LUPINE PUBLISHERS
Open Access

Modern Approaches in Oceanography and Petrochemical Sciences

DOI: 10.32474/MAOPS.2018.01.000108

ISSN: 2637-6652

Research Article

The Effect of Soil Moisture Level on Growing of Two Common Bean (*Phaseolus Vulgaris* L) Cultivars

Abiot molla agemas*

Department of natural resources in Debremrkos University, Ethiopia

Received: February 09, 2018; **Published:** February 23, 2018

***Corresponding author:** Abiot molla agemas, Lecturer, Department of natural resources in Debremrkos University, Debremarkos, Ethiopia

Abstract

The amounts of water use efficiency vary with climatic, soils and crop ability to extract water in the soil. It has been frequently reported, lack of water availability reduce the amount and yield of common bean. The aim of study was to determine the effect of soil moisture level on growth of two common bean cultivars. The study was conducted in greenhouse. The design was factorial arrangement in randomized complete block design. Forty eight treatment pots were used for two common bean cultivars. Four seeds were sown in 48 pots filled with 5cm soil depth and irrigated until water dripping through perforated base. From total pots, 24 pots selected randomly and labeled as BULGA-70 cultivar and the rest as CS-20-DK cultivar. After germination, only one uniform plant was kept and five water treatments levels, 100 % (Control), 75%, 50% and 25% were applied by field capacity. Plant height, leaf area and dry matters were measured. As results, plant height, leaf area and dry weight in both cultivars were significant to soil moisture condition. However, no significant difference was observed 100% and 75% water levels in both cultivars. Therefore, 75% water treatment level is advisable for farmers to minimize water wastage.

Abbreviations: Soil moisture; Common bean; Cultivars; Water treatment

Introduction

Common bean is one of the most important pulse crops in Ethiopia, due to its richness in protein content. Common bean is also an important crop in crop rotation due to its fixation of atmospheric nitrogen, organic matter and improving water use efficiency of the cropping system [1,2]. Crop rotations can increase crop yield than monoculture due to its diversity in plant water use, rooting pattern and crop type [3]. The beneficial effects of crop rotation include;

(i) better soil moisture use and nutrients uptake,

(ii) Reduced disease, insects, weeds and phytotoxic compounds [4]. Inadequate variable water supply has a negative effect on crop production across different climatic regions.

The problem is more prominent in tropical countries including Ethiopia and subtropical semiarid and arid climates, in which water losses through evaporation and evapotranspiration are high [5].

Drought, which can occur at any stage during plant growth, reduces pod yield and pod quality of common bean. Drought reduces the number of flowers, pod setting and leaf area in bean by 51, 63 and 60%, respectively [6]. Many study reported that drought stress at all growth stages reduces yield and yield components in bean, but the effect was worst when drought occurred during reproductive stages [7]. Although there are reports that common bean is susceptible to drought stress or water deficit, the production of this crop in many places of the world is carried out under drought stress conditions [8]. This is due to insufficient water supply by rainfall and/or irrigation. This indicated that drought stress is not only in Ethiopia but also a worldwide production constraint for common bean [9].

Therefore, Water stress has been reported to reduce the expression of many characteristics in faba beans. In common beans, accelerated maturity of crop along with reducing grain yield and mean weight of hundred seeds following water stress, have been reported [3,10]. Furthermore, common bean cultivar has reported to respond differently to soil moisture stress depending on the severity of water stress [9]. In fact, different management techniques like irrigation can contribute to the increase of grain yield under water stress conditions, but the development of tolerant cultivars becomes an efficient and economical production strategy. Therefore, this study aimed to the effect of some water stress treatments (25, 50, 75 and 100% of field capacity) on growth and development of two common bean cultivars (Bulga-70 and CS-20-DK) which were released in 1977 and 1994 respectively by Holeta Research Centre, Ethiopia.

Materials and Methods

Description of the Study Area

The study was conducted at DebreMarkos University greenhouse demonstration site in the year 2016. Debremarkos University is geographically located in DebreMarkos town at latitude and longitude of 10°20′N 37°43′E and an elevation of 2,446 meters above sea level (m.a.s.l). The annual average temperature is 18.70c while the minimum and maximum recorded temperature being 40c and 240c, respectively. Annual average rain fall ranges from 900-1800mm. The climate condition is characterized by woyna dega (1500-2300 m.a.s.l). The soil characteristics of the study area are mainly is clay ranging from 50-73%, silt fraction 15.88%-40.21% and sand fraction 0.36-13.28.

Research Design and Sampling Procedures

The design of study was by 2*4 (two verities with four water treatment level) factorial arrangement in randomized complete block design (RCBD) with replicated in six times. Total of 48 treatment pots were arranged randomly. At beginning, four seeds were sown in 48 pots filled with soil and sand mixture of 3:1 ratio and a depth of 5cm soil depth. Irrigated the 48 pots until water is begins dripping through the perforated base. Then, from the total pots, 24 pots were selected randomly and labeled as BULGA-70 cultivar and the rest as CS-20-DK cultivar. After germination, only one uniform plant was kept in each pot throughout the experiment. Five levels of plant available water treatments of 100 % (as Control), 75%, 50% and 25% capacity by weight), imposed when the plants were established with two true leaves for the two cultivars. The pots were weighed in two days intervals to compensate the water loss by evapotranspiration and therefore, the pot soil moisture was kept at 100, 75, 50 and 25% of field capacity according to treatments.

The plant height, leaf area and leaf dry matters were measured at 35 days after planting. The leaf area, plant height and leaf dry matter was measured by using squared pare method, ruler and oven-dried for 48 hr in 600c., respectively All collected data were statistically elaborated using analysis of variance (ANOVA), followed by means separation using the Least Significant Difference (LSD) at P<0.05. All calculations were performed using SAS 9.0 software package.

Results and Discussions

Plant Height

Plant height was significantly affected by at high water stress level in both cultivars (Table 1). CS-20-DK cultivar produced the tallest plants at all water stress level. Water stress depressed plant height in both cultivars and the shortest plants were produced at higher water stress levels (Table 1). There is no a statically significance between 100% , 75% and 50% water treatment in Bulga-70, but there is significant difference between 100% and 75% with 50% water treatment in CS-20-DK cultivar (Table 1). This finding is in line with the results of Emam et al. [11] and Shenkut and Brick [12] who reported on plant height is affected by severe influence from environmental factors such as water stress.

Table 1: Effect of water stress levels on plant height (cm) of two common bean cultivars.

Treatments Water stress levels (% of FC)					
Common beancultivars	100	75	50	25	Row mean
Bulga-70	9.460±1.15^{aA}	9.330±0.65^{aA}	8.453c±0.56^{aA}	3.988±0.3^{bA}	7.8±0.56^{A}
CS-20-DK	10.78±0.61^{aA}	10.43±0.43^{aA}	8.6±0.63^{bA}	4.48±.43^{cA}	8.6±0.5^{A}
Column mean	10.12±0.65^{a}	9.88±0.41^{a}	8.5±0.41^{b}	4.2±0.3^{c}	8.2±0.41

Mean values followed by different small letter (s) within the same row and different capital letter(s) within the same column are significantly different at p < 0.05(LSD test)

Plant leaf areas

Table 2: Effect of water stress levels on plant leaf area (cm2/plant) of two common bean cultivars.

Treatments Water stress levels (% of FC)					
Common beancultivars	100	75	50	25	Overall mean
Bulga -70	9.79 ±1.73^{aA}	10.3±0.96^{aA}	7.08c±0.34^{bA}	4.00±0.0^{bA}	8.6±0.73^{A}
CS-20-DK	10±0.56^{aA}	10.75±0.76^{aA}	6.0±0.71^{bcA}	3.58±0.58^{cA}	8.2±0.63^{A}
Column mean	9.89±0.8^{a}	10.56±0.6^{a}	6.54±0.41^{b}	3.6±0.3^{c}	8.4±0.5

Mean values followed by different small letter (s) within the same row and different capital letter(s) within the same column are significantly different at p < 0.05(LSD test)

Plant leaf area was significantly affected by high water stress level in both cultivars (Table 2). There is no statically difference between the two cultivars at all water stress level (Table 2). CS-20-DK produces the highest broad leafed plants at 100% and 75% water stress level. Water stress depressed plant leaf area in both cultivars and the narrow leafed plants were produced at higher water stress levels (Table 2). There is no statically significant difference between 100% and 75%, and also between 50% and 25% water stress levels in Bulga-70 cultivar but there is significant difference between 100 % and 75% with 50% and 25% water stress level. Similarly, in CS-20-DK cultivar no statistically significant difference between 100% and 75%, but there is statistically significant between 100% and 75% with 50% and 25%.in water stress level (Table 2).

This study also in lines with finding of Emam [13], Emam et al. [11] who were reported that leaf area was reduced when the plant exposed to drought stress during vegetative growth stages. Furthermore, the study also consisted with Nielsen 1998 observed that there is significant reduction in the common bean leaf area index under drought condition. Markhart [14] also found significant reductions in the leaf area under drought condition at 23 days after planting for two bean species. The loss of leaf area which could be resulted from reduced size of younger leaves and inhibition of the expansion of developing foliage is also considered as an adaptation mechanism to moisture deficit.

Plant leaf dry weight

Plant dry weight was decreased as increased of water stress level in both cultivars (Table 3). There is no statistically significant difference between 100% and 75% water stress levels in CS-20-DK. But, there is significant difference with 50 % and 25% water stress level. There is no significant difference between 100%, 75% and 50% water treatment levels in Bulga-70 (Table 3). Water stress significantly decreased dry weight at 50% and 25% in both cultivars. The highest and the lowest percentage reductions in leaf dry weight were observed in both cultivars. Barrios et al. (2005) reported that leaf dry weight of common beans reduced when plants are exposed to drought stress. Other studies like Emam [15] and Rosales Serna et al. [16] have also reported significant differences in shoot biomass accumulation among dry bean cultivars grown under moderate to severe drought stress conditions.

Table 3: Effect of water stress levels on leaf dry weight (gm) of two common bean cultivars.

	Treatments of Water stress levels (% of FC)				
Common beanCultivars	100	75	50	25	Row mean
Bulga-70	0.14±0.03^{abA}	0.16±0.0.026^{aA}	0.09c±0.0.01^{abA}	0.07±0.01b^{A}	0.126±0.1^{A}
CS-20-DK	0.155±0.01^{aA}	0.166±0.03^{aA}	0.09±0.01^{bA}	0.052±0.01c^{A}	0.127±0.1^{A}
Column mean	0.15±0.01^{a}	0.16±0.01^{a}	0.1±0.05^{b}	0.06±0.01c	0.13±0.01

Mean values followed by different small letter (s) within the same row and different capital letter(s) within the same column are significantly different at $p < 0.05$(LSD test)

Conclusions and Recommendations

The result of this study confirm that water availability play a major role in plant height, plant leaf area and plant leaf dry weight of growing common bean. Common bean production depends mainly on soil water condition. A high level of soil water availability usually ensures an optimal common bean growth. Any restriction in the supply of irrigation water induces decrease plant growth. The impact of deficient irrigation on plant growth can be insignificant where the water stress is applied to the plant during specific growth stage that are less sensitive to moisture deficiency .The result of the study confirms these ideologies. Therefore, for effective utilization of irrigation water and optimum growth of common bean cultivars, 75% water treatment level is advisable for farmers to use so as to avoid wastage of water.

Acknowledgement

Author thanks third year natural resource management students for watering, collecting and managing the research data during the field experiment. I am thankful again to Dr. Kassahun Berihanu for continuous help during the study. I would like to express my cordial thank to the College of agriculture and natural resource for providing of faba bean seeds and allowing to use the greenhouse.

References

1. Saxena MC, Sheldrake AP (1986) Comparison of earlier and later formed pods of chickpeas (Cicerarietinum L). Annals of Botany 43: 467-473.
2. Pala JC, mode Corino N, Janior RJ (1994) Response common bean cultivars and lines to water stress. Crop breed Applied biotechnology 1: 363-372.
3. Nielsen DC, Nelson NO (1998) Black bean sensitivity to water stress at various growth stages. Crop Science 38: 422-427.
4. Crookston RK, Kurle PJ, Copland JH, Fordand, Lueschen WE, et al. (1991) Rotational cropping sequence affects yield of corn and soybean. J Agronomy 83: 108-113.
5. Mavi H, Tupper GJ (2004) Agrometeorology: principles and applications of climate studies in agriculture. Haworth Press Inc, New York, USA, pp. 376.
6. Barrios AN, Hoogenboom G, Nesmith DS, (2005) Drought stress and the distribution of vegetative and reproductive traits of a bean cultivar. Scientia Agriculturae 62: 18-22.
7. Cakir R (2004) Effect of water stress at different development stages on vegetative and reproductive growth of corn. Field Crops Research 89: 1-16.

8. Machado Neto NB, Durães MAB (2006) Physiological and biochemical response of common bean varieties treated with salicylic acid under water Crop Breed. Applied biotechnology 6: 269-277.
9. BoutraaT, Sanders FE (2001) Influence of water stress on grain yield and vegetative growth of two cultivars of bean (Phaseolus vulgaris L) J Agronomy and crop science 187: 251-275.
10. Molina JC, Moda Cirino V, Júnior RT, De Faria , Destro D, et al. (2001) Response of common bean cultivars and lines to water stress. Crop Breed Applied biotechnology 1: 363-372.
11. Emam y, Shekoofa F, Salehi, Jalali, AH (2010) Water Stress Effects on Two Common Bean Cultivars with Contrasting Growth Habits. College of Agriculture, Shiraz University, Shiraz, Iran, American-Eurasian J Agriculture & Environmental Science 9 (5): 495-499.
12. Shenkut AA, Brick MA (2003) Traits associated with dry edible bean (Phaseolus vulgaris L.) productivity under diverse soil moisture environments. Euphytica 133: 339-347.
13. Emam Y, and Seghatoleslami MJ (2005) Crop Yield: Physiology and Processes. 1st edn. Shiraz University Inc, Shiraz pp: 593.
14. Markhart HA (1985) Comparative water relations of Phaseolus vulgaris L. and Phaseolus acutifolius Gray. Plant Physiology 77: 113-117.
15. Emam, Y (1985) Effects of N levels and moisture regimes on agronomic characteristics of four cultivars of dry beans (Phaseolus vulgaris L). M.Sc Thesis, Shiraz University Shiraz, Iran p. 41.
16. Rosales Serna RJ, Kohashi Shibata JA, Acosta Gallegos CT, Lopez J, Ortiz Cereceres JD, et al. (2004) Biomass distribution, maturity acceleration and yield in drought-stressed common bean cultivars. Field Crops. Research 85: 203-211.

DOI: 10.32474/MAOPS.2018.01.000108