.17bc | 2499d |
| and | Flatbed planting +grass | 33.17bc | 2499d |
| and | Closed end tied riding +grass | 37.31ab | 2951b |
| **LSD** | | 4.25 | 138.9 |
| **CV%** | | 10.7 | 4.7 |
| Where: NS = non-significant, Means with the same letters in the same column are not significantly at P < 0.05, TSW= thousand seed weight, GY= Grain yield and LSD= least significant difference, CV=coefficient of variance | | | |

**Table 2:** Interaction effect of Rate of N fertilizer and Conservation mechanism on thousand seed weight grain yield of sorghum

Plant height (PH): The analysis result showed that the main effect of rate of nitrogen fertilizer and the inaction effect did not significant effect (P>0.05) on this parameter in both years. But in moisture conservation practice it had significant response on plant height of sorghum in both cropping season. Numerically, the highest plant height (123.4cm) was obtained from closed end tied ridge plus mulch and the lowest value of plant height were recorded from flat planting table 1. This is due to moisture conservation practice that retains soil water better from being lost from runoff that improved and develop the plant growth and it implies higher result of plant height. Because of this the growth parameters can result in optimum level of fertilizer and best potential of availability of water to the crop.

Panicle length (PL): The main effect of moisture conservation had high significant (P≤0.01) effect on panicle length. However, main effect of rate of nitrogen fertilizer and the inaction effect did not significant effect (P>0.05) on this parameter in both years. Numerically, the panicle length (25.78cm) was obtained from closed end tied ridge plus mulch and the least value (22.29cm) were obtained from flat planting table 1. This may be attributed to an increase in soil water content in these rain water harvesting techniques which lead to better root development leading to increased sorghum growth. This result was complimentary with Mahamed and Shirdon (2013) on maize crop production in Jigjiga area indicated that there was higher performance with the use of ridges and nitrogen fertilizer application.

Leaf area (LA cm2): The leaf area of sorghum was highly significant (P≤0.01) for the main effects of N fertilizer rate and moisture conservation. But there was no significant interaction effect of nitrogen rate and time of N application on this parameter. The highest leaf area (375.6 cm2) was obtained from 46 kg N ha-1 while the lowest leaf area (348.2 cm2) was recorded from 11.5 kg N ha-1. In general, as the nitrogen rate increased, the leaf area also increased (Table 1).

Panicle weight (PW): The main effect of moisture conservation had high significant ($P \leq 0.01$) effect on panicle weight. However, main effect of rate of nitrogen fertilizer and the inaction effect did not significant effect ($P>0.05$) on this parameter in both years. Numerically, the highest panicle weight (77.03 gram) was obtained from closed end tied ridge and the lowest value of panicle weight (59.44 gram) was recorded from flat planting.

Thousand kernel weight (TKW): The analysis of variance showed that thousand seed weight was highly significant ($P \leq 0.01$) affected by the interaction effect of two factors. The highest thousand kernel weight (39.12 gram) was recorded from 46 kg N ha-1 interact with the best moisture conservation (closed end tied riding).

Grain yield: Closed end tied riding integrated with 46 kg N ha-1 gave significantly high grain yield (3663 kg ha-1) and the lowest grain yield was recorded from flat planting integrated with 11.5 kg N ha-1 in both cropping season table 2. Butter in-situ moisture conservation techniques and optimum fertilizer application created favorable condition to absorb water by sorghum plants.

Biomass yield (BY): Rate of nitrogen fertilizer application was significantly influenced biomass yield of sorghum, but moisture conservation techniques and interaction effect did not significantly affect the parameter table 2. The maximum biomass yield (6254 kg ha-1) was obtained from 11.5 kg N ha-1 and the minimum biomass yield (5222 kg ha-1) was recorded from 46 kg N ha-1.

## Conclusion

In areas with low and erratic rainfall, use in-situ moisture conservation techniques and right application of fertilizer are very important for increasing crop yield. From the findings of this study, closed end tied riding integrated with 46 kg N ha-1 gave significantly high grain yield and other yield and yield components compared with farmers' practice in particular in flat bed planting integrated with small amount of nitrogen fertilizer application in both cropping season.

Tied ridging practices are crucial for sorghum yield improvement under moisture stress areas. It was observed that closed end tied ridging proved to be more effective in preserving water and increase availability of fertilizer to the plants it help to enhancing sorghum yield with relatively consistent effects in both seasons than flat bed planting methods with small amount of fertilizer level. Generally, integrated soil and crop management practices should be addressed simultaneously to increase water infiltration and nutrient availability and thereby increase crop productivity in moisture stress areas like Raya valley. Accordingly, efforts have to be made to disseminate tied ridging practice integrated with the recommended fertilizer to the beneficiaries and additional research works on agro-ecologically based in situ moisture conservation techniques and different fertilizer levels is imperative to improve sorghum production in areas where moisture and nutrient deficiency are the major constraints for sustainable crop production. Based on this experiment the maximum grain yield (3633 kg ha-1) and thousands seed weight (39.12 gram) was obtained from closed end tied ridge interact with 46 kg N ha-1. Also closed end tied ridge plus mulch have significant effect on most parameters. Finally as recommendation closed end tied ridge intact with 46 kg N ha-1 could be recommended for study area and related agro ecology.

## Acknowledgements

The authors are thankful to Ethiopian Institute of Agricultural Research (EIAR) especially AGP-II for funding this research project. We are also genuinely acknowledging for Mehoni Agricultural Research Center field assistants for excellent fled management and also sincerely appreciate the finance department for providing all input facilities.

## References

1. Aklilu BN, Mekiso YS (2015) Performance of in-situ rainwater conservation tillage techniques and inorganic fertilizer practices on sorghum production at Ethiopia Somali Region (Kurdha Metan district). Internat J Agri Sci Res 4(5): 098-108.
2. Akram A, Fatima M, Ali S, Jilani G, Asghar R (2007) Growth, yield and nutrient uptake of sorghum in response to integrated phosphorus and potassium management. Pakistan J Bot 39(4): 1083-1087.
3. Belay Y (1998) Effect of tied ridges on grain yield response of Maize (Zea mays L.) to application of crop residue and residual N and P oil two soil types at Alemaya, Ethiopia. South Afr J Plant & Soil 15(4): 123-129.
4. Berhane S, Hayelom B, Gebrmeskel G, Kasaye A (2017) Effect of Tied Ridging and Fertilizer on the Productivity of Sorghum [Sorghum bicolor (L.) Moench] at Raya Valley, Northern Ethiopia. Current Agri Res J 5(3): 396- 403.
5. Breman H, Groot JJR, Van Keulen H (2001) Resource limitations in Sahelian agriculture. Glob Environ Changes 11:59-68.
6. Cooper PJM, Gregory PJ, Tully D, Harris HC (1987) Improving water use efficiency of annual crops in the rainfed farming systems of West Asia and North Africa. Experi Agri 23: 113-158.
7. Gomez KA, Gomez AA (1984) Statistical Procedures for Agricultural Research, 2nd Edition, A Wiley–Interscience Publication, New York.
8. Haghighi BJ, Yarmahmodi Z, Alizadeh O (2010) Evaluation the effects of biological fertilizer on physiological characteristic and yield and its components of corn (Zea mays L.) under drought stress. American J Agric Biol Sci 5(2): 189-193.
9. Hazelton P, Murphy B (2007) Interpreting soil test results: What do all the numbers mean? 2nd Edition. CSIRO Publishing. 152.