ANSF APPLIED AND NATURAL SCIENCE FOUNDATION

*Journal of Applied and Natural Science*
15(1), 443 - 446 (2023)
ISSN : 0974-9411 (Print), 2231-5209 (Online)
journals.ansfoundation.org

*Research Article*

# Improvement in yield of peanut (*Arachis hypogaea* L.) with combination treatments of bio-organic fertilizers

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***Article Info***
https://doi.org/10.31018/jans.v15i1.4351
Received: January 6, 2023
Revised: March 9, 2023
Accepted: March 15, 2023

***How to Cite***
Halim *et al.* (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. https://doi.org/10.31018/jans.v15i1.4351

## Abstract
Peanut is a plant food with high economic value because of their nutritional content, especially protein, and high fat. The nut land needs from year to year continue to increase in line with the increase in number population, nutritional needs of the community, food diversification, and increasing feed and food industry capacity. The present study aimed to determine the effectiveness of bio-organic fertilizers in producing local peanuts (Wadaga) from Muna Island, Indonesia. The randomized block design (RBD) was done with 12 bio-organic fertilizer treatments ($T_1$ to $T_{12}$) based on arbuscular mycorrhiza fungi (AMF) and cow manure fertilizer (CMF). The variables were viz. pod weight, total pod number, filled pod number, percentage of empty pods, seed number, the weight of 100 seeds, dry seed weight, and productivity were observed. The results of the study showed that the highest average pod weight (55.0 g), total pod number (50.3 pods), filled pod number (46.3 pods), and seed number (84.3 seeds) occurred with the treatment of $T_8$: $A_2B_1$ ( AMF 10 g per plant + CMF 3 kg per plot). The highest average productivity was obtained with $T_3$: $A_0B_2$ (without AMF + CMF 6 kg per plot) as 3.97 tons $ha^{-1}$. The use of mycorrhizal fungi combined with organic fertilizers can improve the growth of peanut plants which has a positive impact on their production.

**Keywords**: Arbuscular mycorrhiza fungi, Bio-organic fertilizer, Cow manure, Peanut

## INTRODUCTION

Peanut is an important food ingredient as a source of vegetable protein that can be consumed as a vegetable, fried, or boiled. The community's need for peanuts is increasing along with the development of the increasing population of the food industry. According to Miftakhus and Titiek (2018), the need for peanuts to increase is not offset by high production, so the supply of peanuts is reduced. Halim *et al*. (2015) reported that low plant production causes low soil fertility, especially in Ultisol soils with low cation exchange capacity of granite, sediments and tuffs.

Therefore, efforts are needed to increase soil fertility to improve the production of groundnut with input technology that is environmentally friendly and based on bio-organic fertilizer from mycorrhiza fungi and cow manure fertilizer. The arbuscular mycorrhiza fungi are a form of the mutualistic relationship between fungi and roots of higher plants. This symbiosis can benefit plants by increasing nutrient uptake, especially P, and increasing resistance to drought and pathogen attack (Smith and Read, 2008). Neumann and George (2010) reported that the extra-radical phase of mycorrhizal fungi acts as an extension of the root system to absorb mineral nutrients from the soil and helps release nutrients from the soil sorption complex, especially P, Cu, and Zn. Jing *et al*. (2020) reported that arbuscular mycorrhiza fungi inoculation also enhances growth performance in leaves and stems, benefitting the interception and absorption of light and thus maximizing photosynthesis, transpiration, $CO_2$ assimilation and gas exchange capacity. According to Magdalena *et al*. (2013), cow manure is one source of organic material derived from livestock manure that can improve the soil's physical, biological, and chemical properties. This fertilizer contains macro and micronutrients needed by plants.

The combination of mycorrhiza fungi and cow manure has the potential to be developed and applied to the cultivation of peanut plants. According to Rachmawati *et al*. (2021), the arbuscular mycorrhizal and cow dung increase availability of phosphorus, phosphorus uptake, growth, and yield of the plants. Rachmawati *et al*. ( 2020) observed that the mycorrhiza fungi activity is strongly influenced by the availability of organic matter in the soil, where mycorrhiza fungi are ineffective at working in soils that contain lots of organic matter. The present study aimed to determine the effectiveness of bio-organic fertilizers in producing local peanuts (Wadaga) from Muna Island in Indonesia.

## MATERIALS AND METHODS

### Study area and experimental setup

The study was done in the District of Ranomeeto Selatan, Regency of Konawe Selatan, Indonesia, from December 2018 to March 2019. The land was processed using a hand tractor and loosened with a hoe. Weed roots or secondary vegetation remaining above the soil surface were cleaned and then continued with the making of a trial plot. The area of land used was 40 m x 10 m, and experimental plots were made measuring 3 m x 2 m. The drainage width between groups was 50 cm, and the drainage width between plots within the group was 25 cm.

Mycorrhiza fungi propagules were obtained from corn cultivation in polybag propagation media. The cow manure fertilizer was applicated one week before planting. The fertilizer application was adjusted to each plot's treatment dose by being spread evenly over the plot (Halim *et al*., 2020).) Soil that was still in the form of chunks was crushed until smooth. The corn roots were cut into small pieces. Then the soil and corn roots were mixed evenly. The application of arbuscular mycorrhiza fungi was carried out simultaneously with planting groundnut seeds by inserting them into the planting hole. The plant spacing was 30 cm x 35 cm (Halim *et al*., 2019).

### Experimental design

The randomized block design (RBD) was done with 12 bio-organic fertilizer treatments based on arbuscular mycorrhiza fungi (AMF) and cow manure fertilizer (CMF). The treatments were: $T_1$ ) without AMF + without CMF ($A_0B_0$), $T_2$) without AMF + CMF 3 kg per plot ($A_0B_1$), $T_3$) without AMF + CMF 6 kg per plot ($A_0B_2$), $T_4$) AMF 5 g per plant + without CMF ($A_1B_0$), $T_5$) AMF 5 g per plant + CMF 3 kg per plot ($A_1B_1$), $T_6$) AMF 5 g per plant + CMF 6 kg per plot ($A_1B_2$), $T_7$) AMF 10 g per plant + without CMF ($A_2B_0$), $T_8$) AMF 10 g per plant + CMF 3 kg per plot ($A_2B_1$), $T_9$) AMF 10 g per plant + CMF 6 kg per plot ($A_2B_2$), $T_{10}$) AMF 15 g per plant + without CMF ($A_3B_0$), $T_{11}$) AMF 15 g per plant + CMF 3 kg per plot ($A_3B_1$), $T_{12}$) AMF 15 g per plant + CMF 6 kg per plot ($A_3B_2$) with 3 replications and a total of 36 treatment units.

### Data collection and statistical analysis

The variables like pod weight (g), total pod number, filled pod number, percentage of empty pods (%), seed number, the weight of 100 seeds (g), dry seed weight (g), and productivity (ton $ha^{-1}$) were observed. The data observation was analyzed in accordance with the study design; if it had significant and very significant effects, it was followed by Duncan's Multiple Range Test (DMRT) at a 95% confidence level.

## RESULTS AND DISCUSSION

The different variables of peanuts after biofertilizer treatments are mentioned in Table 1. The highest average of pod weight, total pod number, filled pod number,

**Table 1**. Effect of bio-organic fertilizer treatments on yield components of peanuts

| Treatment | Observed variables | | | | | |
|---|---|---|---|---|---|---|
| | **Pod weight 100 seeds (g)** | **Total pod number** | **Filled pod number** | **Seed number** | **Dry seed weight 100 seeds (g)** | **Productivity of grain yield (ton ha$^{-1}$)** |
| $T_1$ (A0B0) | 38.2 b | 35.8 a | 31.8 a | 52.2 b | 29.3 b | 2.79 b |
| $T_2$ (A0B1) | 44.3 a | 42.3 a | 38.2 a | 65.0 ab | 33.3 b | 3.17 b |
| $T_3$ (A0B2) | 49.0 a | 41.5 a | 39.0 a | 77.3 a | 41.7 a | 3.97a |
| **DMRT 95%** | **2=9.18** | **2=9.90** | **2=8.68** | **2=15.70** | **2=7.62** | **2=0.73** |
| $T_4$ (A1B0) | 40.8 a | 31.8 b | 28.8 b | 56.3 b | 29.8 b | 2.84 b |
| $T_5$ (A1B1) | 46.2 a | 44.7 a | 41.8 a | 78.7 a | 38.3 a | 3.65 a |
| $T_6$ (A1B2) | 48.0 a | 39.5 ab | 37.2 ab | 73.3 a | 34.5 ab | 3.29 ab |
| **DMRT 95%** | **3=9.65** | **3=10.40** | **3=9.13** | **3=16.50** | **3=8.01** | **3=0.76** |
| $T_7$ (A2B0) | 38.8 b | 33.2 b | 31.8 b | 61.7 b | 30.8 b | 2.94 b |
| $T_8$ (A2B1) | 55.0 a | 50.3 a | 46.3 a | 84.3a | 41.3 a | 3.94 b |
| $T_9$ (A2B2) | 43.7 a | 36.3 b | 33.0 b | 75.7 b | 12.8 b | 2.75 a |
| **DMRT 95%** | **4=9.94** | **4=10.70** | **4=9.39** | **4=17.00** | **4=8.24** | **4=0.79** |
| $T_{10}$ (A3B0) | 44.7 a | 43.0 a | 40.8 a | 72.7 a | 33.0 a | 3.14 a |
| $T_{11}$ (A3B1) | 36.7 b | 32.8 a | 31.0 a | 68.8 b | 29.3 a | 2.79 a |
| $T_{12}$ (A3B2) | 43.0 a | 40.3 a | 37.7 a | 65.7 ab | 35.5 a | 3.38 a |

Notes: the numbers followed by a, and b differ significantly with Duncan Multiple Range Test (DMRT) at 95% confidence level.

and seed number occurred with the treatment of AMF 10 g per plant + CMF 3 kg per plot ($T_8$ : $A_2B_1$ as 55.0 g, 50.3 pods, 46.3 pods, and 84.3 seeds, respectively. While the average dry weight ( 41.7 g) of seeds and highest productivity (3.97 ton ha$^{-1}$ ) were obtained with the treatment without AMF + CMF 6 kg per plot ($T_3$: $A_0B_2$), respectively and which was significantly different from the treatment without AMF + without CMF ($T_1$: $A_0B_0$), without AMF + CMF 3 kg per plot ($T_2$ : $A_0B_1$). The result in Table 1 indicated that in the growth and development of peanut plants, organic fertilizers do not need to be given to mycorrhiza fungi.

The recapitulation of the Analysis variance of bio-organic fertilizer-based AMF and CMF on yield components of peanuts is mentioned in Table 2. The results showed that the application of bio-fertilizer significantly affected all the observed variables viz. pod weight, total pod number, filled pod number, seeds number, dry seed weight, and productivity except that it had no significant effect on the percentage of empty pods and the weight of 100 seeds.

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 mycorrhizae. Likewise, the availability of nitrogen, where peanuts can fix it from free air through their symbiosis with rhizobium bacteria, positively impacts plant development. According to Bourion *et al*. (2018), bacterial strains form nodules on leguminous hosts, but only a few of the species can effectively nitrogen on those host plants. Associated plant nitrogen will increase by transferring nitrogen directly from legume crops to cereal plants or simply breaking down the minerals available in the soil.

This was influenced by the addition of organic matter, which can cause the formation of peanut seeds so that phosphorus, potassium, and calcium are met for the formation of plant production components. According to Sarawa and Halim (2020), the growth of the generative plant is influenced by phosphorus and the plant tissue increases metabolism so that the optimal process of seed filling and seed weight increase. Results research by Halim *et al*. (2021), the phosphate, nitrogen, and

**Table 2**. Recapitulation of Analysis variance of bio-organic fertilizer-based AMF and CMF on yield components of peanuts

| **No.** | **Variables observed** | **Result of Variance Analysis** |
|---|---|---|
| 1 | Pod weight (g) | * |
| 2 | Total pod number | * |
| 3 | Filled pod number | ** |
| 4 | Percentage of empty pods (%) | Ns |
| 5 | Seeds number | ** |
| 6 | Weight of 100 seeds (g) | Ns |
| 7 | Dry seed weight (g) | ** |
| 8 | Productivity (ton ha$^{-1}$) | ** |

increase the abiotic (drought, salinity, heavy metals) and biotic (root pathogens) stress resistance with aggregate soil stability of the host plant can be provided by using mycorrhiza fungus. The results of this research showed that the application of bio-fertilizer significantly affected all the observed variables except that it had no significant effect on the percentage of empty pods and the weight of 100 seeds.

## Conclusion

Based on statistical analysis, the application of bio-fertilizer significantly affected all the observed variables viz., pod weight, total pod number, filled pod number, seeds number, dry seed weight, and productivity of peanut (Wadaga), except that it had no significant effect on the percentage of empty pods and the weight of 100 seeds. The highest average pod weight, total pod number, filled pod number, and seed number occurred at the treatment of AMF 10 g per plant + CMF 3 kg per plot ($T_8$: $A_2B_1$) 55.0 g, 50.3 pods, 46.3 pods, and 84.3 seed, respectively. The highest average productivity was obtained in treatment without AMF + CMF 6 kg per plot ($T_3$: $A_0B_2$) as 3.97 ton $ha^{-1}$. The treatment of AMF 10 g per plant and CMF 3 kg per plot ($T_8$: $A_2B_1$) can be used to improve and increase the production of groundnut.

## ACKNOWLEDGEMENTS

All authors would like to thank the Ministry of Research, Technology and Higher Education of the Republic of Indonesia for research funding assistance through the scheme of Applied Research in 2019 with the number: SP DIPA-042.06.1.401516/2017, Date 05 December 2018. The authors would also like to thank the Rector and Chair of the Institute for Research and Community Services of the University of Halu Oleo.

## Conflict of Interest

The authors declare that they have no conflicts of interest.

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