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Research Article

Performance and Growth Analysis of Three Mung Bean (*Vigna radiate*) Genotypes at Hawassa, Ethiopia

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ABSTRACT

Mung bean (*Vigna radiata*) is belong to fabaceae family that currently is grown in different parts of world and it have large role in nutrition at developing countries. The study was conducted at field of agronomy and plant physiology laboratory in Hawassa University College of Agriculture at Hawassa during the period of mid-March to early June 2018. This experiment was conducted to investigate the efficiency of different Mung bean varieties on response of different growth parameters such as Specific Leaf Area, Leaf area ratio, net assimilation rate, and relative growth and total dry Biomass of among 3 mung bean varieties that are Sunaina, MH-97-6, and Gofa local on growth and developmental characteristics of above ground biomass and growth parameters. Three mung bean cultivars were grown in randomized complete block design with three replications. Different growth parameters such as, Days to 50% Emergency, specific leaf area ratio, leaf area ratio, net assimilation rate, relative growth rate and above ground biomass were collected and analyzed by using SAS software (ver 9.1). The study revealed that there is significant difference among cultivars observed for days to 50% emergency and total dry biomass. The SLA and LAR of all cultivars increment from first sample to second sample as crop development progressed. Gofa local cultivar is highest Total dry biomass and late days to emergency. In general, the study result revealed that significant difference among varieties ($P \leq 0.05$).

Keywords: Leaf area ratio; Mung bean; Net assimilation rate; Relative growth; Specific leaf area; Dry biomass

INTRODUCTION

Mung bean (*Vigna radiata*) is also known as green gram, golden gram, oregon pea, chickasano pea, chiroko or simply mung. It is synonymous with phaseolus aureus roxb. The crop is said to have originated from India and must have been derived from var. Sublobata which occurs wild throughout India and Burma. Mung bean belong to fabaceae family that currently is grown in different parts of world and it have large role in nutrition at developing countries. Due to short term growth, nitrogen fixation capability, soil reinforcement and prevention of soil erosion, mung bean is superior plant and requires 75-90 days to mature with advantages of rotation and relay cropping with moisture retention.

Smallholder farmers in drier marginal environments in Ethiopia grow mung bean. In southern Ethiopia, Farmers in some moisture stress areas (gofa, konso, south omo zone and konta) have been producing mungbean to supplement their protein needs and also effectively use scanty rainfall. The Higher biomass of leaves, improve nutrient utilization and lower environments pollution through reducing the amounts of fertilizers added to soil.

Mung bean requires 27°C-30°C temperature, Soil: Sandy, loam soils, pH: 6.3-7.2, Planting: 4 cm deep in a well-prepared seedbed and if the surface layers are dry 7.5 cm. Fertilization nitrogen fertilizer is usually not applied as mung bean fixes its own nitrogen, but it is advisable to use rhizobium inoculums on the see.

Mung bean is produced for both human consumption and as fodder. Its seed contains 24.3% protein and 0.67% fats.

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In spite of its importance as food and feed, mung beans on farmer's field are the continuous cultivation of traditional low potential cultivars. This field experiment focus on the above ground biomass growth analysis of mung bean in a trial to determine the potential performance difference among 3 mung bean varieties on growth and developmental characteristics of above ground biomass and to gain information for further studies and requirement recommendations of varieties for the area.

MATERIALS AND METHODS

The experiment was conducted at field of agronomy and plant physiology laboratory in Hawassa University College of Agriculture at Hawassa during the period of mid-March to early June 2017.

Treatments and experimental design

Three Mung bean varieties Sunain, MH-97-6, and goffa local, were used as treatments. Treatments were assigned on Randomized Complete Block Design (RCBD) with three replications and mung beans was sown with plant spacing 40 × 10 cm, on plot size of 2 m × 2 m, 5 rows per plot area of 4 m^2, gross total area of the experiment 49 m^2. Fertilizer TSP 20 g per plot was added and all recommended agronomic practices were carried out accordingly.

Data collection

Days to 5% emergence: Were recorded as the number of days from sowing to when 50% of the plants emerged in each plot.

Leaf area (cm^2): Stem and leaf dry weight (g/m^2).

Total dry weight (gm^2): After 22 and 50 days from emerging the first and the second samples were taken by destructive sampling respectively.

For both samples, three plants per plot were taken randomly from middle rows, measured leaves area by leaf area meter to determine leaves area (cm^2), subjected leaves and stems to oven dry for about 48 hours by 70°C to dry weights of stems and leaves (gm). Final biomass harvest after 65 days after emergency date taking two row of each plot were harvested destructively as the final samples which were important to determine or measure above ground dry matter of total biomass (AGTBM) (g/m^2).

Growth parameters (growth analysis)

Growth refers to the irreversible changes in the size of a cell, organ or whole plant. It involves both the cell division and enlargement. The plant growth can be visualized in terms of increase in length or plant height, stem diameter, volume of tissue, increase in cell numbers, increase in fresh weight and dry weight, increase in leaf area, leaf weight etc. The following the major growth parameters.

The growth analysis Specific Leaf Area (SLA), Leaf Area Ratio (LAR), Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) were carried out by the following.

Data analysis

Each growth parameters were analyzed and computed mean values ± SE (Standard Error) by using the above listed formula for each treatment (genotypes). The recorded data of the mung bean genotypes for growth parameters was subjected to Analysis of Variance (ANOVA) appropriate to the experimental design analyzed using SAS software version 9.1 and tested significance at 5% probability level using the F test.

RESULTS AND DISCUSSION

Growth parameters

Specific Leaf Area (SLA): Specific leaf is a measurement of leaf thickness which plays an important role in leaf and plant functioning and related to species' strategies of resources acquisition and use related with dry matter accumulation. Results of this experiment indicated that there were differences between three varieties. Highest specific leaf area of a crop indicates that it has larger leaf area and this helps the crop to have highest efficiency of light harvesting which means higher photosynthetic rate. SLA is an important trait characterizing plant adaptation to environmental conditions: its plasticity is often seen as a way for plants to increase the efficiency of light harvesting, and/or the efficiencies of resource use (e.g., light, water and nitrogen-use efficiencies).

Leaf Area Ratio (LAR): Leaf Area Ratio is the ratio of photosynthesizing to respiring material (biomass). A high LAR has been considered a desirable characteristic because it indicated the plant had a high photosynthetic potential in relation to its respiratory load. The yields of bean cultivars were more highly correlated with their LAR than with either their LAI. The LAR of all cultivars increased as crop development progressed. This result argued that decline was reported. But the differences in LAR among the cultivars were relatively high. The LAR of Sunian was better than MH-97-6 and Gofa local with the mean values of 68.6398, 55.35 and 63.75 respectively. All cultivars showed a great increment in LAR. The comparisons of several dry bean cultivars and found the yields were highly and positively correlated with the LAR. A negative relationship between the grain yields of soybean cultivars and their LAR values. The results of the present study from the yield and biomass relationship agree with those of Wallace and Munger.

	1st sample		2nd sample	
	SLA ($cm^2 g^{-1}$)	LAR ($cm^2 g^{-1}$)	SLA ($cm^2 g^{-1}$)	LAR ($cm^2 g^{-1}$)
Trt				
sunaina	60.80 787 ± 9.514	46.58474 ± 7.981653	155.8889 ± 16.69473	90.69486 ± 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. 792059	51.45253 ± 0. 806804	133.895 ± 9.4 41825	76.05607 ± 4. 675801

Table 1. Response of different growth parameters, SLA (Specific Leaf Area) and LAR (Leaf Area Ratio) for two samples of *Vigna radiate*.

First Sampling at 22 days after emergence and Second sampling at 50 days after emergence. SE= Standard Error, SLA1 = Specific Leaf Area first sampling, SLA2 = Specific Leaf Area second sampling, LAR1= Leaf Area Ratio first sampling and LAR2=Leaf Area Ratio second sampling.

The Leaf Area Index increases from one growth phase to another. Therefore, from the above experimental (Table 1) result we can understand that as the level of growth increases both Specific Leaf Area (SLA) and Leaf Area Ratio (LAR) increases in the first and the second sample. This result agrees with the research under taken on comparing the growth characteristics of four Mosla species.

Net Assimilation Rate (NAR): Net Assimilation Rate can be described as plant materials increment per assimilatory material unit per time unit. It was indicated on the result that there were great differences among the three varieties that is 49.5, 2.3, and 59 in mgm^{-2} Sunaina, MH-97-6, and Goffa local respectively. This parameter has frequently been calculated in field research to estimate the photosynthetic efficiency of crop leaves. Donald pointed out that the NAR value for a crop was an average value for all leaves. From result showed Sunaina high NAR than MH-97-6 and Gofa local.

Several studies have found a negative correlation between leaf area ratio and NAR the rate of decline in LAR per unit increase in NAR has been used as a measure of the canopy efficiency of crops. The NAR of improved cultivars showed a slower rate of decline than the older standard ones. They attributed this to improvements of canopy architecture. The cultivars with a higher LAR would have a higher NAR, also this experimental results in line with relationship. They found that SLA had a high heritability and suggested it would be a good characteristic for easy, indirect selection of photosynthetic efficiency.

Relative Growth Rate (RGR): Rate of plant dry weight increment relative to the total dry weight of that plant is referred to as Relative Growth Rate. Output of this experiment presented 56, 66.5, and 64.4 in sunuina, MH-97-6, and Gofa local respectively. The relative RGR of the cultivars depended on the stage of crop development. During the period, between two samples date, the RGR of MH-97-6 was better than Sunian and Gofa local numerically.

The correlation between LAR, the ratio between total leaf area and total plant weight, and RGR was very high. This positive correlation was mainly due to the SLA, the ratio between leaf area and leaf weight, and to a lesser extent caused by the leaf weight ratio, the fraction of plant biomass allocated to the leaves.

Trt	LWR_1 (gg^{-1})	LWR_2 (gg^{-1})	NAR ($mg\ dm^{-2}$)	RGR ($mgg^{-1}\ day^{-1}$)	LAI_1 (cm^{-2})	LAI_2 (cm^{-2})	CGR ($gm^{-2}\ day^{-1}$)
Sunaina	0.775	0.580769	49.5	56	0.000535 ± 6.456153	0.006555 ± 30.91489	0.0000595
MH-97-6	0.773585	0.636145	2.3	66.5	0.000645 ± 6.39799	0.006885 ± 42.06054	0.000111
Goffa local	0.711111	0.570588	59	64.4	0.000641 ± 3.191812	0.007215 ± 41.0635	0.0000803
Mean ±STD	0.753232 ± 0.021064	0.595834 ± 0.020368	36.9333 ± 17.5325	62.3 ± 3.208	-	-	0.0000836 ± 0.0000 14958

Table 2: Net Assimilation Rate (NAR), Leaf Weight Ratio (LWR), Leaf Areal Index (LAI) and Relative Growth Rate (RGR).

The above Table 2 ground total biomass showed significant difference for Gofa local from suniana and MH-97-6 Mung bean cultivars with the mean values 767.0833, 695.5833 and 569.625, respectively. Leaf dry weight was the major component of the total dry weight. Dry matter accumulation in crops has a direct relationship with leaf area ratio. The LSD shows there is significant difference between treatments that means varieties has a positive effect on total dry matter. This implies that genetic and environmental effect have influence to differentiate dry matter accumulation. The result showed that Gofa local is the highest Total dry biomass than Suniana and MH-97-6 varieties.

It was also evident from the results that leaf area index increased linearly from one growth phase to another. The highest leaf area indices were observed in cultivar Gofa local 0.00064 to 0.0072 cm^{-2} which has direct relationship with photosynthetic activities of the plant that leads affect assimilate accumulation of the plant.

Relative Leaf Weight ratio show slight decreasing (RLWR1-RLWR2) this is due to as plant size increases, the leave number partitioned (denominator) increases.

The NAR value for a crop was an average value for all leaves. Several studies have found a negative correlation between leaf area ratio and NAR the rate of decline in LAR per unit increase in NAR has been used as a measure of the canopy efficiency of crops. The NAR of improved cultivars showed a slower rate of decline than the older standard ones. The cultivars with a higher LAR would have a higher NAR, however, in our experimental results have shown the opposite relationship.

Thus, the more a plant invests in leaf area, the higher the total carbon gain and the faster growth will be. This was, amongst others, also found in studies on Taraxacum micro species. Growth rates the varieties MH-97-6 and Gofa local have showed relatively great difference (RGR) 66.5 mg g^{-1} day^{-1} and 64.4 mg g^{-1} day^{-1} (on a dry weight basis) respectively (Table 3). As larger plants tend to have a lower RGR, due to self-shading or to a larger investment in supporting structures, comparison of species which differ in size may obscure possible trends.

SV	df	ss	MS	F cal.	F tab. 5%
Rep	2	4340.566	2170.283	0.477651	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 for biomass dry weight (g/plot area) of *Vigna radiate*

Treatments	Mean	Group
Gofa local	767.033	a
sunaina	695.5833	b
MH-97-6	569.625	c
Lsd	10.6	

Table 4: Mean separation for biomass (g/plot).

Aboveground biomass dry weight: The highest level of biomass dry weight obtained from variety Gofa local 767.033 g/plot with equivalent of followed by sunaina of 695.5833 g/plot (Table 4). This biomass dry weight difference is an indication of the photosynthetic rates varied significantly among the varieties at all three stages mung bean varieties. As growth period increase ground covered by plants increases that increase soil moisture level and also plant leaves per plant increase so, there attributes have great role for photosynthesis increased performance and assimilate accumulations.

In short, dry matter accumulation in crops has a direct relationship with leaf area ratio. The LSD shows there is significant difference between treatments that means varieties has a positive effect on total dry matter. This implies that genetic and environmental effect is to difference dry matter accumulation.

CONCLUSION

For the specific leaf area and leaf area ratio as the plant continue its growing they did show increment performance. The cultivars which show higher value at the first sampling and at the second sampling increased. From this study indication these mung bean cultivars perform differently across their growing period. As it is shown on the result, when relative growth rate increase leaf area ratio and specific leaf area also increases. So we can conclude that both leaf area ratio and specific leaf area affect the mung bean growth rate.

From the present studies it can be concluded that the variety Gofa local have significant difference from sunaina and MH-97-6 varieties. NAR is positively highly influenced by environment stress. This may explain why RGR, for short periods is strictly related with NAR at the same time, the considerable negative effect of LAR on NAR should be noted.

Genetic factor is a key factor for achieving optimum growth and dry matter production of crops. The genetic and environmental factors can cause a different level of variation of the tested characteristics of mung bean varieties. Because plant growth parameters trait resulting from the interaction of morphological, phonological physiological and environmental. Mung beans are important for good agronomic performance for greater growth and total dry biomass showed in the studied area. Based on the obtained result of the present experiment, almost all the parameters under study showed, Gofa local Variety is almost in all studied parameters show significance performance.

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