Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.8, No.13, 2018

Haricot Bean (Phaseolus vulgaris L.) Varieties Growth Analysis at Hawassa University, Ethiopia

Shimelis Mohammed
South Agricultural Research Institute (SARI), Worabe Agricultural Research Centre, Ethiopia

Abstract
A field experiment was conducted with haricot bean varieties and were planted for growth analysis in 2018 before cropping season at Hawassa University, It geographically located at $07^0$3'N and 38028'E, and at 1708 masl. Maximum and minimum daily temperature was 27 and 13^oc respectively. This experiment used RCB design with 4 replications and 3 Haricot bean varieties Ibado, Omo-95 and Red Wolayita. The plot area was 2m×2 m and was planted with 5 rows. The primary data for growth analysis were collected twice; such as leaf area, stem weight, leaf weight and total weight. SLA, LAR, NAR and RGR were analyzed. Ibado and Omo-95 varieties are the highest and least in leaf area ratio accounts 200.98 (cm^2g^{-1}), 171.57 (cm^2g^{-1}) respectively at 1st sampling but at second sampling Ibado becomes the least, Red Wolayita scores higher in leaf area ratio 162.17(cm^2g^{-1}). On the other hand from first sampling Ibado take the pick position in specific leaf area 312.46 (cm^2g^{-1}) and the least was Red Wolayita. But from second sampling Omo- 95 takes the higher position with 340.65(cm^2g^{-1}) and Ibado was the least with 300.85(cm^2g^{-1}) in specific leaf area. Red Wolayita relatively grows higher 72.81 ($mgg^{-1}day^{-1}$) than Omo-95 and Ibado varieties. And also by their net assimilation rate (NAR) go similarly like that of relative growth rate (RGR) Red Wolayita 43.55($mgdm^{-2}day^{-1}$) was higher in sink from sources. All tested parameters from ANOVA tables are not significantly different.
Keywords: Specific Leaf Area, Leaf Area Ratio, Relative Growth Rate and Net Assimilation Rat

1. INTRODUCTION

Haricot bean (*Phaseolus vulgaris* L.) originated in Latin America and domesticated in Mexico more than 6000 years ago. It spread from Latin America to Europe, Africa and other parts of the world. It grows well in area of medium rainfall from the tropics to the temperate regions (Alghamdi, 2007).

In Ethiopia pulse crops accounted for about 436,435.21 hectares (24.64% of the total grain area) and about 4,013,627.28 quintals production (which is 21.03% of the total grain production). From this common bean (red and white) share in area coverage is 306,334.91 hectares and 2,766,571.4 quintals in production with productivity rate of 9 quintals per hectare (CSA, 2016).

Leaves are of fundamental importance to plants. They constitute the plant's power generation and aerial environmental sensing units. The amount of photosynthetic light harvested depends directly on the leaf-area (LA), which affects plant growth and bio-productivity and hence also the agro-economic return from the crop (Meziane and Shipley, 1999; Vile *et al.*, 2005). The leaf area index (LAI) of a stand of plants is one of the most frequently used parameters for the analysis of canopy structure and is an important structural characteristic of crop/forest monitoring and crop productivity (Behera et al, 2010).

Dry matter production is directly related with agromorphic characters of plants (Amanullah and Muhammad, 2011).

Objectives

1. Understand how to collect and measure primary data for growth analysis in common bean varieties at Hawassa University crop physiology field experiment
2. Know the analysis of growth characteristics using the primary values

2. MATERIALS AND METHODS

2.1. Description of the Experimental Site

The experiment was carried out at Hawassa university college of Agriculture crop physiology experimental field geographically located at 07^0 3' N and 038^0 28' E, and at 1708 masl. Maximum and minimum daily temperature was 27^o c and 13^o c respectively.

2.2. Experimental Materials.

Three varieties of haricot bean were used for the study. The varieties namely were: Ibado, Omo-95 and Red Wolayita and fertilizer used as input 50 kilograms DAP $hectare^{-1}$. Other materials used at field and in the laboratories include: Leaf area meter, Oven dry, sensitive balance, paper bags, scissors.

2.3. Treatment and Experimental Design

The experiment was layed out on RCBD design with four replications. The position of each variety within the plot was randomized. Each block within a replication consisted of 3 varieties. Each experimental unit with

dimensions of 2 m ×2 m and haricot bean varieties were planted in 2018 before cropping season. Each variety within the plot has been grown in a five rows of 2 meters length. A spacing of 40 centimetres between rows and 10 centimetres between plants in a row was used. The spacing between blocks and between plots used 1 meter and 0.5 meter respectively. The experimental fields and experimental units have been managed as per the recommended practices for haricot beans.

2.4. Data Collection

The destructive samplings have been collected from three randomly selected plants. Leaf area, leaf weight, and stem weight were taken two times at **29th** days and **43rd** days from emergence by taking three individual plants randomly from center rows of each plot and in all replications. Weighing of parameters was done after drying by oven dry for **48** hours by **70°c.**

2.5. Data Analysis

Analyzed data: - SLA, LAR, NAR and RGR were analyzed by using collected data according to formula. The Analysis of Variance (ANOVA) was carried out using statistical packages and procedures out lined by Gomez (Gomez KA, and Gomez AA 1984).

$SLA = \frac{A}{Wleaf} = cm^2\ g^{-1}$

$LAR = \frac{A}{W} = cm^2\ g^{-1}$

$\mathbf{NAR} = \frac{(W2-W3)(\ln A2-\ln A1)}{(A2-A1)(T2-T1)} = g\ cm^{-2}\ day^{-1}$ (multiply by 100,000 to change to mg $dm^{-2}\ day^{-1}$)

$\mathbf{RGR} = \frac{\ln W2-\ln W1}{T2-T1} = gg^{-1}\ day^{-1}$ (multiply by 1000 to change it to mg $g^{-1}\ day^{-1}$)

3. Results and Discussion

3.1. Specific Leaf Area(SLA) and Leaf Area Ratio(LAR)

In this study, three haricot bean (*Phaseolus vulgaris* L.) Varieties tested to specific leaf area (SLA),leaf area ratio (LAR). Form these parameters observing calculating for two consecutive samplings at 29th and 43rd dates from emergences. At first sampling Ibado variety is high in leaf area ratio accounts 200.98 (cm^2g^{-1}) and Omo-95 was the least in leaf area ratio 171.57 (cm^2g^{-1}) but for the second sampling it becomes the second and Ibado becomes the least, Red Wolayita scores higher in leaf area ratio for the second sampling 162.17(cm^2g^{-1}) these shows Red Wolayita grows when the other two ceases growth. On the other hand from first sampling Ibado take the pick position in specific leaf area 312.46 (cm^2g^{-1}) and the least was Red Wolayita. But from second sampling Omo-95 takes the higher position with 340.65 (cm^2g^{-1}) and Ibado was the least with 300.85(cm^2g^{-1}) in specific leaf area. When the ANOVA tables (2) shows no significance differences from LAR and SLA for both consecutive samplings.

Table 1:Variation in leaf area ratio (LAR) and Variation in specific leaf area (SLA) for different genotypes of haricot bean during two consecutive samplings*.

LAR (cm^2g^{-1})			SLA (cm^2g^{-1})	
Haricot bean Varieties	First Sampling	Second Sampling	First Sampling	Second Sampling
	Mean±SE	Mean±SE	Mean±SE	Mean±SE
Ibado	200.98±15.05	147.28±6.65	312.46±27.61	300.85±**14.75**
Omo-95	171.57±15.05	159.09±6.65	294.46±27.61	340.65±**14.75**
Red Wolayita	174.58±15.05	162.17±6.65	284.12±27.61	335.92±**14.75**

*, First and second samples were taken at **29** and **43** days after emergence, respectively.

Table 2: ANOVA of variation in leaf area ratio (LAR) and Variation in specific leaf area (SLA) for different genotypes of haricot bean during two consecutive samplings*.

Mean Squares					
Source	**DF**	SLA 1st sampiling (cm^2g^{-1})	**SLA 2nd** sampiling (cm^2g^{-1})	LAR 1st sampiling (cm^2g^{-1})	LAR 2nd sampiling (cm^2g^{-1})
Rep	3	1782.25	1400.11	555.86	204.894
Variety	2	822.87 Ns	1890.80 Ns	1047.44 Ns	247.092 Ns
Error	6	3050.45	870.70	906.62	177.234
Grand Mean		297.01	325.81	182.38	156.18
CV		18.6	9.06	16.51	8.52

*, First and second samples were taken at **29** and **43** days after emergence, respectively.

3.2. Net Assimilation Rate (NAR), Relative Growth Rate (RGR) and Biomass

The partitioning of assimilates to an organ is not only dependent on its potential to attract assimilates, i.e. its sink

strength, but depends on the sink strength of other organs (Marcelis, 1996). 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 6). And NAR represents the combined physiological processes of photosynthesis and respiration (Younis et. al, (1993).

Biomass peaked at Ibado variety with average 19.14 (gm) comparing with Omo-95 and Red Wolayita haricot bean varieties (16.85 and 16.76 gm) respectively.

From tested varieties of three haricot bean Red Wolayita relatively grows higher 72.81($mgg^{-1}day^{-1}$) than Omo-95 and Ibado varieties their growth rate were 52.53 and 49.81 ($mgg^{-1}day^{-1}$) respectively. And also by their net assimilation rate (NAR) go similarly like that of relative growth rate (RGR) Red Wolayita 43.55 ($mgdm^{-2}day^{-1}$) was higher in sink from sources even if does not show significance difference from Omo-95 and Ibado varieties which assimilates with a rate of 33.34 and 29.47 ($mgdm^{-2}day^{-1}$) assimilates from source to sink respectively. But when observing ANOVA tables (4) did not exhibit significance differences on relative growth rate, net assimilation rate and biomass at second sampling time among varieties.

Table 3. Mean total relative growth rate (RGR) and net assimilation rate (NAR) for different genotypes of haricot bean during two consecutive samplings* and biomass (BM) as dry weight. of second sampling stage.

Haricot bean Varieties	RGR ($mgg^{-1}day^{-1}$)	NAR ($mgdm^{-2}day^{-1}$)	Biomass (gm)
	Mean±SE	Mean±SE	Mean±SE
Ibado	49.815±8.04	29.475±5.77	19.14±1.78
Omo-95	52.535±8.04	33.347±5.77	16.85±1.78
Red Wolayita	72.813±8.04	43.558±5.77	16.76±1.78

*, First and second samples were taken at **29** and **43** days after emergence, respectively.

Table 4: ANOVA mean total relative growth rate (RGR) and net assimilation rate (NAR) for different genotypes of haricot bean during two consecutive samplings* and biomass (BM) as dry weight of second sampling stage.

Mean Squares					
Source	**DF**	NAR	**RGR**	BM	LAR 2nd sampiling (cm^2g^{-1})
Rep	3	137.280	318.718	10.0893	204.894
Variety	2	211.705 Ns	631.640 Ns	7.2777 Ns	247.092 Ns
Error	6	133.315	259.097	12.7574	177.234
Grand Mean		35.46	58.388	17.58	156.18
CV		32.56	27.57	20.3	8.52

*, First and second samples were taken at **29** and **43** days after emergence, respectively.

4. Conclusion

A field experiment was conducted with haricot bean varieties and were planted for growth analysis in 2018 before cropping season at Hawassa University, It geographically located at $07^0$3'N and 38028'E, and at 1708 masl. Maximum and minimum daily temperature was 27 and 13^oc respectively. This experiment used RCB design with 4 replications and 3 Haricot bean varieties Ibado, Omo-95 and Red Wolayita. The plot area was 2m×2 m and was planted with 5 rows. The primary data for growth analysis were collected twice. First and second samples were taken at **29** and **43** days after emergence, respectively; the data were leaf area, stem weight, leaf weight and total weight. SLA, LAR, NAR and RGR were analyzed. Ibado and Omo-95 variets are the highest and least in leaf area ratio accounts 200.98 (cm^2g^{-1}), 171.57 (cm^2g^{-1}) respectively at 1st sampling but at second sampling Ibado becomes the least, Red Wolayita scores higher in leaf area ratio 162.17(cm^2g^{-1}). On the other hand from first sampling Ibado take the pick position in specific leaf area 312.46 (cm^2g^{-1}) and the least was Red Wolayita. But from second sampling Omo- 95 takes the higher position with 340.65(cm^2g^{-1}) and Ibado was the least with 300.85(cm^2g^{-1}) in specific leaf area. Red Wolayita relatively grows higher 72.81 ($mgg^{-1}day^{-1}$) than Omo-95 and Ibado varieties. And also by their net assimilation rate (NAR) go similarly like that of relative growth rate (RGR) Red Wolayita 43.55 ($mgdm^{-2}day^{-1}$) was higher in sink from sources. At second sampling Ibado gets pick by biomass with average value of 19.14 (gm). From the varieties used Red Wolayita scores the least 16.76 (gm). All tested parameters from ANOVA tables are not significantly different among varieties.

5. References

Alghamdi, S. S. 2007. Genetic behavior of some selected faba bean genotypes. *African Crop Sci.Conference proceedings. African Crop Science Society. El-Minia, Egypt,* 8: 709-714.

Amanullah, A. and A. Muhammad. 2011. Evaluation of common bean germplasm collected from the neglected pockets of Northwest Pakistan at Kalam (Swat). *Pak. J. Bot*., 43: 213-219.

Behera SK, Srivastava P, Pathre UV, Tuli R. 2010. An indirect method of estimating leaf area index in Jatropha curcas L. using LAI-2000 Plant Canopy Analyzer. *Agricultural and Forest Meteorology*, 150: 307-311.

CSA (Central Statistical Agency Agricultural Sample Survey) July, 2016. "Statistical report volume V on area and production of major crops (private peasant holdings, *belg* season)," Addis Ababa, Ethiopia.

Gomez KA, Gomez AA (1984). Statistical Procedures for Agricultural Research, 2nd edn, John Wiley and Sons, New York, p: 680.

Hunt R. 1982. Plant growth curves: The functional approach to plant growth analysis. Arnold, London, and Univ. Park Press, Balti- more, MD.

Marcelis,L.F.M.(1996). Sink strength as a determinant of dry matter partitioning in the whole plant. *Journal of Experimental Botany,* 47, 1281-1291.

Meziane D, Shipley B. 1999. Interacting determinants of specific leaf area in 22 herbaceous species: effects of irradiance and nutrient availability. *Plant, Cell and Environment* 22:447-459

Vile D, Garnier E, Shipley B, Laurent G, Navas M-L, Roumet C, Lavorel S, Díaz S, Hodgson JG, Lloret F, Midgley GF, Porter H, Rutherford MC, Wilson PJ, Wright IJ. 2005. Specific leaf area and dry matter content estimate thickness in laminar leaves. *Annals of Botany* 96: 1129-1136.

Younis M.E., Abbas M.A., Shukry W.M., (1993). Effects of salinity on growth and metabolism of *Phaseolus vulgaris*, Biol. Plant. 35, 417–424.