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Garlic Response to Supplemental Irrigation at Different Growth Stage in Ginchi Condition

Mohammed Temam[1]

MSc, Irrigation and Water Harvesting Research, Holeta Agricultural Research Centre,
Ethiopia Institute of Agricultural Research, Ethiopia

Abstract: *Garlic (Allium sativum L.) is an important edible bulbous crop with culinary and medicinal purposes for most people in Ethiopia. It is a major cash crop widely cultivated in Ginchi and other districts of west shewa of Oromia Region in Ethiopia.*

SI is the addition of small amount of irrigation water to rainfaid crops during shortage of rainfall or during stress. However there was no clear information about the amount of supplemental irrigation and the effects of supplemental irrigation of garlic crop on yield. The purpose of this study was to determine the effects of supplemental irrigation on yield of garlic crop under vertisol in order to create suitable condition for garlic crop to get high yield and acceptable quality. The experiment was designed as a randomized complete block design with three replication and eight supplemental irrigation treatments. Plant height, tuber yield and WUE were calculated in this trial. The over year result of this trial indicated that plant height, tuber yield and WUE did not vary significantly.

Keywords: *Garlic, Supplemental irrigation, vertisoil*

1. Introduction

Supplemental irrigation may be defined as 'the addition of small amounts of irrigation water to rain-fed crops during times when rainfall is insufficient to provide sufficient moisture for normal plant growth, in order to increase yields and to avoid stress (Oweis and Hachum, 2003). According to Rockström et al. 2007 Supplemental irrigation is the opposite of conventional irrigation and the principal source of moisture is fully controlled irrigation water, and highly variable limited precipitation is only supplementary.

Supplemental irrigation is also dependent on the precipitation as a primary source of water for the crop. Supplemental irrigaion is an effective method of irrigation to alleviating the adverse effects of soil moisture stress on the yield of rain fed crops during dry spells. Supplemental irrigation as a response Shortage of soil moisture in the dry rain-fed areas often occurs during the most sensitive growth stages (flowering and grain filling) of the crops. Supplemental irrigation, using a limited amount of water, if applied during the critical crop growth stages, can result in substantial improvement in yield and water productivity. In addition to yield increases, SI also stabilizes rain-fed crop production (Oweis and Hachum, 2003).

Ilbeyi et al. (2006) indicated that, when rainfall was insufficient for crop germination, supplemental irrigation given at sowing substantially wheat yield increased by more than 65% (from about 2.0 t ha^{-1} to the average dry farming yield of 3.2 t ha^{-1}) in the Central Anatolian Plateau of Turkey.

Zhang and Oweis (1999) reported that yields and water use efficiency in northern Syria increased significantly by applying 75 to 212 mm of supplemental irrigation in the beginning to the end of flowering. Therefore, SI is an effective response to avoid the adverse impact of soil moisture stress during dry spells on the yield of rain-fed crops.

Garlic is one of the important legumes in Ethiopia. It is grown after Teff or Wheat either as sole or mixed crop. Garlic is produced for fresh market, dehydrated as ingredient for food processing and food supplement output like dehydrated powder, essential oil, oil macerate, powder and aged garlic extract (Wiczkowski, 2011). Alemu et al., 2016 reported that in Ethiopia, garlic is one of the important bulb crops produced for home consumption as spice in the preparation of soup, pickle and other preservatives as well as a source of income to many rural farmers in many parts of the country. However there is no clear information about the amount of supplemental irrigation and the effects of supplemental irrigation of garlic on yield. The main aim of this study was to determine the effects of supplemental irrigation on yield of garlic crop under vertisol in order to create suitable condition for garlic crop to get high yield and acceptable quality.

1.1 Objectives

The objectives of this activity were as indicated below:

- To maximize garlic productivity of rain fed agriculture

- To determine the effect of supplementary irrigation on garlic yield
- To determine water use efficiency
- To prevent crop failure caused by less rain water

2. Methodology

2.1 Study Area

The study was carried out in 2016/2017-2019 at Ginchi sub center situated at 2200 m altitude. Average annual rainfall is about 1080 mm of which about 65% falls between June and September. Soil type is a heavy clay with 0.91-32% organic matter, 0.09-0.14% N and 4.2-9.9 ppm available P (Morton, 1977); the pH is about 6.4 (Hailu Kenno and Lulseged Gebre Hiwet, 1983).

2.2 Crop Water and Water Amount Applied

The study was supplemented with soil moisture determination gravimetrically and/or using soil moisture meter at 15 cm interval from the surface to the depth of maximum root zone depth. Crop evapotranspiration (ETc) for individual treatments was determined for seasonal total and between the growing stages using the soil water balance equation:

ETc = I+ER + ΔS – Dr

Where I is the amount of irrigation (mm); ER is the effective rainfall as measured from the nearby meteorological station and estimated using appropriate standard method; ΔS is the change of soil moisture storage; Dr is the drainage below the root zone. Since plots are blocked, no surface runoff during the growing season is expected.

The amount of irrigation water applied was calculated using CROP WAT 8.0 software by using necessary input data (crop, soil and long term climatic data) and Amount of water applied at 100% Etc will be calculated as a difference between crop water requirement (crop evapo transpiration) and effective rain fall using CROPWAT model (smith 1995) then other irrigation treatments will be applied by deducting from T2 (100% Etc) with respective percentage.

Each application of water was measured using partial flume with 3 inch dimension. The experimental plots area, inter and intra row spacing was determined based on the Garlic Agronomic Recommendation.

Experimental field was prepared was 3*3m plot area. Garlic was planted with a spacing of 10cm (intera space) and 1m spacing was left between the rows. Surface irrigation system was used to apply the required amount of irrigation water.

Garlic was allowed to deplete the allowable soil moisture depletion of the total available soil moisture (the difference in soil water storage between field capacity and permanent wilting point in the root zone) in the root zone before the next irrigation, otherwise no Supplement Irrigation.

Irrigation at full SI was applied to restore root zone moisture to field capacity. Other treatments received a proportion of full irrigation amount as predetermined to each treatment. The amount of water applied each irrigation was measured using appropriate measuring devices a 3'' parshalflume.

Table 1. Treatments

Treatment	Description	Amount of water	Interval
T1	No SI / Only Rainfall	Only Rainfall= 600mm	No Interval
T2	SI of 100 % Etc	50mm	Every eight days
T3	SI of 75 % Etc	37mm	Every eight days
T4	SI of 50 % Etc	25mm	Every eight days
T5	SI of 25 % Etc	12.5 mm	Every eight days
T6	One SI at flowering stage	50mm+ RF	One irrigation at flowering (50mm) + Rain Fall
T7	One SI at fruit setting stage	50mm+RF	One irrigation at flowering (50mm) + Rain Fall
T8	Two SI at flowering and fruit setting stage	50mm+RF	Two irrigation at flowering & fruit(50mm) + Rain Fall

2.3 Water Use Efficiency and Yield

Water use efficiency was estimated as a ratio of above-ground dry matter at maturity and grain yield to the total ETc through the growing season.

The increased production in the SI relative to that of the rain fed agriculture was assumed to be only to water applied in SI. Accordingly, WUE for SI was computed as the ratio of the difference in crop yield (grain or dry matter) between SI and rain fed treatments to the difference in ET for the same treatments as follows (Bos, 1980):

$$WUE_{st} = (Yt - Yr)/(ETt - Etr)$$

Where Y is grain or dry matter yield (qt/ha) and ET is evapotranspiration (mm) and the subscription t and r refers to treatment (rainfed + SI) and rainfed growing conditions, respectively.

3. Result and Discussion

3. 1Effect of supplemental irrigation on garlic height

The result shown from the table 2 indicate that the effect of supplemental irrigation on garlic plant height which was measured from the ground level. The analysis of variance indicate that the effect of supplemental irrigation on garlic plant height not significant.

Table 2. Effect of supplemental irrigation on garlic plant height

Treatments	Height (cm)
1	58.86
2	59.33
3	52.59
4	62.06
5	58.26
6	59.39
7	59.93
8	62.53
MEAN	59.12
CV %	5.00
LSD	NS

3.2 Effect of supplemental irrigation on garlic yield

The table below showed that supplemental irrigation has no significant difference on garlic yield than control. The analysis of variance indicate that the effect of supplemental irrigation on garlic yield not significant.

Table 3. Effect of supplemental irrigation on garlic yield

Treatments	Yld (Q/ha)
1	18.84
2	19.565
3	20.29
4	21.015
5	18.55
6	18.55
7	21.45
8	17.68
MEAN	19.49
CV %	17.025
LSD	NS

3.3Effect of supplemental irrigation on garlic water use efficiency

Table 4 showed that the result of supplemental irrigation on water use efficiency. The over year analysis indicated that the effect of supplemental irrigation on water use efficiency not significant than control in this trial.

Table 4. Effect of supplemental irrigation on garlic water use efficiency

Treatments	WUE kg/m3
1	0.116
2	0.1015
3	0.098
4	0.0935
5	0.1075
6	0.1135
7	0.0915
8	0.11
MEAN	0.104
CV %	19.795
LSD	NS

4. Conclusion and Recommendation

All supplemental irrigation were economical important during dry spell with minimum yield loss. Supplemental Irrigation was effective to alleviate the adverse impact of soil moisture stress during dry spells on the yield of rain-fed crops.

The experiment showed that supplemental irrigation has no significant difference on plant height, garlic yield and water use efficiency than control around Ginchi town in Oromia region this happens because of

there is sufficient rainfall from May to November. Over year analysis indicated that Maximum average plant height were registered at Treatment 8 (Two SI at flowering and fruit setting stage) which is 62cm, the maximum averageyield were registered at Treatment 7 (One SI at fruit setting stage) which is 21.45 quital and the maximum average water use efficiency were registered from Treatment 1(No SI / Only Rainfall) which is 0.116 kg/ m3.

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