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Adaptability Study of Improved Mung Bean (*Vigna radiata*) Varieties in Moisture Stress Areas of Guji Zone, Southern Ethiopia

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Abstract: Mung bean (Vigna radiata L.), a green gram, is the best important short duration legume crops for moisture stressed areas globally. On account of the prolonged drought in moisture stress areas in Ethiopia, drought tolerant and early matured with a little soil moisture crops are utmost important and production of mung bean crop is very crucial in the lowland areas of Guji zone. During the 2020–21 cropping season, a study was carried out at the Bore Agricultural Research Center's research mandate regions to assess the adaptation of mung bean cultivars. In order to assess eight characteristics—namely, days to 50% flowering, seed filling period, 90% physiological maturity, plant height, number of pods per plant, number of seeds per pod, seed yield, and hundred seed weight—for five mung bean varieties—Rasa, Shewa robit, NVL, Local, and Chinese—under rain-fed conditions at the Bore Agricultural Research Center on farms in the Guji Zone, a field experiment was set up in a randomized complete block design with three replications. With six rows per plot and a distance of 40 cm between rows and 10 cm between plants, each plot measured 2.4 meters by 4 meters. With the exception of plant height, which is not significantly different among varieties, the analysis of variances showed that Days to 50% blooming, Days to 90%maturity, number of pods per plant, number of seeds per pod, hundred seeds weight, and grain output per hectare changed as impacted by variety. The highest grain yield (1014.04kg/ha) was recorded from Rasa variety followed by local cultivar (938. 45kg/ha) whereas the minimum grain yield value (715.67kg/ha) was recorded by variety, NVL. Hence, the variety Rasa was best adapted in the study areas and it will be used for production.

Keywords: Early Mature Crop, Legume Crop, Drought Tolerant, Seed Yield, Green Gam

1. Introduction

Phaseolus radiates L., an annual herb in the Leguminosae family, is indigenous to Bangladesh, India, and Pakistan and is green. Other names for it are golden gram, Oregon peas, and chokoro (Swahili). Asia cultivates this legume for its tasty seeds and sprouts. With diploid chromosome number $2n = 2x = 22$, it is a member of the Fabaceae family and subfamily of the Papilionaceae. *Vigna radiata* is divided into three subgroups: Vigna radiata subsp. radiata, which is farmed, and Vigna radiata subsp. sublobata and Vigna radiata subsp. glabara, which is wild. The most significant crops for food and feed in Ethiopia's semi-arid regions are grain legumes. Dry land grain legumes high in protein, primarily haricot beans, pigeon peas, cowpeas, and mung beans, are the other crops included in the strategy to increase food security, enhance nutrition, and create revenue.

The vital short-duration, self-pollinated, diploid mung bean (Vigna radiata L. Wilczek) is a legume crop with significant nutritional value and the ability to fix nitrogen [7]. It is a leguminous food grain that is environmentally benign and a rich source of vitamins, minerals, and proteins in dry land agriculture. It holds a significant position in vegetarian diets. Compared to most other legumes, mung bean seeds are a good source of dietary protein and have higher quantities of iron and folate [7]. Unlike many other legumes, mung beans are low in calories, high in fiber, and an easily digested crop that doesn't induce flatulence [8]. Sprouts are rich in calcium, phosphate, some vitamins, and protein (between 21 and 28%). In tropical regions of the world, they take the place of animal protein, which is hard to come by, in human diets [9].

Additionally, it is a relatively new addition to Ethiopian pulse production, and it is grown in the SNNPR (Gofa area), several woreda's of Benishangul Gumuz regional state and pocket, and the northeastern Amhara region (North Shewa, Oromiya special zone, and Southern Wollo) [4]. Even though Ethiopia's demand on the global market is rising, there is a persistent shortage of production-side Ethiopian goods. Though Ethiopia's mung bean exports have occasionally increased [5], more has to be done to spread the crop's production to other promising regions of the country.

Ethiopia's lowland regions have a climate that is typified by high temperatures and little rainfall throughout the growing season. The crops farmed in this region of the country have very short growing seasons. Farmers in Ethiopia's lowlands are particularly interested in crops that mature early, can withstand drought, and can withstand greater temperatures. Mung beans are a crop that matures very early, are resistant to drought, and have a lot of potential for semi-arid regions with short growing seasons. Excellent yield, excellent nutritional content, early maturity/drought resistance, and affordable production costs are among the unique qualities.

In the lowland Guji areas of southern Ethiopia, where moisture stress poses a serious threat to the production of long-maturing commodities like cereals and other pulse crops, there is a need to expand its production to other viable locations. Additionally, lowland pulses like mung beans, which mature early and can withstand drought with a little rain during sowing, have potential in the research area. Farmers haven't yet been introduced to the enhanced variety, though, especially in the Guji zone's lowland parts. Thus, the goal of this study was to assess and choose the mung bean variety that was most suited to the Guji zone's moisture stress conditions while still producing a high yield.

2. Materials and Methods

2.1. Description of the Study Area

During the main cropping season of 2020–2021, the study was carried out at the Adola research sub-site of the Bore Agricultural Research Center, as well as on farms in Kiltu-sorsa and Wadera. Bimodal rainfall of 500 mm on average and minimum and maximum temperatures of 22°C and 32°C, respectively, are the characteristics of the research area. The experimental area's soil texture class is clay loam, with a pH range of 7.9 to 8.1. The region is distinguished by a mixed farming system that produces both crops and livestock.

2.2. Treatments and Experimental Procedures

A total of five varieties (Shewa robit, Rasa, NVL, Local cultivar, and Chinese) were used in the study. The experiment was designed using a Randomized Complete Block Design with three (3) replications. The plot size was 4 m × 2.4 m (9.6 m^2) with six rows and a harvestable plot size of 1.6 m × 4 m (6.4 m^2) with a spacing of 0.40 m between rows and 0.10 m between plants. 1.50 m between blocks and 1 m between plots within each block were used. Fertilizer was applied at a rate of 121 kg NPS per hectare at the time of planting. All agronomic practices were conducted uniformly to all plots of the treatments per recommendations.

2.3. Data Collection and Statistical Analysis

Data were gathered and analyzed separately for each plant, including plant height (cm), number of pods per plant, number of seeds per pod, and days to 50% flowering, days to 90% maturity, grain yield (kg ha-1), and 100 seed weight (g). Using SAS version 9.1 [11], data on the phenological, growth, and yield components were subjected to analysis of variance (ANOVA) at $P<0.05$. Significant difference among the treatment means was done by least significant difference (LSD) test to compare the means of the treatments at $P<0.05$ [6] level of significance.

3. Result and Discussion

3.1. Phenological and Growth Traits

3.1.1. Days to 50% Flowering

The result revealed that the effect of varieties across location on days to 50% flowering was highly significant (Table 1), where the minimum days required to flowering is recorded on Rasa variety (39.44) followed by Local cultivar (41.33) whereas the maximum days required to flowering was recorded on variety Shewa robit (42.11) and chinese (42.11) which is statistically similar with NVL (42.67) varieties. The outcome was consistent with the research of Teame *et al*. which found that varieties have a highly substantial impact on the number of days to flowering [12]. This finding is at odds with Aklilu and Abebe who claimed that variety had no significant impact on the number of days to 50% flowering [2].

3.1.2. Days to 90% Maturity

The effect of varieties across location on days to 90% maturity was significant (Table 1) in which the minimum days to 90% maturity was obtained on variety Rasa (91.00) which is on par with NVL (91.67) whereas the maximum days to 90% maturity was recorded on variety Shewa robit (93.00). The finding was in line with previous reports by Teame *et al*. and Wendm that effect of varieties on days to 90% maturity was highly significant [12, 14].

3.1.3. Plant Height

The results of the analysis of variance indicated that there was no discernible variation in plant height between varieties at all sites. This finding was the same to Aklilu and Abebe who reported that mung bean varieties have no significance differences in plant height [2].

Table 1. *Combined analysis of Variance for agronomic traits.*

Source of variation	df	Mean squares		
		DF	DM	PH
variety	4	28.60***	7.69**	20.59ns
Rep	3	ns	ns	13.16ns
location	2	800.53***	79.76**	122.65ns
Var*loc	12	60.700	3.92*	38.96ns

Where, ns; not significant at P≤0.05, * significant at P≤0.05; ** significant at P≤ 0.001 probability level. df: Degree of freedom, CV: Coefficient of variance, DF50%: Days to 50% flowering, DM, Days to 90% maturity, PH: Plant height (cm)

Table 2. *Combined mean of Phenology and growth traits (DF, DM, and PH) of mung bean varieties across location.*

Treatments	DF	DM	PH
Local	41.33a	92.11ab	36.64
Rasa	39.44b	91.00bc	36.56
NVL	42.67a	91.67bc	35.81
Shewa Robit	42.11a	93.00a	38.93
Chinese	42.11a	91.67bc	34.83
Mean	41.53	91.69	36.55
LSD	1.68	1.11	ns
CV (%)	6.09	1.26	18.46

The means that have the same letters in each column do not differ substantially at p≤0.05.

The variables that are used are: PH, plant height (cm); CV, coefficient of variance; LSD, least significant difference; DF50%, days to 50% flowering; and DM, days to 90% maturity.

3.2. Yield and Yield Components

3.2.1. Number of Pods Per Plant

Number of pods per plant is the main yield component in determining the yield performance of the leguminous crops. The analysis of variance revealed that the effect of varieties on number of pods was highly significant across location. Significantly higher number of pods was recorded on variety Rasa (12.28) which is statistically similar to local (11.68) and the smallest number of pods recorded was on variety chinese (8.87). According to Teame *et al*. and Wedajo, there was a notable difference in the quantity of pods per plant between types, which is consistent with our findings [12, 13].

3.2.2. Number of Seeds Per Pods

An analysis of variance on Table 3 revealed a highly significant difference (P<0.001) between the various varieties. The result (Table 4) showed that maximum seed number was recorded on variety Rasa (9.56) followed by local (8.65) whereas the minimum seed number was recorded on variety Chinese (7.54). The results aligned with the research of Belay *et al*. and Ahmad *et al*. who suggested that genetic variations could account for variations in the number of seeds per pod among the cultivars [1, 3].

Table 3. *Combined analysis of variance for yield and yield components.*

Source of variation	df	Mean Squares			
		NPPP	NSPP	HSW (g)	GY (Kg)
Variety	4	23.935**	6.1064**	6.378**	263091.588***
Rep	3	ns	4.1753**	ns	116535.438***
Location	2	47.490**	34.288**	2.097*	470320.80ns
Var*loc	12	11.208*	ns	1.416*	32317.600ns

Where, ns; not significant at P< 0.05, * significant at P< 0.05; ** significant at P< 0.001 probability level. DF: Degree of freedom, CV: Coefficient of variance, NPP, Number of pods/plant, NSP, Number of seeds/pod, HSW, Hundred seed weight (g), GY: Grain yield (kg ha^{-1})

Table 4. *Combined mean of number of yield and yield components (number of pod/plant; number of seed/pod, hundred seed weight and grain yield) of mung bean varieties across location.*

Treatments	PPP	SPP	HSW (gm)	GY (kg)
Local	11.68a	8.65b	3.95c	938.04ab
Rasa	12.28a	9.56a	5.14ab	1014.45a
NVL	9.01b	7.93bc	4.64b	715.67c
Shewa Robit	9.36b	7.75c	4.09c	794.76bc
Chinese	8.78b	7.54c	5.27a	798.98bc

Treatments	PPP	SPP	HSW (gm)	GY (kg)
Mean	10.22	8.28	4.62	852.38
LSD	1.96	0.88	0.52	145.93
CV (%)	19.82	11.09	16.83	25.65

Where LSD, Least Significance Difference; CV, Coefficient of variance; NPP, Number of pods/plant; NSP, Number of seeds/pod; HSW, Hundred seed weight (g); GY, Grain yield (kg ha^{-1})

3.2.3. Hundred Seed Weight (g)

Table 3 shows that there is a highly significant difference (p<0.001) among varieties across locations according to analysis of variance. The maximum hundred seed weight (HSW) was obtained on variety Chinese (5.27) followed by Rasa (5.14) whereas the lowest HSW was recorded on local (3.95) which is on par with Shewa Robit (4.09). These results are consistent with those of Ahmad *et al*., Wedajo, and Teame *et al*. who revealed that variations in the hundred seed weight across mung bean varieties could be caused by factors such as increased nutrient translocation, absorption, growth rate, crop potential, and dry matter partitioning [1, 12, 13].

3.2.4. Grain Yield

The impact of the mung bean crop's varietal variation on grain production varied significantly. A highly significant difference was noticed on grain yield among the varieties as influenced by variety. Considerably, the highest grain yield was obtained on variety Rasa (1014.45) followed by local (938.04) in arbitrary to this the lowest grain yield was recorded on NVL (715.67). The higher grain yield on variety Rasa and local may be due to the maximum number of pods per plant and seeds per pods. There has been documented evidence of a notable variance in grain production amongst mung bean varieties [10, 12, 13]. Rasa was more adaptive in drought-prone locations since it produced a far larger yield than other mung bean varieties and took fewer days to full its seeds. This variety may have the highest output because of its innate genetic potential. Better local adaptation to the research location may potentially be the cause.

4. Conclusion

Mung bean (*Vigna radiata* L. Wilczek) is a fundamental early maturing with drought tolerant, self-pollinated diploid legume crop with high nutritive values and nitrogen fixing ability. The trial was conducted with the objective to evaluate and select well adapted varieties of high yielding performance in the study area. From this study, the phonological and growth traits except plant height and also yield and yield components were significantly affected by variety. The highest grain yield (1014.04.8kg /ha) was obtained from Rasa variety, followed by Local cultivar (938.45kg/ha) whereas the lowest grain yield value (715.67kg/ha) was recorded on variety NVL. Alternatively, significantly minimum days to 90% maturity (91.00) and maximum days to 90% maturity (93.00) were found at those varieties of Rasa and Shewa Robit respectively. This stated that Rasa matured much earlier than other varieties. Since the lowland area was characterized by shortage and erratic rainfall, thus earliness in maturity is one of the best criteria for selection and recommendation of varieties for these areas. Therefore, it could be concluded that Rasa variety might be recommended for farmers and growers of mung bean in the study area.

Conflicts of Interest

The authors declare no conflicts of interest.

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