

ISRG Journal of Agriculture and Veterinary Sciences (ISRGJAVS)



ISRG PUBLISHERS

Abbreviated Key Title: ISRG. J. Agri.Vet.Sci.

ISSN: 3048-8869 (Online)

Journal homepage: <https://isrgpublishers.com/gjavs/>

Volume – III Issue - III (May-June) 2026

Frequency: Bimonthly



The Impact of Arbuscular Mycorrhizal Fungi and Planting Distance on Mung Bean Production (*Vigna radiata* L.)

Halim^{1*}, Makmur Jaya Arma¹, Fransiscus Suramas Rembon²

¹ Department of Agrotechnology, Faculty of Agriculture, Halu Oleo University, Kendari, Indonesia

² Department of Soil Science, Faculty of Agriculture, Halu Oleo University, Kendari, Indonesia

| **Received:** 09.05.2026 | **Accepted:** 14.05.2026 | **Published:** 17.05.2026

*Corresponding author: Halim

Abstract

*This study aims to investigate the impact of arbuscular mycorrhizal fungi and plant spacing on the production of mung beans (*Vigna radiata* L.). This study employed a randomized block design (RBD) in a factorial pattern, consisting of two factors. The first factor is arbuscular mycorrhizal fungi (AMF) with four levels: expressly without AMF propagules (M0), 5 g AMF propagules/planting hole (M1), 10 g AMF propagules/planting hole (M2), and 15 g AMF propagules/planting hole (M3). The second factor is planting distance, consisting of three levels: a plant spacing of 40 cm x 10 cm (J1), a planting distance of 40 cm x 20 cm (J2), and a planting distance of 40 cm x 30 cm (J3). The treatment was repeated three times to obtain 36 experimental units. The variables observed were: number of flowers, total number of seeds, number of filled pods, number of empty pods, pod weight, seed weight, dry weight of 100 seeds, and productivity. The results showed that arbuscular mycorrhizal fungi and planting distance had a very significant effect on the total number of pods, number of filled pods, pod weight, seed weight, dry weight of 100 seeds, and productivity. The best treatment was obtained at 15 g AMF propagules/planting hole (M3) and a planting distance of 40 cm x 30 cm (J3).*

Keywords: *arbuscular mycorrhizal fungi, Mung beans, planting distance*

INTRODUCTION

Mung beans are a widely consumed food crop, and productivity at the farmer level remains low due to sub-optimal technology implementation, competition with weeds, and inadequate land use. According to Triyanti et al. (2024), photosynthesis will be more active, allowing plants to grow well. Solid fertilizer, in addition to

improving the physical properties of the soil, can provide nutrients for plants.

Increasing the production of mung bean plants can be done by applying biological as arbuscular mycorrhizal fungi, and adjusting the planting distance. According to Prasetya and Anderson (2011),

plant roots infected with mycorrhizal fungi can optimally utilize soil nutrients, increasing the roots' capacity to absorb nutrients and water. Furthermore, mycorrhizal fungi can enhance plant growth, increasing root infection, leaf dry and wet weight, leaf phosphorus content, and leaf phosphorus absorption (Diannastiti et al., 2022). While the planting distances have a clear effect on the number of plants and their distribution in the unit area, which affects the nature of competition between plants for various growth elements such as moisture, nutrients, and sunlight, and the effect on the physiological processes in the plant, which is reflected in the growth, productivity, and quality of the crop (Al-Bhadly and Mohsen, 2024). The setting of planting distance that is too wide will cause the presence and growth of weeds to compete with the plants.

Appropriate plant spacing is one of the most important agronomic practices that significantly contributes to mung bean seed yield (Tehulie et al., 2021). The presence of mycorrhizal fungi can increase plant growth, such as enhancing root infections, leaf fresh and dry weight, leaf Phosphorus content, and leaf Phosphorus uptake; consequently, the use of mycorrhizal fungi as a plant growth promoter can contribute to sustainable agriculture (Diannastiti et al., 2022).

MATERIALS AND MATERIALS

This research was conducted from July to November 2024 at the Experimental Field Garden 2 of the Faculty of Agriculture, Halu Oleo University, Southeast Sulawesi Province, Indonesia.

Research Procedures

Land Preparation and Soil Cultivation. Land preparation in this study involved clearing weeds from the area to be used for the study. After clearing the land, the soil was tilled twice, using a tractor to turn the soil. After loosening the soil thoroughly with a hoe, the plots were divided into 36 plots measuring 2m x 3m, followed by the construction of 50 cm drainage channels between the plots.

Planting and Application of Mycorrhizal Fungi. Planting is done by planting mung bean seeds in holes made using a dip. The planting spacing used is 40 cm x 10 cm, 40 cm x 20 cm, and 40 cm x 30 cm. The arbuscular mycorrhizal fungi propagules are applied at the same time as the mung bean planting by placing the propagules under the mung bean seeds.

Plant Maintenance. Maintenance activities in this study included replanting to replace dead plants and plants that were not growing well. Replanting was carried out one week after planting. Weeding was carried out by removing or removing weeds growing in the experimental plot. Watering was carried out daily, in the morning and evening, when there was no rain. Hilling was carried out when the plants were approximately 28 days old after planting.

Research Design

This research was conducted using a Randomized Block Design (RBD) in a factorial pattern consisting of two factors. The first factor was arbuscular mycorrhizal fungi (AMF) propagules, which consist of four levels: no AMF propagules (M_0), 5 g AMF propagules/planting hole (M_1), 10 g AMF propagules/planting hole (M_2), and 15 g AMF propagules/planting hole (M_3). The second factor was plant spacing, consisting of three levels: 40 cm x 10 cm (J_1), 40 cm x 20 cm (J_2), and 40 cm x 30 cm (J_3). These two factors resulted in 12 combinations with three replications, resulting in 36 experimental units.

Observation Variables

Mung bean plant observations were conducted on three samples/plots by randomly sampling 36 different plots. The variables observed in this study were as follows: number of flowers counted after flowering, total number of pods counted after harvest, number of filled pods counted after harvest, number of empty pods) counted after harvest, pod weight weighed after harvest, seed weight weighed after harvest, dry weight of 100 seeds observed at harvest by weighing 100 dried seeds that had been oven-dried at 60°C for 2 x 24 hours in each treatment, productivity (tons ha⁻¹). Productivity can be calculated using the formulation:
$$\text{productivity} = \frac{\text{area of 1 Hectare}}{\text{plant spacing}} \times \frac{\text{seed weight per plant}}{1.000.000}$$

Data Analysis

The research data were analyzed using analysis of variance. If the calculated F-value was greater than the table F-value, it was then subjected to the Duncan Multiple Range Test (DMRT) at a 95% confidence level.

RESULTS AND DISCUSSION

The results of the analysis of the effects of arbuscular mycorrhizal fungi and plant distance on the number of flowers are presented in Table 1.

Table 1. Effect of Arbuscular Mycorrhizal Fungi and Planting Distance on the Number of Flowers in Mung Bean Plants

Treatment	Number of Flowers	DMRT 95%
Without the AMF propagule (M_0)	2.59a	
5 g AMF propagules/planting hole (M_1)	2.44a	2 = 0.37
10 g AMF propagules/planting hole (M_2)	2.59a	3 = 0.39
15 g AMF propagules/planting hole (M_3)	3.04b	4 = 4.00
Treatment	Number of Flowers	DMRT 95%
Planting distance of 40 cm x 10 cm (J_1)	2.47a	
Planting distance of 40 cm x 20 cm (J_2)	2.58a	2 = 0.32
Planting distance of 40 cm x 30 cm (J_3)	2.95b	3 = 0.33

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 1 shows that the highest average number of flowers of mung bean plants was obtained in the treatment of 15 g AMF propagules/planting hole (M_3), as 3.04 flowers, which was significantly different from the treatment without AMF propagules (M_0), 10 g AMF propagules/planting hole (M_2), and 5 g AMF propagules/planting hole (M_1). The highest average number of flowers of mung bean plants was obtained in the treatment of 40 cm x 30 cm plant spacing (J_3), with 2.95 flowers, which was significantly different from the 40 cm x 20 cm plant spacing (J_2) and the 40 cm x 10 cm plant spacing (J_1). The results of this research indicate that the application of arbuscular mycorrhizal

fungi at a dose of 15 g /planting hole (M_3) was the best treatment for all observed variables, i.e., number of flowers, total number of seeds, number of filled pods, number of empty pods, pod weight, seed weight, dry weight of 100 seeds, and productivity. This is because arbuscular mycorrhizal fungi are structures formed through association with plant roots and develop within them to obtain nutrients from the host plant, in the form of phosphorus, thereby expanding the reach of plant roots and absorbing nutrients from the soil. Carballar-Hernandez et al. (2018) stated that symbiosis between arbuscular mycorrhizal fungi and the rooting plant is of great relevance to sustainable agriculture because of its ability to increase productivity and nutrient uptake. The best planting distance was 40 cm x 30 cm (J_3), except for corn productivity, where the best treatment was 40 cm x 10 cm (J_1). Based on the results of this study, the effect of planting distance on production components differs from that on productivity. This indicates that adjusting planting distance is crucial for improving crop productivity. According to Al-Bhadly and Mohsen (2024), the reason for this difference may be that plants planted at narrow distances and high plant density per unit area increased competition for light to meet the requirements of photosynthesis, which led to an increase in plant height. Independent treatment of planting distance significantly affected the number of flowers and total number of seeds, the number of filled pods, the number of empty pods, pod weight, seed weight, dry weight per 100 seeds, and mung bean productivity (Table 1). This occurs because optimal planting distance allows for greater light intensity and better crop production as the plant's needs are met.

Total Number of Pods

The results of the analysis of the effects of arbuscular mycorrhizal fungi and plant spacing on the total number of mung bean pods are presented in Table 2.

Table 2. Effect of Arbuscular Mycorrhizal Fungi and Plant Distance on the Average Total Number of Mung Bean Pods

Treatment	Total Number of Pods	DMRT 95%
Without the AMF propagule (M_0)	157.48a	
5 g AMF propagules/planting hole (M_1)	162.48a	2 = 15.06
10 g AMF propagules/planting hole (M_2)	156.85a	3 = 15.81
15 g AMF propagules/planting hole (M_3)	189.89b	4 = 16.29
Treatment	Total Number of Pods	DMRT 95%
Planting distance of 40 cm x 10 cm (J_1)	149.50a	
Planting distance of 40 cm x 20 cm (J_2)	151.92a	2 = 13.04
Planting distance of 40 cm x 30 cm (J_3)	198.61b	3 = 13.69

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 2 shows that the highest average total number of green bean pods was obtained in the treatment of 15 g AMF propagules/planting hole (M_3), namely 189.89 pods, which was significantly different from 5 g AMF propagules/planting hole (M_1), without AMF propagules (M_0), and 10 g AMF propagules/planting hole (M_2). The highest average total number of mung bean pods was obtained in the treatment of 40 cm x 30 cm planting distance (J_3), as 198.61 pods, which was significantly different from 40 cm x 20 cm planting distance (J_2) and 40 cm x 10 cm planting distance (J_1). Wide or optimal planting distance provides more growing space for mung bean plants, thereby reducing competition between plants for sunlight, water, and nutrients. Plant spacing allows plants to grow and develop optimally without experiencing significant competition for nutrients, water, and sunlight, which can occur with dense spacing. Proper spacing allows for adequate space and maximizes light utilization early in the growth cycle.

Number of Filled Pods

The results of the analysis of the effects of arbuscular mycorrhizal fungi and planting distance on the number of filled pods are presented in Table 3.

Table 3. Effect of Arbuscular Mycorrhizal Fungi and Planting Distance on the Average Number of Mung Bean Pods

Treatment	Number of Filled Pods	DMRT 95%
Without the AMF propagule (M_0)	142.78a	
5 g AMF propagules/planting hole (M_1)	145.84a	2 = 13.94
10 g AMF propagules/planting hole (M_2)	141.52a	3 = 14.63
15 g AMF propagules/planting hole (M_3)	171.78b	4 = 15.08
Treatment	Number of Filled Pods	DMRT 95%
Planting distance of 40 cm x 10 cm (J_1)	135.63a	
Planting distance of 40 cm x 20 cm (J_2)	137.09a	2 = 12.07
Planting distance of 40 cm x 30 cm (J_3)	178.72b	3 = 12.67

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 3 shows that the highest average number of filled pods of mung bean plants was obtained in the treatment of 15 g AMF propagules/planting hole (M_3), namely 171.78 pods, which was significantly different from 5 g AMF propagules/planting hole (M_1), without AMF propagules (M_0), and 10 g AMF propagules/planting hole (M_2). The highest average number of filled pods of mung bean plants was obtained in the treatment of 40 cm x 30 cm planting distance (J_3), namely 178.72 pods, which was significantly different from 40 cm x 20 cm planting distance (J_2) and 40 cm x 10 cm planting distance (J_1). Wider spacing results in better plant growth and ensures adequate plant nutrition. Conversely, if the spacing is too close, the performance of each plant declines due to competition for light, water, weed growth,

and nutrients, which can negatively impact the development and production of mung bean plants. Plant spacing allows plants to grow and develop optimally without experiencing significant competition for nutrients, water, and sunlight, which can occur with dense spacing.

Number of Empty Pods

The results of the analysis of the effects of arbuscular mycorrhizal fungi and planting distance on the number of empty pods are presented in Table 4.

Table 4. Effect of Arbuscular Mycorrhizal Fungi and Planting Distance on the Average Number of Empty Mung Bean Pods

Treatment	Number of Empty Pods	DMRT 95%
Without the AMF propagule (M ₀)	14.70a	
5 g AMF propagules/planting hole (M ₁)	16.63ab	2 = 2.17
10 g AMF propagules/planting hole (M ₂)	15.33a	3 = 2.28
15 g AMF propagules/planting hole (M ₃)	18.11b	4 = 2.35
Treatment	Number of Empty Pods	DMRT 95%
Planting distance of 40 cm x 10 cm (J ₁)	13.86a	
Planting distance of 40 cm x 20 cm (J ₂)	14.83a	2 = 1.88
Planting distance of 40 cm x 30 cm (J ₃)	19.89b	3 = 1.97

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 4 shows that the highest average number of empty mung bean pods was obtained in the treatment of 15 g AMF propagules/planting hole (M₃), namely 18.11 pods, which was not significantly different from 5 g AMF propagules/planting hole (M₁), but significantly different from without AMF propagules (M₀) and 10 g AMF propagules/planting hole (M₂). The highest average number of empty mung bean pods was obtained in the treatment of 40 cm x 30 cm planting distance (J₃), namely 19.89 pods, which was significantly different from 40 cm x 20 cm planting distance (J₂) and 40 cm x 10 cm planting distance (J₁).

Pod Weight

The results of the analysis of the effects of arbuscular mycorrhizal fungi and planting distance on pod weight are presented in Table 5.

Table 5. Effect of Arbuscular Mycorrhizal Fungi and Planting Distance on the Average Pod Weight of Mung Bean Plants

Treatment	Pod Weight	DMRT 95%
Without the AMF propagule (M ₀)	12.84a	

5 g AMF propagules/planting hole (M ₁)	14.66a	2 = 1.75
10 g AMF propagules/planting hole (M ₂)	13.14a	3 = 1.84
15 g AMF propagules/planting hole (M ₃)	17.70b	4 = 1.89
Treatment	Pod Weight	DMRT 95%
Planting distance of 40 cm x 10 cm (J ₁)	12.49a	
Planting distance of 40 cm x 20 cm (J ₂)	13.23a	2 = 1.51
Planting distance of 40 cm x 30 cm (J ₃)	18.04b	3 = 1.59

Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 5 shows that the highest average weight of mung bean pods was obtained in the treatment of AMF propagules 15 g/planting hole (M₃), which was 17.70 g, which was significantly different from AMF propagules 5 g/planting hole (M₁), AMF propagules 10 g/planting hole (M₂), and without AMF propagules (M₀). The highest average weight of mung bean pods was obtained in the treatment of planting distance of 40 cm x 30 cm (J₃), which was 18.04 g, which was significantly different from planting distance of 40 cm x 20 cm (J₂) and planting distance of 40 cm x 10 cm (J₁).

Seed weight

The results of the analysis of the effect of arbuscular mycorrhizal fungi and planting distance on seed weight are presented in Table 6.

Table 6. Effect of Arbuscular Mycorrhizal Fungi and Planting Distance on Average Weight of Mung Bean Seeds

Treatment	Seed Weight	DMRT 95%
Without the AMF propagule (M ₀)	10.29a	
5 g AMF propagules/planting hole (M ₁)	12.02ab	2 = 1.55
10 g AMF propagules/planting hole (M ₂)	10.89a	3 = 1.63
15 g AMF propagules/planting hole (M ₃)	13.92b	4 = 1.68
Treatment	Seed Weight	DMRT 95%
Planting distance of 40 cm x 10 cm (J ₁)	9.60a	
Planting distance of 40 cm x 20 cm (J ₂)	10.83a	2 = 1.34
Planting distance of 40 cm x 30 cm (J ₃)	14.91b	3 = 1.41

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 6 shows that the highest average weight of mung bean seeds was obtained in the treatment of 15 g AMF propagules/planting hole (M₃), which was 13.92 g, which was not significantly different from 5 g AMF propagules/planting hole (M₁), but

significantly different from without AMF propagules (M_0) and 10 g AMF propagules/planting hole (M_2). The highest average weight of mung bean seeds was obtained in the treatment of 40 cm x 30 cm planting distance (J_3), which was 14.91 g, which was significantly different from 40 cm x 20 cm planting distance (J_2) and 40 cm x 10 cm planting distance (J_1).

Dry Weight of 100 Seeds

The results of the analysis of the effect of the interaction between arbuscular mycorrhizal fungi and planting distance on the dry weight of 100 mung bean seeds are presented in Table 7.

Table 7. Interaction between Arbuscular Mycorrhizal Fungi and Planting Distance on the Average Dry Weight of 100 Mung Bean Seeds

Planting distance	Arbuscular Mycorrhizal Fungi (g)/planting hole			
	0 (M_0)	5 (M_1)	10 (M_2)	15 (M_3)
40 cm x 10 cm (J_1)	8.23 a	8.25 a	8.18 ab	7.69 a
	p	p	pq	p
40 cm x 20 cm (J_2)	8.27 a	8.17 a	7.74 a	8.09 ab
	p	p	p	pq
40 cm x 30 cm (J_3)	8.40 b	8.48 b	7.98 a	8.33 b
	q	q	p	q
DMRT 95%		2 = 0.16	3 = 0.17	4 = 0.18

Notes: Numbers followed by different letters in columns (a,b) and rows (p,q) are significantly different based on DMRT at a 95% confidence level.

Table 7 shows that the highest average dry weight of 100 mung bean seeds was obtained in the M_1J_3 treatment, namely 8.48 g, which was significantly different from the M_1J_1 and M_1J_2 treatments. The effect of mycorrhizal fungi and planting distance on the average dry weight of 100 mung bean seeds is listed in Table 8.

Table 8. Effect of Arbuscular Mycorrhizal Fungi and Planting Distance on the Average Dry Weight of 100 Mung Bean Seeds

Treatment	Weight of 100 Seeds	DMRT 95%
Without the AMF propagule (M_0)	8.30a	
5 g AMF propagules/planting hole (M_1)	8.30a	2 = 0.16
10 g AMF propagules/planting hole (M_2)	7.97b	3 = 0.17
15 g AMF propagules/planting hole (M_3)	8.04b	4 = 0.18
Treatment	Weight of 100 Seeds	DMRT 95%
Planting distance of 40 cm x 10	8.09a	

cm (J_1)		
Planting distance of 40 cm x 20 cm (J_2)	8.07a	2 = 0.14
Planting distance of 40 cm x 30 cm (J_3)	8.30b	3 = 0.15

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level.

Table 8 shows that the highest average dry weight of 100 mung bean seeds was obtained in the AMF propagule treatment (M_0) and was 8.30 g, which was not significantly different from the AMF propagule 5 g/planting hole (M_1), but significantly different from the AMF propagule 15 g/planting hole (M_3) and the AMF propagule 10 g/planting hole (M_2). The highest average mung bean pods were obtained in the 40 cm x 30 cm planting distance treatment (J_3), which was 8.30 g, which was significantly different from the 40 cm x 10 cm planting distance (J_1) and the 40 cm x 20 cm planting distance (J_2). Table 8 shows that the highest average dry weight of 100 mung bean seeds was obtained in the AMF propagule treatment (M_0) and was 8.30 g. The highest average mung bean pods were obtained in the 40 cm x 30 cm planting distance treatment (J_3), which was 8.30 g. According to Barea et al. (1991); Parniske (2008), the association of mycorrhiza fungi with the roots of higher plants increases the uptake of mineral nutrients from the soil through the external hyphal network (extra-radical hyphae) by solubilizing phosphate and nitrogen.

Productivity (ton ha^{-1})

The results of the analysis of the effects of arbuscular mycorrhizal fungi and planting distance on mung bean productivity are presented in Table 9.

Table 9. Effect of Arbuscular Mycorrhizal Fungi on Average Productivity (ton ha^{-1}) of Mung Bean

Treatment	Productivity (ton ha^{-1})	DMRT 95%
Without the AMF propagule (M_0)	1.48a	
5 g AMF propagules/planting hole (M_1)	1.64a	2 = 3.17
10 g AMF propagules/planting hole (M_2)	1.52a	3 = 3.33
15 g AMF propagules/planting hole (M_3)	2.26b	4 = 3.43
Treatment	Productivity (ton ha^{-1})	DMRT 95%
Planting distance of 40 cm x 10 cm (J_1)	2.40a	
Planting distance of 40 cm x 20 cm (J_2)	1.30b	2 = 2.50
Planting distance of 40 cm x 30 cm (J_3)	1.48b	3 = 2.88

Notes: Numbers followed by different letters in (a,b) are significantly different based on DMRT at the 95% confidence level

Table 9 shows that the highest average productivity of mung bean plants was obtained in the treatment of 15 g AMF propagules/planting hole (M_3), which was 2.26 tons ha^{-1} , which was significantly different from without AMF propagules (M_0), 5 g AMF propagules/planting hole (M_1), and 10 g AMF propagules/planting hole (M_2). The highest average productivity of mung bean plants was obtained in the treatment with a 40 cm x 10 cm planting distance (J_1), at 1.48 tons ha^{-1} , which was significantly higher than those of the 40 cm x 20 cm (J_2) and 40 cm x 30 cm (J_3) planting distances. According to Halim et al. (2023), the application of compost can increase the soil organic matter content, which will increase the movement and availability of P nutrients in the soil, so that with more compost doses, it allows the availability of more P nutrients and results in decreased effectiveness of mycorrhizal. This shows that the arrangement of planting distances has a different effect on the productivity of mung bean plants. The results of research by Kanoosh and Mohammed (2024) indicated that seed yield differs according to planting distances.

REFERENCES

1. Triyanti, Tety, S., R. Eviyati, R. 2024. The Effect of Plant Spacing and Type of Manure on the Growth and Yield of Green Beans (*Vigna radiata* L.) Cultivar Vima I. Journal of Agricultural Sciences (Agrosoci), 1(3):129-144.
2. Prasetya, B. dan Anderson, C. 2011. Assessment of the Effect of Long-Term Tillage on the Arbuscular Mycorrhiza Colonization of Vegetable Crops Grown in Andisols. *Journal Agrivita*, 33(1): 85-92.
3. Diannastiti, F.A., Sri Nuryani, H.U., Jaka, W., 2022. The Role of Indigenous Mycorrhizae of Corn Plants in Various Soil Types in Gunung Kidul, Indonesia. *Planta Tropika: Jurnal Agrosains*, 10(1):70-83. Doi:10.18196/pt.v10i1.11428.
4. AL-Bhadly, Y.M. and Mohsen, K.H. 2024. Effect of planting distances on the growth and productivity of mung bean (*Vigna radiata* L.) varieties in southern Iraq. University of Thi-Qar Journal of Agricultural Research, 13(2): 253-268.
5. Tehulie, N.S., Tarikua Fikadu, Jhon Hardy Purba. 2021. Response of Mungbean [*Vigna radiata* (L.)Wilczek] Varieties to Plant Spacing under Irrigation at Gewane, Northeastern Ethiopia. *Agro Bali: Agricultural Journal*, 4(1):1-14. DOI: 10.37637/ab.v4i1.613.
6. Carballar-Hernandez, S., Hernandez-Cuevas, L.V., Montano N.M., Ferrera-Cerrato, R., Alarcon, A. 2018. Species Composition of Native Arbuscular Mycorrhizal Fungal Consortia Influences Growth and Nutrition of Poblano Pepper Plants (*Capsicum annum* L.). *Applied Soil Ecology* 130,50-58. <https://doi.org/10.1016/j.apsoil.2018.05.022>.
7. Barea, J.M., Azcon-Aquilar, C. and Azcon, R. 1991. The role of VA mycorrhizas in improving plant N acquisition from soil as assessed with ^{15}N . In: C. Flitton (ed.). *The Use of Stable Isotopes in Plant Nutrition, Soil Fertility and Environmental Studies*, "Joint IAEA, FAO Division, Vienna, 209-216.
8. Parniske, M. 2008. Arbuscular mycorrhiza: The mother of plant root endosymbiosis. *Nature Reviews Microbiology*, 6:763–775.
9. Halim, Laode Sabaruddin, Nini Mila Rahni, Makmur Jaya Arma, Imran Subair, Eka Febrianti, Andi

Awaluddin, Wa Ode Nuraida, Waode Siti Anima Hisein. 2023. Improvement in yield of peanut (*Arachis hypogaea* L.) with combination treatments of bio-organic fertilizers. *Journal of Applied and Natural Science*. 15(1):443-446.443 – 446.

10. Kanoosh, A.A and Mohammed, Y.A. 2024. The Effect of Herbicides and Planting Distances on Growth Traits of Mung Bean Crop and Some Traits of Weeds, 5th International Conference of Modern Technologies in Agricultural Sciences, IOP Conf. Series: Earth and Environmental Science. doi:10.1088/1755-1315/1371/5/052064.