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Mungbean Vigna radiata (L.) Wilczek Varieties Evaluation Trial Based on Some Selected Physiological Growth Parameters at Hawassa Ethiopia

Demelash Bassa Belayneh*

Areka Agricultural Research Center, P.O. Box 79, Areka, Ethiopia

Abstract

The experiment was conducted at the experimental site of Hawassa University College of Agriculture in the year 2019 cropping season. The experiment aimed to familiarize researchers with how to collect and measure primary data for growth analysis of Mungbean and how to analyze those growth characteristics using the primary values. Then; using those primary values, to see the performance of Mungbean cultivars based on selected physiological growth parameters. The experiment was laid down by using RCBD with three replications with the experiment field length and width of 7m and 7m respectively. The experimental area plot width, length, and distance between the plot and block were 2m, 2m, 0.5m, and 0.5m respectively. The treatments were MH-97-6, Goffa Local, and Sunaina Mungbean varieties. Data such as Days to 50% emergence, Leaf area (cm2), Stem and leaf dry weight (g), and Biomass (g) were collected. These parameters were the basis to analyze growth parameters such as LAI, LWR, SLA, LAR, NAR, RGR, and CGR. All these growth parameters were analyzed and the ANOVA of the above-ground biomass showed a significant difference ($P<0.05$) among the three mung bean varieties in the tested location. The mean biomass kgha-1 value of the treatments was 695.5833, 569.625, and 767.08 for Sunaina, MH-97-6, and Goffa-L respectively. Accordingly, Goffa-L showed better biomass as compared to the other two varieties of Mungbean. This study needs to be repeated across locations and over years to exploit the environment, variety, and interactions.

Keywords: Performance; Mungbean; Cultivars; Primary; Growth analysis; Physiological; Parameters

Introduction

The Mungbean Vigna radiata L. Wilczek] has been grown in India and Central Asia since ancient times. It is commonly known as Green Gram and considered as an excellent source of protein. It is the best-known pulse crop in the USA, where it is used for the production of sprouts. However, it is not produced on a commercial scale due to its late and erratic pod maturity period and thus it is difficult to determine the harvesting period. It is majorly produced in South Africa Limpopo and Mpumalanga. It is a warm-season annual grain legume. The optimum temperature range for good production is 27- 30°C (Imrie, 1998). This means that the crop is usually grown during summer. Seed can be planted when the minimum temperature is above 15 °C. Mung beans are responsive to daylight length. Short days result in early flowering, while long days result in late flowering. However, Mungbean varieties differ in their photoperiod response. It is considered to be heat and drought-tolerant. It is a quick crop, requiring 75–90 days to mature. It is a useful crop in drier areas and has a good potential for crop rotation and relay cropping with cereals using residual moisture [1]. Its average seed yield is 550kgha^{-1} [2]. Mung beans do best on fertile, sandy loam soils with good internal drainage and a pH in the range of 6.3 and 7.2. Mung beans require slightly acid soil for the best growth. Root growth can be restricted on heavy clays. Mung beans do not tolerate saline soils and can show severe iron chlorosis symptoms and certain micronutrient deficiencies in more alkaline soils (DAFF, 2010). It plays a key role in various cropping systems and sustainable agriculture production due to its nitrogen-fixing ability and low water requirement. However, its agricultural productivity is drastically limited Ethiopia due to low genetic diversity and, even if there are some genotypes, there are no improved genotypes [3].

Objective of the experiment

It was to be familiar with how to collect and measure primary data for growth analysis and how to analyze growth characteristics using the primary values. Then; using those primary values, to see the performance of Mungbean cultivars based on selected physiological growth parameters [4].

Materials and Method

Description of the study

The experiment was conducted at the experimental site of Hawassa University College of Agriculture in the year 2019 cropping season. Geographically, the site is located at 07^{0}03.194N latitude, 38^{0}28.279E longitude, and at an altitude of 1650 meters above sea level [5]. The site receives a mean annual rainfall of 900mm, and a mean annual temperature of 13C^{o} and 27C^{o} minimum and maximum respectively. The soil type of the experimental site is sandy loam with a pH of 5.5. However, in the meantime of experimenting, the Temperature was raised to 31C^{o}.

Experimental design and treatments

The experiment was laid down by using RCBD (Randomized Complete Block Design) with an experiment field length and width of 7m and 7m respectively [6]. The experiment was replicated three times. The experimental area plot width, length, and distance between the plot and block were 2m, 2m,0.5m, and 0.5m respectively. The Mungbean varieties used in the experiment were MH-97-6, Goffa Local, and Sunaina. The Mung bean varieties seed was planted on March 08,

***Corresponding author:** Demelash Bassa Belayneh, Areka Agricultural Research Center, P.O. Box 79, Areka, Ethiopia, E-mail: demelashbassa2000@gmail.com

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2019. The varieties were randomized in each block separately. Since the seed size was very small, it was sown in the drilling method at 40cm row length and adjusted to 10cm between seeds after emergence. Thus, spacing was 40cm between rows and 10cm between plants after thinning the plants. There were 5 rows per plot and 20 plants per row. Thus, the number of plants per plot was 100. Regarding fertilization, TSP (Triple Super Phosphate) at the rate of 50kg ha^{-1} was used instead of DAP fertilizer. It is said to be single fertilizer and represented as 0kg: 46kg: 0kg. It comprises only 46kg of phosphorous. The amount applied to each plot was 0.02kg.

Materials used

The experiment to be undertaken, essential materials have to be prepared ahead of implementation, accordingly; Garden rake, pick fork, row marker stick, peg, string, and tape meter were used for layout preparation, tillage, and leveling of the plots. The watering can was also being used to irrigate the plots every morning and afternoon around 7:00 am and 6:00 pm respectively until the natural rainfall came. The Mungbean seed of the three varieties; sunaina, MH- 97-6, and Goffa Local, were used as a treatment and TSP (Triple Super Phosphate) fertilizer was used during sowing. The portable area meter was used to measure the leaf area of the sample plant. The oven dry was also used to dry the leaf and stem.

Data collection and analysis

Data collection: Days to 50% emergence were recorded as considering the number of days from sowing or when the plant gets its first water shower up to when 50% of the plants of each variety emerged in each plot. Leaf area (cm2) was recorded by taking a destructive sample; harvesting destructively the representative plants, of three plants from the second and fourth row per plot. The leaf area was measured before flowering using a portable leaf area meter. The average leaf area of the three plants was taken for statistical analysis. The sample was labeled indicating block, treatment, and plot number for easy differentiation and to avoid the mix-up of the treatments. The first sample for leaf area, stem, and leaf dry weight was taken from the field on April 7, 2019. It was inserted into the oven dry on the same date.

Stem and leaf dry weight: The average of three randomly taken plants was measured in gram and the average weight of the three plants was taken for statistical analysis. For stem and leaf dry weight, the leaf and the stem sample was kept in oven dry for 48hrs at 70Co. It was this dried stem and leaf measured for plant dry weight and leaf dry weight.

Biomass: it was measured from the central two rows of each plot (1.6m2) and then converted into biomass weight (g) and used for statistical analysis. The central two rows were harvested on May 04, 2019. Each variety was labeled and left to sundry. It is large in amount to dry it in the oven.

Data analysis

All the collected data were fed into computer Micro Soft Excel to calculate growth indices with Excel. Firstly, every collected was organized into primary values to calculate growth indices and were analyzed using MS- Excel. The ANOVA for biomass was done by using this software. Since there was a significant difference in the F test at the level of α = 5% among treatments, the mean separation was done by hand calculation using LSD (Least Significant Difference).

LSD (5%) = $t_{0.025(9)}\sqrt{\frac{2MSE}{b}}$, where MSE = error mean square; r = number of replications, b = number of treatments. In addition to these parameters, such as LWR, SLA, LAR, NAR, RGR, CGR and LAI was analysed by using MS- Excel. Relative Growth Rate is the rate of increase in plant dry weight relative to the total dry weight of that plant: RGR = (lnW2-lnW1) / (T2-T1) $gg^{-1}day^{-1}$. Net assimilation rate is the increases of plant material per unit assimilatory material per unit time: NAR= $(W_2\text{-}W_1)(\ln A_2\text{-}\ln A_1)$ / $(A_2\text{-}A_1)(T_2\text{-}T_1)$ and is expressed in the unit $gmcm^{-2}day^{-1}$. Leaf Weight Ratio (LWR) is the ration of weight of assimilatory material per unit of plant dry weight at any given time point. LWR (Leaf Weight Ratio) $=W_{leaf}/W_{plant}$ where W_{leaf} is leaf dry weight and W_{plant} is plant dry weight. LAI (Leaf Area Index) gives an estimate of the leafiness of a crop with in a field trial plot and represents the area of leaf for a given land area. LAI=A/P, A, Leaf Area and P ground area.

Crop growth rate (cgr): is a widely used parameter of production efficiency of plant stands, and enables comparisons to be made between stands (weight*ground $area^{-1}$*$time^{-1}$). CGR= $(W_2\text{-}W_1)/P\ (T_2\text{-}T_1)$. Specific Leaf Area (SLA) is the ratio of leaf area per unit of leaf dry weight at any given time point. SLA= Area/weight of leaf (cm^2g^{-1}). Leaf Area Ratio (LAR) is the ratio of the assimilatory material per unit of plant dry weight at any given time point. LAR= Area of assimilatory material/ plant dry weight ($cm^2g\text{-}^1$).

Results and Discussion

Effect of days to emergence on mungbean varieties performance

Days to 50% emergence were recorded; accordingly, the Mungbean variety suinaina was relatively late in days to 50% emergence as compared to MH-97-6 and Goffa Local. The average emergence day of suinaina, MH-97-6, and Goffa Local was 6, 5.3, and 5.3 respectively. The variety suinaina was not as vigorous as the other two Mungbean varieties. The earlier the emergence the better the opportunity to accumulate heat for the expansion of the leaf area. These results are in line with the research findings of Rasul et al., (2012) and Wodajo (2015) that showed the performance difference of three different Mungbean varieties.

Effect of days SLA and LAR on Mungbean varieties performance

First Sampling at 22 days after emergence and Second sampling at 50 days after emergence. The thickness of the leaf, which is expressed by SLA, was increasing from the first sample to the second sample. This indicated the leaf thickness increased in the time interval of growth. Similarly, the assimilatory material per unit of plant dry weight was increased with time. Thus, as the mung bean crop was getting matured physiologically, assimilatory material was high (Table 1).

Variation in three Mungbean varieties in the growth parameters

As indicated in the table, the varieties sowed different responses for each analyzed parameter. For instance, the NAR of the Mungbean variety Suninia is the highest followed by Goffa-L (Table 2). The MH-97-6 was measured as the least among them. By the same token, the value of RGR was 56, 66.5, and 64.4 for sunaina, MH-97-6, and Goffa-L respectively. Some research results indicated that cultivars with a higher LAR would have a higher NAR (Wallace, 1965). This idea agrees with this specific trial. For instance, the LAR value of Goffa L was the highest, and similarly, its NAR value is higher. This result agrees with the findings of Teame et al., (2017) who showed the yield and related

Table 1: Variations in Specific Leaf Area (SLA) and Leaf Area Ratio (LAR) for three Mungbean varieties during two consecutive samplings 2019.

Trt	1st Sample		2nd Sample	
	SLA (cm^2g^{-1})	LAR (cm^2g^{-1})	SLA (cm^2g^{-1})	LAR (cm^2g^{-1})
Sunaina	60.80787±9.514	46.58474±7.981653	155.8889±16.69473	90.6986±10.41097
MH-97-6	58.28±7.194091	43.8528±3.38598	112.9627±35.45205	66.84819±18.92605
Goffa-L	72.16019±0.79259	51.45253±0.806804	133.895±9.441825	76.05607±4.675801

Table 2: The mean of growth parameters analysis 2019.

SV	Df	SS	MS	F cal	F tab 5%
Rep	2	4340.566	2170.283	0.477651^{NS}	6.94
Trt	2	251064.7	125532.4	27.62804*	6.94
Error	4	18174.63	4543.658		
total	8	273579.9			

Table 3: ANOVA table showing variations in biomass production for mungbean, 2019.

SV	Df	SS	MS	F cal	F tab 5%
Rep	2	4340.566	2170.28	0.477651NS	6.94
Trt	2	251064.7	125532	27.62804*	6.94
Error	4	18174.63	4543.66		
total	8	273579.9			

CV=9.95%, CV (Coefficient of Variance)

traits significant difference (F<0.05) among nine Mungbean varieties (Table 2).

Variation in three Mungbean cultivars in biomass

CV=9.95%, CV (Coefficient of Variance). The final above-ground dry-weight biomass data were collected on the 65th day after emergence. It was by harvesting two consecutive middle rows with an area of $1.6m^2$. There was a significant difference among treatments (F<0.05) as influenced by biomass. The non-significance of replication indicated that CRD (Complete Randomized Design) can also be used for this specific trial. There was a significant difference among Mungbean cultivars in the biomass mean value as it is indicated in the mean separation. They have a mean value of 695.5833, 569.625, and 767.08 for Sunaina, MH-97-6, and Goffa-L respectively. A study on the three Mungbean varieties in the southern region of Ethiopia indicated that the potential yield of Mungbean is 860kg ha^{-1}, however; the obtained yield on each variety was 257kg ha^{-1}, 210kg ha^{-1} and 207kg ha^{-1} of MH-97-6, N-26, and shewarobit respectively (Wodajo, 2015) which was in line with the results of these findings. Teame et al., (2017) in their findings indicated similar results in performance evaluation of nine mungbean varieties at Raya valley of Northern Ethiopia (Table 3&4).

Table 4: Comparing above ground biomass (g) means of three Mungbean, 2019.

Observation	Treatments	Means	Group letter
1	Goffa-L	767.0833	A
2	Sunaina	695.5833	B
3	MH-97-6	569.625	C

LSD = 10. 6

Conclusion and Recommendations

Taking as a whole Mungbean variety significantly affected growth parameters in the experiment time at Hawassa. Growth indices such as SLA, LAR, RGR, NAR, and also others with the total dry matter accumulation of Mungbean were affected by Mungbean varieties in this study. Therefore, Mungbean can be produced at Hawassa with a significant yield performance difference. However, the Collection of all available released Mungbean varieties and evaluation of them across locations and over the year may give ample evidence to explain the performance of Mungbean at Hawassa. From this study, it can be recommended that Goffa-L gave the best yield as compared with MH-97.6 and Sunaina mungbean varieties; it can be produced in the tested location in large scale.

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