Effects of Irrigation Interval on Growth Analysis of Soybean [(*Glycine max* (L.) Merr.]

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Abstract
A field experiment was conducted with the ultimate goal of irrigation is to utilize added water efficiently on soybean that can give the greatest seed yield per hectare increase from added water in crop year 2015/2016 BC at Hawassa located at $07^0$3'N and $38^0$28'E, and at 1708 masl. Maximum and minimum daily temperature was 27 and 13°c respectively. This experiment was RCB design with 4 replicates was performed on earth. Each experimental unit with dimensions of 2×2 m and was planted with 5 rows. The irrigation interval includes 3,8,13 days. After collecting data such as stem weight, leaf weight, leaf area, plant weight and plant height. SLA, LAR, NAR and RGR were analyzed. SLA and LAR decreased with age increase under all irrigation intervals and maximum RGR and NAR were achieved at 8 day irrigation interval with a value of 102.5 mg g^{-1} day^{-1} and 77.5 mg dm^{-2} day^{-1} respectively. The highest biomass of soybean was recorded at irrigation intervals of 3 days with a mean value 176.7163g/m^2.
Keywords: SLA, LAR, RGR and NAR

Introduction

The origin and early history forms the soybean crop is unknown, it is often said that the soybean is native to East Asia (Adcock and Neill, 2003). Soybean [(*Glycine max* (L.) Merr.] is a dominant world crop for vegetable oil and protein for animal and human consumption. Interest in soybean production has increased because soybean has a wide range of adaptation in regard to different climatic, soil and growth conditions.

Soybean plants under drought stress on field observations indicate that significant amounts of soil water Access during all stages of plant development has an important effect on plant growth imposed. Briyer *et al* (2000) also concluded that climatic factors have no tangible impact on the spread of soybean roots, but in his view there is some contrary information. However, in most cases it seems that the total numbers of unit roots seriously affected by soil water regime are not seasonal but this does not mean that the rate of soil water availability is not affected.

The germination of soybeans, 50 percent of its weight in water requires extra moisture rising from the soil surface is required (John, 2001).

Water and nitrogen alone and in interaction, have a negative impact on growth and yield (Taylor *et al*, 2005).When the grain crop production is desired, a time of tension with the stress intensity is the same (Sarmadnia and Koucheki, 1993). Drought stress reduced nitrogen demand and the need to shoot, also reduce the transfer of solutes such as urea is nitrogen (Astare and Scarisbrick, 1995). Taylor *et al* (2005) Soybean stem height at the time of the stress factor for predicting tolerance to dehydration cultivars has been introduced.

High and stable yields of soybean can reliably be obtained only by supplementing crop water requirement through irrigation. Only optimum conditions permit the plants to use water according to their needs, i.e. to the level of potential evapotranspiration (450-480 mm, Vučić and Bošnjak 1980, Bošnjak 1983). Even though a lot of literatures are recommend to produce soybean by irrigation no optimum irrigation intervals were recommended across different agro ecologies. The objective of this experiment is to conduct appropriate irrigation intervals for maximum growth and grain yield of soybean in a specified location.

Material and Methods

The experiment was carried out at Hawassa university college of Agriculture experiment field (at 07^0 3'N and 038^0 28'E, and at 1708 masl. Maximum and minimum daily temperature was 27 &13°c respectively) in the period of 2015/2016 B.C growing season. This experiment was laid in randomized complete block design with 4 replicates. Each experimental unit with dimensions of 2×2 m and was planted with four rows 40cm between rows and 10 cm between plants with recommended NP rate. Treatments in this experiment were irrigation interval i.e. three, eight and thirteen day's interval. Furrow irrigation method was done for all irrigation intervals. Until the crop was emerged all plots are irrigated equally. Rainfall during the growing season was negligible. Time of seed planting was November 13, 2015 after the land was well prepared. All agronomic practice was done according to the recommendations except irrigation intervals.

Collected data: - Plant height, leaf area, leaf weight and stem weight were taken two times in 18 day intervals by taking three individual plants randomly from each rows and at the end of growing season total dry mass were taken from one row of each plot.

Weighing of all parameters except biomass which was dry by sun was done after drying by oven dry for 48 hours by 70°c.
Analyzed data: - SLA, LAR, NAR and RGR were analyzed by using collected data according to formula.
SLA=leaf area/leaf weight
LAR=leaf area/plant weight
NAR= (W2-W1)(lnA2-lnA2)/(A2-A1)(T2-T1)
RGR= (lnW2-lnW1)/T2-T1
Except biomass all data were collected two times in 18 day intervals.

Results and Discussion
Start soybean irrigation before any visible signs of drought stress. Research shows that, in most years, soybeans will not show a yield increase from irrigation until just before bloom. If it is extremely dry (especially with late plantings or double-cropping) during the vegetative growth stage, you may need irrigation to give the plants some height (harvest ability) and a quicker canopy. Irrigate soybeans as frequently as necessary until pods have completely filled. The number and frequency of irrigations will vary with the season, variety, soil, and irrigation system capability.

Several studies conducted for a wide range of environments have demonstrated that soybean yield increases with irrigation (Dogan *et al*. 2007, Sincik *et al*. 2008, Bajaj *et al*. 2008, Gerçek *et al*. 2009).

During first sampling maximum LAR and SLA was obtained with 13 day irrigation interval while, its minimum value was obtained with 3 day irrigation interval. However, during the second sampling the reverse is true (Table.1).

Table1: Variation in LAR and SLA for different irrigation interval of soybean at 23 and 41 days after emergence.

LAR(cm^2 g^{-1})			SLA(cm^2 g^{-1})	
Irrigation interval	first sampling mean ± SE	second sampling mean ±SE	first sampling mean ± SE	Second sampling mean ± SE
3	147.85±7.39	123.28±2.49	244.54±17.5	208.33±4.47
8	161.03±7.39	120.57±2.49	307.39±17.5	201.655±4.47
13	181.40±7.39	109.37±2.49	354.49±17.5	184.996±4.47

LAR= leaf area ratio and SLA= specific leaf area

LAR and SLA was reduced through age of plant because leaf area is decreased after full expansion stage of leaf due to senescence. In addition, both LAR and SLA increase with increasing irrigation interval at first sampling yet, decrease with increasing irrigation intervals (Fig. 1)

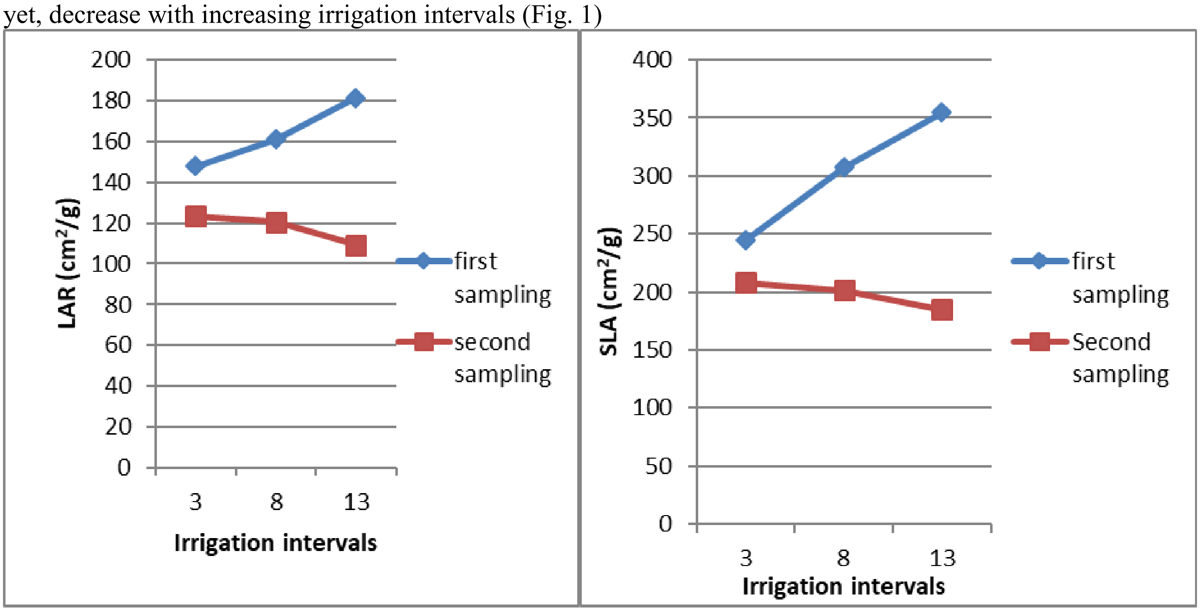

Figure 1. Changes in LAR and SLA of soybean under different irrigation intervals at two consecutive sampling.

However, weight of plant and leaf increased because carbohydrate and other assimilate concentrated on their older leaf and stem. Total DM is influenced by RGR, relative growth rate, relative leaf area growth rate, and net assimilation rate (Hunt, 1982), but in this experiment from treatments with low RGR recorded high biomass (Table 2). Because as indicated by Jeffers and Shible (1969) subsequent studies showed that the relationship between DM and optimal RGR varied with environmental conditions.

Several quantitative determinations have been made of soybean growth and development using growth analysis. However, most research has investigated soybean yield compensation using various plant populations

(Wells, 1991; Carpenter and Board, 1997; Board, 2000).

Biomass peaked at three days irrigation interval with average 176.72gm/m^2 comparing with eight days and thirteen days irrigation intervals (89.69 and 81.38gm/m^2) respectively.

The soybean plants which are capable of maintaining its altitude at the time of drought, reduced performance will be less (Taiz and Zigger, 1998).

When starting irrigation for the first time, or after a rainfall, start soon enough to get across the field before stress occurs. Once you start irrigation, flood and furrow systems typically need water again in 8 to 10 days. Pivots should run continuously because most supply only an inch in 4 days, which nets about 0.8 inch in 4 days. If the pivot can put out more than 1 inch (gross) in 4 days, then adjust to about 0.25 inch per day (gross) and repeat accordingly.

Table 2: Mean total relative growth rate, net assimilation rate and dry weight for soybean grown under different irrigation interval (3 day, 8day and 13 day).

	RGR (mg g^{-1} day^{-1})	NAR (mg dm^{-2} day^{-1})	Biomass (gm^{-2})
Irrigation Interval	mean ± SE	mean ± SE	mean ± SE
3	83.75±5.57	63.5±5.57	176.7163±19.04
8	102.5±5.57	77.5±5.57	81.375±19.04
13	94.25±5.57	70.75±5.57	89.68625±19.04

RGR= relative growth rate and NAR= net assimilation rate

Conclusion

The results showed that the effect of irrigation interval on biomass was significant at the 5% level. The highest biomass was recorded from three day irrigation interval with a value of 176.72gm/m^2. Though, no significant difference between 8 and 13 day irrigation intervals there were increment from 13 to 8 days intervals. SLA and LAR were decreased with age increase. Maximum RGR and NAR i.e. 102.5 mg g^{-1} day^{-1} and 77.5 mg dm^{-2} day^{-1} respectively were achieved at 8 day irrigation interval.

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