



Research Article

Effect of watering frequency on germination and early growth of maize (*Zea mays*) seed

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Abstract

Maize (*Zea mays*) is one of the most important cereal crops grown principally during the raining season in Ethiopia which is commonly used for both human consumption and poultry feed. Green house experiment on the effect of watering frequency on germination and early growth of maize was carried out at Ambo Agricultural Research Center using a hybrid maize variety (Jibat) (*Zea mays*) from December 1 to January 20th, 2018/19. The study was conducted to determine the effect of watering frequencies on germination and early growth of maize seed (*Zea mays*). The highland maize hybrid variety of AMH-851 (Jibat) was used as a test crop for the experiment. Three watering frequencies one day interval, three days intervals and five days intervals were used as an experimental treatment, and they were laid out in a Completely Randomized Design (CRD) with four replications. The watering frequencies showed statistically significant differences, on plant shoot length and biomass weight, but the treatments didn't reveal statistical difference on seedlings emergence. Therefore, one day watering interval shows better performance on shoot length, fresh and dry biomass.

Introduction

Irrigation can be described as the artificial application of water to soil for the purpose of agricultural production. It is primarily considered when there are suspected problems with rained crop production. Rainfall may be unreliable in amount and duration of timing. For instance, rainfall may vary from year to year, or the onset and cessation of the rains may be uncertain (Gevens, 2007). Meanwhile, there may be period of drought during the rainy season itself. Irrigation systems are considered because they solve the problem of food production and the materials needed or used for the practice are not as scarce as they appear to be. Effective irrigation will influence the entire growth and yield process from seedbed preparation, germination, root growth, nutrient utilization, plant growth regrowth, yield and quality [1]. Water is essential for irrigation purposes, but its indiscriminate use can lead not only to shortages, but also to the deterioration of crop yields and soils.

It is hence vital to ensure that it is applied as effectively as possible in order to reach sustainability. Maize production was increased with a combination of deep tillage and good irrigation system.

Maize (*Zea mays*) is one of the most important cereal crops grown principally during the raining season in Ethiopia which is commonly used for both human consumption and poultry feed. The local production of the crop is not sufficient to meet the continuous increase of consumption. Therefore Deborah, et al. [2] compared three methods of irrigations under climatic conditions such as wind, drip and furrow irrigation, she then came up with the conclusion that drip and furrow irrigation methods are preferred to sprinkler. Humphreys [3], while comparing the same irrigation methods under slope condition submitted that sprinkler and drip irrigation are preferred to furrow irrigation. Whether sprinkler, drip or furrow, a significant effect has been realized on the growth and yield of a crop when a system is properly designed [4].

Irrigation frequency is the number of days between irrigation periods without rainfall. Crop irrigation requirement is the portion of the water consumptive use of crop, which must be supplied by irrigation to ensure optimal crop growth and development. With the rising human population and resultant increase in daily demand for maize for various uses, it becomes imperative to intensify effort at all year-round Maize Production in the country. Traditional crop of maize is greatly affected by various weather conditions. The rain in the country is very uncertain and may either cause prolonged drought or water-logged conditions. It is, therefore, essential to consider both aspects of water requirement to produce 1 kg of dry matter is the lowest in case of maize. Thus, very high water use efficiency can be achieved by maize as compared to other cereal crops. Although maize needs less water requirement for germination, it needs 10 to 30 times greater than that of wheat and mustard. According to (Rathore, 2005), it is very critical to have enough moisture for the maize seed, during germination so that successful seed germination may occur. In Ethiopia, there is no adequate information on early time water requirement of maize.

General objective

- To determine the effect of watering frequencies on germination and early growth of maize

Specific objective

- To evaluate the germination and growth of maize in different watering frequency

Material and methods

Soil type

According to FAO classification, the soil type of the study area is Vertisols [5]. The soil of study area is clay dominated and the soil textural class is clay [6]. Vertisols are clay rich soils contain a type of expansive clay that shrinks and swells dramatically. Vertisols is categorized in problematic soil due to its waterlogging problem. However, Vertisols are highly fertile soil type than red soils due to their high clay content with high cation exchangeable capacity [5]. The soil type is characterized as follows Table 1.

Table 1: The physical characteristics of the soil in the study area.

Soil Characteristic	Value
Clay (%)	67.46
Silt (%)	20.36
Sand (%)	12.18
pH-H ₂ O (1:2.5)	6.0
OC (%)	1.19
OM (%)	2.05
Total N (%)	0.12
CEC (cmol(+) kg soil)	36.56
P (ppm)	20.05

Source: ambo agricultural research center natural resource department unpublished data (2018)

Experimental location

The experiment was undertaken in Ambo Agricultural Research Center, one of the Ethiopian Institute of Agricultural Research located. The research centre is located in West Shewa Zone of Oromia Regional state. The site is located at 116 km west of Addis Ababa (The capital city of the Ethiopia) having an altitude of 2185 m.a.s.l., latitude of 8.9658333 N and longitude of 37.85556 E with mean annual minimum and maximum temperatures of about 11°C and 26°C, respectively. According to metrological data obtained from Ambo Agricultural Research Center the area receives mean annual rainfall of 1244 mm with uni-modal rainfall pattern. Similarly, according to long term metrological data from this station the mean minimum mean maximum and average air temperatures of in the study area is 10.2, 26.4 and 18.3°C, respectively (Ambo Agricultural Research Center Metrological Station).

Experimental material

Sterilized soil was filled in 8 cm diameter clay pots and sown with maize seed in Ambo Agricultural Research center green house. Four seeds were sown per each pot evenly and with equal sowing depth. Maize hybrid variety - *Jibata* was used as planting material. The pots were arranged in CRD with four replication in a greenhouse such a way that 4 pots were watered at day interval, four pots with the three days interval and four pots with the five days interval were watered using an equal volume of water for consecutive 20 days. The twelve pots (15cm diameter) height of the pots are 20 cm were used to triplicate twelve treatment combinations (6×2) with a two factor factorial completely randomized design. The pots were lined with plastic bags from inside to restrict leaching. Each pot was filled with 10 kg soil after mixing combining. The pots possess holes at the bottom to suck water during watering.

Experimental design and data analysis

The treatment was arranged in Completely Randomized Design (CRD) with four replications. Data collected were number seeds emerged, shoot length and biomass weight. The collected data were analyzed using standard data analysis method using MSTATC (Version 9.4) programmed software and mean separation was made using Duncan's Multiple Range Test at alpha level of 0.05 ($\alpha=5\%$). Seeds emerged Procedure was take after 20 day interval emerged Seeds was count. It was calculated by counting normal seedlings after 20 days from planting. If seed is large the emerging seedling has a larger food source to depend on before it gets established. Seedlings from bigger seeds tend to emerge more successfully and are more vigorous both at the start of their life and throughout their whole life. Shoot length (cm) after 20 days from planting the seedling biomass was gently washed to remove the soil and shoot length was measured of each pot and each treatment seedlings (cm). Biomass weight after evaluating shoot and root lengths, from each pot 4 seedlings were dried in a forced air at green house at room temperature 28°C for 5 days to obtain seedlings dry weight and expressed as grams. The number of seedlings were limited to only four, because of the experiment was designed for the green house and to use the advantage of the pot size.



Results and discussion

The effect of watering frequencies on germination and early growth of maize seeds were observed under different watering frequencies. As shown in Table 2, watering frequencies had no significance effect on number of maize seedlings emergence, but considerable variation was observed on their emergence date, that the early emergence of maize seeds were enhanced during watering made daily than the rest of the treatments. As watering frequency decreased from 1 to 5 days interval, seedling emergence was delayed significantly ($P < 0.05$). This indicates that a continuous application of enough water to the soil and maintaining soil moisture enhance the emergence of maize seeds to be takes placed earlier. These findings are in agreement with the results of Kang, et al. and Ismail, et al. [7,8], they stated that watering frequencies had a significant and negative effect on maize shoot length, as the date of watering elongated, the shoot length consistently and significantly reduced (Table 3). Thus, unlike maize seedlings emergence its growth very much dependent up on the amount and rate of watering. Similarly, watering frequencies had significance effect on maize biomass production. In that daily watered plots considerably outperformed the others in biomass weight gained.

A total of 16 seeds were used for each interval (One day interval, three-day interval and Five-day interval) and two counts were done during the present studies. The first count was done five days after sowing. In these rounds a total of 16 seed were used for each of the three intervals. The present studies result elucidates that continuous application of enough moisture via watering in three-day interval enhance relatively higher (50%) percentage of germination followed by one day interval (43.75%) (Figure 1). This implied that moisture stress negatively affects root initiation earlier even in pot growing conditions as in field conditions. This is related with a work done by Konopka, et al. [9], irrigation intervals of 14 or 21 days initiated an earlier growth of seminal roots in the seedlings than when irrigated more frequently. The delay in root emergence with frequent irrigations could be due to the diffusion of water into the seed for its physiological processes of early growth But maintaining adequate amount of moisture in the soil fasten early emergence. The second count was done seven days after sowing. In these rounds a total of 16 seed were used for each of the three intervals. The result showed that the application of water or providing enough moisture at five-day interval enhance or promote relatively better germination performance (68.75%) followed one day interval (56.25%) (Figure 2).

As shown in Table 3, watering frequencies on all the treatments had no significance effect on number of maize seedlings emergence.

Watering frequencies had significance effect on maize shoot length, therefore, as date of watering elongated the shoot length consistently and significantly reduced (Table 4).

Table 3: Effect of watering frequency on number of maize seedlings emerged at Ambo, 2019.

Treatment	Emergence seedlings
One day interval	4a
Three days interval	4a
Five days interval	4a
CV (%)	0
LSD (0.05)	0
F Value	0
P Value	0

Means followed by the same letters within Columns are not significantly different at $P < 0.05$ level of probability

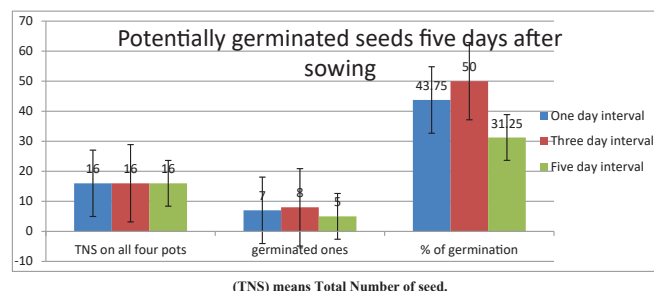


Figure 1: Percentage germination of maize seeds for three intervals five days after sowing.

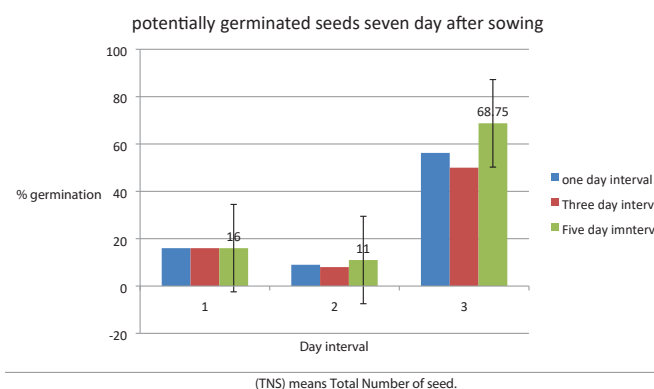


Figure 2: Percentage germination of maize seeds for three intervals seven days after sowing.

Table 2: Effect of watering frequency on number of maize seeds Germination at Ambo, 2019.

Treatment	First Count / five day after sowing							Second Count / Seven day after sowing						
	Pot 1	Pot 2	Pot 3	Pot 4	Total seed sown	Total germinated	% of germination	Pot 1	Pot 2	Pot 3	Pot 4	Total seed sown	Total germinated	% of germination
One day interval	2	2	1	2	16	7	43 %	2	2	3	2	16	9	56.25%
Three days interval	2	1	2	3	16	8	50 %	2	3	2	1	16	8	50%
Five days interval	2	1	1	1	16	5	31.25%	2	3	3	3	16	11	68.75%



Thus, Treatment One day interval is significantly different from three days interval and five days interval. However, there is no significant difference between both treatment (Three-day interval and Five-day interval). In the early stages of vegetative growth, plants are more susceptible to water stress than at the middle stages. Thus, water stress during the vegetative stages of crop growth can lead to reduced plant growth [10]. With increased water application, plant height increases. Research by Dunford and Vazquez [11] supports these findings where plants that received more water accumulated more plant material and, therefore, increased in height Table 5 [12–18].

Watering frequencies had significance effect on maize green biomass production among the treatments, for instance, in one day interval watered plots had maximum weight of green biomass when compared with the remaining treatments. However, there is no considerable significant difference between the two treatments (Three-day interval and five-day interval) in terms of green biomass Table 6.

Watering frequencies had significance effect on maize dry biomass production among the treatments, for instance, in one day interval watered pots had maximum weight of dry biomass when compared with the remaining treatments. However, there is no considerable significant difference between the two treatments (Three-day interval and five-day interval) in terms of dry biomass [19–22].

Conclusion

The research work determined the effect of watering frequency on emergence and early growth of maize seedlings.

Table 4: Effect of watering frequency on shoot length (cm) of maize at Ambo, 2019.

Treatment	Shoot length (cm)
One day interval	52.875a
Three days interval	41.950b
Five days interval	41.100b
CV (%)	13.42
LSD (0.05)	10.52
F Value	2.93
P Value	0.1114

Means followed by the same letters within Columns are not significantly different at $P < 0.05$ level of probability

Table 5: Effect of watering frequency on green biomass weight (g) of maize at Ambo, 2019.

Treatment	Green biomass (g)
One day interval	83.000a
Three days interval	48.025b
Five days interval	36.650b
CV (%)	15.419
LSD (0.05)	14.911
F Value	13.82
P Value	0.0031

Means followed by the same letters within Columns are not significantly different at $P < 0.05$ level of probability

Table 6: Effect of watering frequency on dry biomass weight (g) of maize at Ambo, 2019.

Treatment	Dry biomass weight (g)
One day interval	9.125a
Three days interval	4.9250b
Five days interval	4.3000b
CV (%)	13.30136
LSD (0.05)	1.4077
F Value	18.13
P Value	0.0015

Means followed by the same letters within Columns are not significantly different at $P < 0.05$ level of probability

The early growths of maize are greatly affected by the different watering frequency. So that, the different watering frequencies considerably affected plant shoot length, green biomass weight and dry biomass weight, however, these studies have revealed there is no significant difference among the treatments (One day interval, three-day interval and five-day interval) in terms of maize seed emergence. So that we concluded that moisture however is critical for seedling emergence in the treatments used in the study.

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