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Improving The Growth of Mung Bean Plants (*Vigna radiata* L.) with Various Soil Tillage Methods

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ABSTRACT

Soil tillage plays a crucial role in determining the productivity of mung bean plants. It is essential to conduct research aimed at identifying the optimal soil tillage techniques for enhancing mung bean growth. This study was carried out from August to November 2023 at the Gunung Gede Experimental Field, located at IPB Bogor Vocational School. A one-factor randomized complete block design was employed, featuring three treatment levels: Maximum Tillage, Minimum Tillage, and No Tillage. The Vima 2 variety of mung beans was utilized for this investigation. The analysis of variance (ANOVA) revealed significant differences in yield characteristics, specifically seed weight and overall productivity. Furthermore, Pearson Correlation Analysis indicated a notable relationship between stem diameter and plant height, as well as the number of leaves and productivity. A particularly strong correlation was observed between seed weight and productivity. The findings suggest that the Maximum Tillage Method is the most effective approach for cultivating the Vima 2 variety of mung beans.

Keywords: Cultivation, Fertilizer, pH, Productivity, Yield

1. INTRODUCTION

Mung beans (*Vigna radiata* L.) are a type of food plant belonging to the Fabaceae family that contains a high amount of protein, iron, calcium, and vitamins. This plant offers numerous health benefits, such as supporting the immune system and enhancing bodily endurance. The relatively high protein content of mung beans (23.6%) makes this plant widely consumed and cultivated in Indonesia (Melawti et al. 2023).

Lubis (2021) stated that efforts to meet the domestic demand for mung beans can be achieved by increasing production through intensification. Agricultural intensification is the effort to cultivate agricultural land with the aim of enhancing production. Effective soil management techniques are one of the important factors that influence the productivity levels of crops.

Land cultivation techniques can be categorized into three primary systems: Maximum Tillage (OTS), Minimum Tillage (OTM), and No Tillage (TOT). The Maximum Tillage approach involves intensive cultivation across the entire land area, which includes the removal of plant residues and weeds, as well as the loosening of soil to prepare it for planting. This method is designed to create an optimal physical environment for plant growth (Yusmaningsih et al. 2022). However, frequent application of this technique can lead to detrimental effects on soil structure and result in soil saturation. In contrast, the Minimum Tillage method is implemented selectively, focusing on specific areas rather than the entire field. This approach aims to preserve soil structure and promote the healthy growth of soil microorganisms. The No Tillage system, on the other hand, involves minimal disturbance of the land, allowing for the establishment of small grooves or holes for planting seeds or seedlings. In this system, plant residues and weeds are managed to prevent interference with planting while simultaneously serving as mulch to inhibit the growth of new weeds. This method also contributes to reduced evaporation, thereby ensuring greater water availability for the plants.

Subandi et al. (2024) took a study examining the impact of tillage practices on the growth of the Vima 2 variety of mung beans. This investigation involved various tillage treatments alongside different doses of nitrogen fertilizer. The findings revealed no statistically significant differences among the tillage treatments, suggesting a necessity for further research incorporating additional treatments that may have a more pronounced effect on production. This aligns with the assertion made by Prasetio et al. (2022), which emphasizes that enhancing mung bean production can be achieved through multiple strategies, including fertilization. Future research should focus on the application of manure in conjunction with specific tillage methods to evaluate its influence on production outcomes. The primary aim of this study was to assess the effects of different tillage methods and identify the most suitable approach for promoting mung bean growth.

2. MATERIAL AND METHODS

2.1 Growing season and Experiment Site

This research was conducted from August to November 2023 at the Gunung Gede experimental garden, Vocational School of the Bogor Agricultural Institute, West Java. (6°35'15.7"S 106°48'28.3"E).

2.2 Tools and Materials

The materials used in this research are Vima 2 variety mung bean seeds, chicken manure (dose 5 t/ha), urea (dose 100 kg/ha), SP 36 (dose 100 kg/ha), and KCl (dose 50 kg/ha). The tools used include a hoe, soil fork, trowel, measuring tape, watering can, bucket, polybag, caliper, and scale. The observation data were analyzed using SAS v9.0 software.

2.3 Research Method

This research employed a one-factor Randomized Complete Block Design featuring three treatment levels: maximum tillage (OTS), minimum tillage (OTM), and no tillage (TOT), each replicated three times. The data were analyzed using the SAS version 9.0 software, which facilitated a comprehensive analysis of variance (ANOVA). For those observation variables that exhibited significant differences in the ANOVA results, Duncan's Multiple Range Test (DMRT) was subsequently applied. Mung bean seeds were sown in a plot measuring 9 m by 2 m, with a planting configuration of 40 cm by 20 cm, utilizing two seeds per planting hole. Five plants were sampled from each replication for analysis. The soil type in the study area was identified as latosol, characterized by a pH of 5.2. The vegetative traits assessed included plant height, leaf count, and stem diameter, while the yield characteristics measured encompassed pod length, seed count per pod, seed weight, and overall productivity.

The research flowchart illustrates the sequence of research activities, commencing from the preparatory phase and culminating in the research outcomes (Figure 1). In the case of the land treated with the Maximum Tillage (OTS) method, it was plowed using a tractor, and chicken manure was uniformly distributed one week prior to planting. During the planting process, fertilizers including urea, SP 36, and KCl were applied to the furrows adjacent to the plant rows. Conversely, the land subjected to the Minimum Tillage (OTM) method was only loosened in the planting rows with a hoe, while manure, urea, SP 36, and KCl were similarly applied in the furrows next to the plant rows. For the land designated as Without Tillage (TOT), no loosening occurred; instead, manure was placed in the planting holes, and urea, SP 36, and KCl fertilizers were applied around these holes.

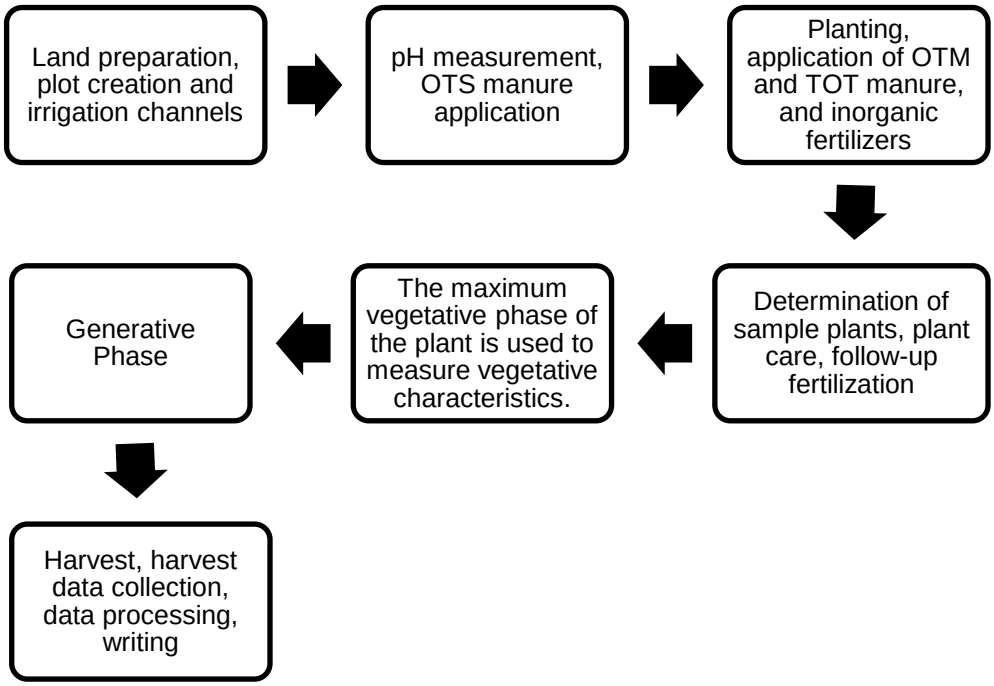

Figure 1. Research flow diagram

Measurements were conducted utilizing meters, calipers, and scales. A random selection process was employed to identify five sample plants, which were marked with stakes. Mung bean plants were harvested at regular intervals, commencing at 8 MST. The height of the plants was measured during the peak vegetative stage with a meter. Stem diameter was assessed using a caliper,

while pod length was measured at the time of harvest on the selected plants with a meter. Seed weight observations were recorded during the harvest phase using scales to evaluate the yield from each planting plot. Productivity was determined by converting the seed weight values obtained per plot.

3. RESULTS AND DISCUSSION

The analysis of variance (ANOVA) results indicated that the coefficient of variation percentages varied between 3.52% and 21.96%. Furthermore, the different tillage methods significantly influenced seed weight and overall productivity. To assess the characters that exhibited a notable response to the treatments, Duncan's Multiple Range Test (DMRT) was employed. In a study conducted by Abid et al. (2018) at Kerala Agricultural University, four tillage systems were evaluated: minimum tillage, minimum pendimethalin tillage, minimum imazethapyr + imazamox, and conventional tillage combined with two manual weeding practices, alongside four cultivars. The findings revealed that tillage methods had a substantial impact on various production characteristics, including the number of pods per plant, seed count, pod weight, seed weight, stalk weight, and pod length.

Table 1. ANOVA Results of Soil Tillage Treatments on Vima 2 Mung bean Variety

No.	Observation Characters	MSE	Pr > F	CV (%)
1.	Plant Height	23,55	tn	21,96
2.	Number of Leaves	0,59	tn	12,86
3.	Stem Diameter	0,34	tn	10,67
4.	Pod Length	0,11	tn	3,52
5.	Number of Seeds per Pod	0,21	tn	4,32
6.	Seed Weight	0,03	**	14,85
7.	Productivity (t/ha)	0,01	**	16,02

Notes: MSE = Mean Squared Error, CV = Coefficient of Variance

The vegetative characteristics of the mung bean plants observed in general did not show a significant response between treatments. The results showed that the tillage method did not affect the observed vegetative characteristics of the peanuts (Table 2). This is in line with Saputra et al. (2022) which stated that the combination of soil tillage and chicken manure doses had no significant effect on the height of mung bean plants at the ages of 10 and 30 HST and the number of leaves at the age of 10 HST. These results are also in line with the results of research conducted by Julaili et al. (2019) which stated that the minimum tillage system was not significantly different compared to the maximum tillage system on the height of mung bean plants. Yulanda et al. (2021) stated that the treatment of the soil tillage system had no significant effect on observations of plant height at the ages of 15 MST, 30 MST and 45 MST, Number of Branches at the ages of 15 MST, 30 MST and 45 MST.

Table 2. Mean Values of Vegetative Characters of Mung bean Plants of Vima 2 Variety

No.	Treatment	Character		
		Plant Height (cm)	Number of Leaves	Stem Diameter (mm)
1.	Maximum Tillage	23,6±0,8	7,1±0,7	6,0±1,8
2.	No Tillage	21,9±3,8	5,7±0,2	5,4±1,3
3.	Minimum Tillage	20,8±5,9	5,1±0,5	5,1±1,5

The results of the DMRT further test at a significant level of 5% showed that the Maximum Tillage method was superior in terms of seed weight (1.67 kg) which also showed the highest productivity level at (0.94 + 0.01 t / ha)

(Table 3). This indicates that the maximum tillage system is the most ideal tillage method for Vima 2 mung bean plants. This is in line with research conducted by Meena et al. (2015) regarding the effect of tillage and residue management on soil properties, plant performance and their relationships in the research area of the Indian Agricultural Research Institute, New Delhi with four tillage systems and four different planting systems. They found that the maximum value of pods per plant, number of seeds per pod, seed weight and stover were found in conventional tillage with residue retention. Similar research was conducted by Subandi et al. (2024) regarding the effect of tillage systems and Nitrogen fertilization on planting Vima 2 mung bean varieties on ultisol soil. The results of the study showed that production figures were not significantly different with a range of 1.07-1.34 t/ha. Soil type can be one of the differentiating factors in productivity levels.

Table 3. Mean Values of Yield Characters of Mung bean Plants of Vima 2 Variety

No.	Treatment	Character			
		Pod Length	Number of Seeds per Pod	Seed Weight (kg)	Productivity (t/ha)
1.	Maximum Tillage	9,47±0,20	10,67±0,41	1,67a±0,02	0,94a±0,01
2.	No Tillage	9,63±0,06	10,57±0,15	0,83b±0,17	0,46b±0,09
3.	Minimum Tillage	9,33±0,17	10,70±0,16	0,80b±0,12	0,45b±0,07

Notes: numbers followed by the same letter in the same column show no significant difference in the DMRT test with a significance level of 0.05.

The results of the observations indicated variations in pod and seed characteristics across different treatments. Specifically, the no tillage treatment exhibited a tendency for reduced pod diameter and seed size (see Figure 2). This reduction may contribute to the lack of a significant impact of tillage treatment on pod length characteristics; however, a notable difference was observed in seed weight characteristics. This finding aligns with the research conducted by Abid et al. (2018), which reported that the highest number of seeds per pod was associated with minimum tillage, whereas the longest pod lengths were recorded under conventional tillage. Additionally, Shen et al. (2016) noted that the no-till treatment resulted in the smallest pod sizes compared to other tillage methods, with pod length and width generally decreasing by 8.9–11.9% across three different locations.

Figure 2. Performance of mung bean pods and seeds of Vima 2 variety in the treatments (a) Complete cultivation, (b) Minimum cultivation, (c) No cultivation.

Amanullah et al. (2015) studied the impact of different tillage systems on the growth and yield of mung bean varieties under dry land conditions at the Ahmadwala Agricultural Research Institute, Karak. They observed that the highest values for the characters of number of pods per plant, number of

seeds per pod, thousand grain weight, bunch weight and seed weight were produced at maximum tillage compared to other treatments.

Pearson Correlation Analysis was conducted to determine the relationship between the observed characters. The results of the analysis showed that there was a close (r>0.5) negative relationship between the vegetative characters of stem diameter and plant height (-0.71). A close positive relationship was observed in the vegetative character of number of leaves and productivity character (0.67). A very strong and positive relationship was found in the characters of seed weight and productivity (0.99) this is understandable because the value of productivity was calculated based on seed weight.

Table 4. The Results of Pearson Correlation Analysis between Observed Characters of Mung bean Plant of Vima 2 Variety

Character	PH	NL	SD	PL	NS	SW
NL	-0.22					
SD	-0,71*	0,59				
PL	-0,06	-0,28	-0,17			
NS	-0,28	0,09	0,17	0,31		
SW	-0,10	0,67	0,16	0,19	0,09	
PR	-0,09	0,67*	0,16	0,19	0,08	0,99**

Remark: PH = Plant Height, NL = Number of Leaves, SD = Stem Diamater, PL= Pod Length, NS = Number of Seeds per Pod, SW= Seed Weight, PR= Productivity, * = significant at the 0.05 level and ** = significant at the 0.01 level.

The findings align with the correlation analysis performed by Yanti et al. (2020), which examined the characteristics of mung bean production. Their study revealed a positive correlation, albeit moderate, between seed weight per plant and the number of seeds per plant (0.42) as well as pod length (0.30). Additionally, Candra et al. (2020) indicated that seed weight per plant was significantly affected by vegetative growth; robust vegetative development tends to enhance generative growth. However, this relationship cannot be definitively established, as it may be influenced by both genetic and environmental factors. Furthermore, the correlation test results from Junaedi et al. (2021) demonstrated a positive association between seed weight per plot and the number of trifoliate leaves in mung bean plants.

4. CONCLUSION

The tillage method had a notable impact on the production traits of seed weight and overall productivity. Findings from the DMRT Advanced Test indicated that the Maximum Tillage treatment yielded the highest seed weight. A significant correlation was identified among stem diameter, plant height, leaf count, and productivity. Furthermore, a highly significant relationship was established between seed weight and productivity. The study's conclusions advocate for the Maximum Tillage Method as the preferred approach for cultivating the Vima 2 variety of mung beans.

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