JPPIPA 9(3) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Role of Carrier Media and Types of Indigenous MVA Isolates on Soil Quality in Corn Plants in the Dry Land of West Nusa Tenggara

Sukmawati[1*], I Made Adnyana[2], Dewa Ngurah Supraptha[2], Riski Busaifi[2]

[1] Faculty of Agriculture Nahdhatul Wathan Mataram University, Indonesia.
[2] Faculty of Agriculture Udayana University, Indonesia.

Received: January 30, 2023
Revised: March 28, 2023
Accepted: March 30, 2023
Published: March 31, 2023

Corresponding Author:
Sukmawati
SukmawatiNW69@gmail.com

DOI: 10.29303/jppipa.v9i3.3537

Abstract: Corn plants have many benefits and are needed by the government as a national food reserve. West Nusa Tenggara (NTB) maize production fluctuated. If managed optimally, dry land agriculture in NTB can provide benefits for increasing agricultural production, especially corn production. The sustainability of dry land farming systems must be continuously improved even with various farming strategies with the main objective of improving soil fertility and overcoming drought stress constraints. One of the efforts to increase the productivity of NTB's dry land is the use of arbuscular vesicular mycorrhizal biofertilizers which are an alternative to improve the quality of soil and plants. Arbuscular vesicular mycorrhiza will colonize and infect roots maximally if using a carrier media that is compatible with MVA inoculant. Appropriate MVA carrier media will provide optimal environmental conditions for host plant growth. The aim of the research was to determine the role of Indigenous MVA and carrier media on soil quality in dryland maize. The research was carried out on corn plants using different carrier media and native MVA types. The study was designed as a factorial study using a completely randomized design (CRD) with 2 factors, namely the type of indigenous MVA isolates with 3 treatment levels and the Carrier Media Type factor with 4 treatment levels. There were 12 treatment combinations that were repeated 3 times so that 36 treatment combinations were obtained which were carried out at the Green House of the Faculty of Agriculture, Nahdhatul Wathan University, Mataram from December 2020 to February 2021. The results showed that the MVA type factor, the MVA isolate had a significantly different effect for all observation parameters, namely soil water content, soil pH, soil total N content and soil available P content, the best isolate was Glomus sp. The carrier media factor gives the result that the type of carrier media has a significant effect on the parameters of observing soil water content, soil total N content and soil pH with the best carrier media being rice husk charcoal biochart.

Keywords: Carrier Media, Indigenous MVA Isolates, Soil pH, Soil total N content and P content

Introduction

Corn plants have many benefits and are needed by the government as a national food reserve. West Nusa Tenggara (NTB) corn production fluctuated. In 2022, corn production in West Nusa Tenggara will be 2.3 million tons dry weight (Distanbun, 2023). The dry land of NTB is generally used for dry land, fields and plantations with a slope of >15% and 3 wet months (Permono, 2015) and is very suitable for the growth of corn plants. The NTB government has not made dry land a top priority for NTB agricultural development. Dry

How to Cite:
Sukmawati, S., Adnyana, I.M., Supraptha, D.N., & Busaifi, R. (2023). The Role of Carrier Media and Types of Indigenous MVA Isolates on Soil Quality in Corn Plants in the Dry Land of West Nusa Tenggara. *Jurnal Penelitian Pendidikan IPA*, *9*(3), 1512–1517. https://doi.org/10.29303/jppipa.v9i3.3537

land becomes marginal and has an impact on increasing various socio-economic problems, such as poverty, unemployment and low farmer income.

If managed optimally, dry land agriculture in NTB can provide benefits for increasing agricultural production, especially corn production. Limited agricultural supporting infrastructure, undulating topography and limited water availability are alleged to be the biggest contributors to the phenomenon of crop failure (Astiko, 2015). The sustainability of dry land farming systems must continue to be improved even with various farming strategies with the main objective of improving soil fertility and overcoming drought stress constraints. Integrated management applied in dry land farming systems can actualize the achievement of crop production, maintain soil fertility and improve farmers' income.

The productivity of the NTB dry land can be increased by using biological fertilizers such as vesicular arbuscular mycorrhizal biofertilizers which are an alternative to improve the quality of soil and plants. Arbuscular vesicular mycorrhizal (MVA) biological fertilizer added to soil and plants is expected to increase the availability and uptake of nutrients and minerals for plants, especially for plant growth on marginal lands. Arbuscular vesicular mycorrhizae can increase fertilization efficiency (Musafa et al., 2015), provide nutrients and plant growth hormones (Purba, 2015), facilitate the absorption of various types of nutrients, synthesis of phytohormones and are antagonistic to pathogenic bacteria and fungi (Kesaulya et al., 2015) states that the absorption efficiency of macro and micro nutrients increases with the use of MVA associated with host plants. Muis (2016) in their research reported that there was an increase in soil P levels of 0.09% and tissue P levels of 0.07 g/plant in plants that were treated with Indegenus MVA inoculants in soybean cultivation on dry land with inoculum sources from the corn rhizosphere. Musfal (2010), reported that maize yields were 5.03 tonnes/ha higher in 100% NPK fertilizer treatment and 20 g Indigenous MVA/plant. compared to the treatment of only 100% NPK fertilizer. MVA, which is symbiotic with plants, forms external hyphae which can increase the reach of plants to absorb nutrients, especially P, by improving the plant's root system (Lukiwatid & Simanungkalit, 2002).

MVA carrier media greatly affects root colonization and infection in host plants (Shrivastava et al., 2015). Appropriate MVA carrier media will provide optimal environmental conditions for host plant growth. Ingels (1985)states that the proper carrier medium is one of the conditions for successful plant cultivation (Nosheen et al., 2021). An ideal carrier media must have the conditions of having good aeration and drainage, sufficient moisture, free from organisms and hazardous materials, sufficient nutrients, and light weight. The carrier media serves as a mechanical support for roots and soil temperature. The development of healthy roots and the process of breathing air by the roots is a measure of whether or not air aeration is good in the soil structure.

The carrier media that is often used for MVA inoculation is a carrier material with a composition of soil, sand, clay, kaolin, peat and zeolite (Simanungkalit, 2003). Carrier materials from organic materials such as fuel husks need to be considered (Girelli et al., 2020) because production costs are economical and environmentally friendly and are available in various locations. Organic materials as carriers for MVA inoculants are still lacking. MVA can interact positively with organic matter in the soil, including problem areas such as saline soils (Nurbaity et al., 2005) and drought-stressed lands (Sukmawati et al., 2022). The roasted husks contained 0.32% N, .15% P, 0.31% K, 0.96% Ca, 180 ppm Fe, 80.4 ppm Mn, 14.10 ppm Zn and pH 6.8. Burnt husks have the advantage of being able to improve the physical and chemical properties of the soil (Istomo, 2012). In addition, adding roasted husks to the planting medium can improve aeration and drainage in the planting medium (Tumanggor, 2006).

Therefore, to improve the productivity of corn-planted dry land, it is necessary to conduct research on a combination of MVA and carrier media on corn plants in the dry land of West Nusa Tenggara.

Method

Place and time of research

Experiments were carried out on corn plants using different carrier media and native MVA types. The experiment was carried out at the Green House of the Faculty of Agriculture, Nahdhatul Wathan University, Mataram from December 2020 to February 2021.

Experimental design

This research was a factorial study designed using a completely randomized design (CRD) with 2 factors, namely the type of indigenous MVA isolates and the type of carrier media. The details of the two factors showed in Table 1. Factor 1: Indigenous MVA (S) isolate type which consists of 3 levels, namely:

S_0 = without MVA spores
S_1 = Glomus sp.
S_2 = Gigaspora sp.

Factor 2: Types of Carrier Media consisting of 4 (M) levels, namely:

A_1 = Carrier Media 1 (1 kg of zeolite : 3 kg of soil)
A_2 = Carrier Media 2 (1 kg kaolin : 3 kg soil)
A_3 = Carrier Media 3 (1 kg of quartz sand : 3 kg of soil)

A_4 = Carrier Media 4 (1 kg charcoal husk biochart : 3 kg soil)

Table 1. Treatment combinations of 2 factors tested on the Role of Indigenous MVA Isolate Types on Various Carrier Media

Isolate Type	A_1	A_2	A_3	A_4
No isolates (S_0)	S_0A_1	S_0A_2	S_0A_3	S_0A_4
Glomus sp. (S_1)	S_1A_1	S_1A_2	S_1A_3	S_1A_4
Gigaspora sp. (S_2)	S_2A_1	S_2A_2	S_2A_3	S_2A_4

Each treatment was repeated 3 times to obtain 36 experimental units. The research was conducted within 2 months. Each experimental unit consisted of 1 plant.

Research procedure

Indigenous MVA isolates used are superior isolates obtained in the propagation process by providing 50 spore grains/polybag. 1 kg of kaolin, zeolite, quartz sand, rice husk biochart and 3 kg of soil (1:3 ratio) were put into polybags so that each polybag contained 4 kg of carrier media. Soil and carrier media are thoroughly mixed and then sterilized in a large drum at 105 ^oC for 3.5 hours. The carrier media is cooled for 24 hours. Corn seeds were planted in each polybag within 45 days and watered regularly every evening using groundwater according to field capacity.

Observation Parameters

The observed soil quality parameters i.e pH was measured using a pH meter, moisture content was measured by gravimetric method, total N levels were measured with Kjeldal, and soil available P levels with a spectrophotometer.

Data analysis

Data were analyzed quantitatively using analysis of variance (ANOVA) at 5% level using Costat software. If between treatments have a significant effect on the observed variables, then continue with Duncan's Multiple Range Test (DMRT) at 5% level.

Result and Discussion

Research on the role test of Indegenus MVA isolates on various carriers on maize plants on dry land showed an increase in soil quality. The variety factor of Indigenous MVA isolates showed significant differences in all soil quality parameters.

Table 2. Test of the Role of Indigenous MVA Isolate Types on Various Carrier Media on Soil Water Content

Isolate Type	Soil water content in different media			
	A_1	A_2	A_3	A_4
No isolates (S_0)	25.85 de	31.77 ab	22.29 c	35.33 a
Glomus sp. (S_1)	26.82 cd	29.48 ab	22.13 dc	37.14 a
Gigaspora sp. (S_2)	23.77 de	27.07 ab	24.94 de	33.30 a

Description: The average value of the treatment followed by the same lowercase letter shows no significant difference based on the DMRT test at the 5% level. Media A_1 = soil-zeolite mixture: Media A_2 = soil-kaolin mixture: medium A_3 = soil-quartz sand mixture: Media A_4 = soil-charcoal husk mixture.

Table 3. Test of the Role of Indigenous MVA Isolate Types on Various Carrier Media on Total Soil N Content

Isolate Type	Total N content of soil on different media			
	A_1	A_2	A_3	A_4
No isolates (S_0)	0.24 a	0.23 a	0.24 a	0.24 a
Glomus sp. (S_1)	0.22 a	0.19 b	0.23 a	0.24 a
Gigaspora sp. (S_2)	0.23 a	0.18 b	0.23 a	0.23 a

Description: The average value of the treatment followed by the same lowercase letter shows no significant difference based on the DMRT test at the 5% level and media A_1 = soil-zeolite mixture: Media A_2 = soil-kaolin mixture: medium A_3 = soil-quartz sand mixture: Media A_4 = soil-charcoal husk mixture

Table 3 shows the type of MVA Indigenus isolate and the type of carrier media significantly affected the parameters of total soil N content observation. There is an interaction between the two factors.

Table 4. Test of the Role of Indigenous MVA isolates on various Carrier Media

Isolate Type	Available P content of soil on different media			
	A_1	A_2	A_3	A_4
No isolates (S_0)	23.77 ^{ab}	25.93 ^{ab}	34.77 ^{ab}	68.62 ^{a}
Glomus sp. (S_1)	41.48 ^{ab}	30.76 ^{ab}	31.58 ^{ab}	76.32 ^{a}
Gigaspora sp. (S_2)	22.99 ^{ab}	12.41 ^{bc}	15.31 ^{bc}	67.57 ^{a}

Description: The average value of the treatment followed by the same lowercase letter shows no significant difference based on the DMRT test at the 5% level and media A_1 = soil-zeolite mixture: Media A_2 = soil-kaolin mixture: medium A_3 = soil-quartz sand mixture: Media A_4 = soil-charcoal husk mixture

Table 4 shows that in the observed P parameters there was a significant difference in the type of MVA Indegenus isolate, there was no significant effect on the carrier factor parameters and there was an interaction between the treatments on both factors.

Table 5 shows that in the observed parameters of soil H_2O pH there was a significant difference in the type factor of Indigenous MVA isolates and the variety of carrier media and there was no interaction between the two factors.

Table 5. Test of the Role of Indigenous MVA Isolate Types on Various Carrier Media on Soil H2O pH

Isolate Type	Soil H_2O pH on different media			
	A_1	A_2	A_3	A_4
No isolates (S_0)	8.77b	8.14de	8.48b	8.21d
Glomus sp. (S_1)	8.77a	8.28cd	8.44bc	8,.6cd
Gigaspora sp. (S_2)	8.78a	8.01e	8.52b	8.7ed

Description: 1. The average value of the treatment followed by the same lowercase letter shows no significant difference based on the DMRT test at the 5% level, and media A1 = soil-zeolite mixture: Media A2 = soil-kaolin mixture: medium A3 = soil-quartz sand mixture: Media A4 = soil-charcoal husk mixture

Better soil quality is thought to be due to the association between maize plants and Indigenous MVA which is seen in the increase in soil chemical properties in all treatments inoculated with MVA with the best chemical properties in the treatment using isolate I1 (Glomus sp.) on the observed parameters pH, available P and N total land. Sari & Ermavitalini (2014), stated that changes in the chemical properties of MVA-inoculated soil were caused by MVA colonization of plant roots which could expand the area of root uptake of nutrients and water. Muis (2016) stated that plants added to MVA would be better because of the greater surface area of the roots in absorbing nutrients and water and the greater number of leaves to carry out photosynthetic activities. In all observation parameters, the soil quality of the Glomus genus is superior to that of the Gigaspora genus.

In addition to being influenced by soil nutrient levels, MVA performance is also influenced by soil pH (Tuheteru, 2003). H_2O pH analysis of 36 soil samples showed a slightly alkaline pH range (8.01-8.78). Changes in soil pH do not affect the performance of MVA because MVA is resistant to changes in soil pH. The available P content of the soil ranged from 12.41 to 76.32 ppm while the total soil N content was 0.18 to 0.24%. The highest nutrient levels were found in the application with rice husk charcoal carrier media and the addition of Glomus sp. MVA inoculant. The high levels of P nutrients in the application of Glomus sp and husk charcoal carrier media were due to a mutualism symbiosis with host plant roots which played a role in increasing the absorption of nutrients, especially P (Ambarwati et al., 2022; Muis et al., 2013; Thomas & Singh, 2019). The use of biochar husk media and soil fertilized with spores of the genus Glomus sp provides better soil quality. Husk charcoal biochar will maintain moisture and increase soil fertility, increase water and air circulation in the soil, provide nutrients so that it can stimulate plant growth (Bhanse et al., 2022; Rawat et al., 2019). Research conducted by Kolo & Raharjo (2016) proved that husk charcoal has a positive effect on the growth and yield of tomatoes. Other media such as a mixture of soil with zeolite, quartz sand and kaolin have quite varied texture differences. Kaolin is in the form of flour, zeolite and quartz sand are in the form of granules, grains like small stones. Kaolin flour in wet conditions will agglomerate and blend with the soil. MVA hyphae of the genus Glomus did not spread optimally in the soil-kaolin flour medium so that the nutrient absorption process was low. Vaidya et al. (2007) stated that a mixture of coarse soil such as zeolite and quartz sand was a medium that did not give the best results for the growth of MVA-inoculated corn plants because the coarse soil conditions had high porosity so that the absorption of nutrients and water was not optimal.

Conclusion

The type of MVA isolate has a significantly different effect on all observation parameters, namely soil water content, soil pH, soil total N content and soil available P content with the best isolate being Glomus sp. The type of carrier media has a significant effect on the observation parameters of soil water content, soil total N content and soil pH with the best carrier media being rice husk charcoal biochart.

Acknowledgments

Place acknowledgments, including information on grants received, before the references, in a separate section, and not as a footnote on the title page

References

Ambarwati, E., Arwiyanto, T., Widada, J., Alam, T., & Andika, I. P. (2022). The Genes Associated with Jasmonic Acid and Salicylic Acid Are Induced in Tropical Chili Pepper against Ralstonia solanacearum by Applying Arbuscular Mycorrhizal Fungi. *Horticulturae*, *8*(10), 876. https://doi.org/10.3390/horticulturae8100876

Astiko, W. (2015). *Peranan Mikoriza Indigenus pada Pola Tanam Berbeda dalam Meningkatkan Hasil Kedelai di Tanah Berpasir*. Arga Puji Press.

Bhanse, P., Kumar, M., Singh, L., Awasthi, M. K., & Qureshi, A. (2022). Role of plant growth-promoting rhizobacteria in boosting the phytoremediation of stressed soils: Opportunities, challenges, and prospects. *Chemosphere*, *303*, 134954. https://doi.org/10.1016/j.chemosphere.2022.134954

Distanbun, N. (2023). *Dinas Pertanian dan Perkebunan*. https://distanbun.ntbprov.go.id/

Girelli, A. M., Astolfi, M. L., & Scuto, F. R. (2020). Agro-industrial wastes as potential carriers for enzyme immobilization: A review. *Chemosphere*, *244*,

125368. https://doi.org/10.1016/j.chemosphere.2019.125368

Ingels, J. E. (1985). Ornamental horticulture: principles and practices. In *New York Agricultural and Technical*. Delmar Publishers.

Istomo, V. N. (2012). Pengaruh perlakuan kombinasi media terhadap pertumbuhan anakan tumih (Combretocarpus rotundatus (Miq.) Danser. *Jurnal Silvikultur Tropika*, *3*(2), 81–84. https://journal.ipb.ac.id/index.php/jsilvik/article/download/6307/4860

Kesaulya, H., Baharuddin, B., Zakaria, & S.A, S. (2015). Morphological Characteristic Potato (Solanum tuberosum L) Variety Hartapel Origin South Buru Moluccas. *International Journal of Current Research in Biosciences and Plant*, *Biology.2(*. https://onesearch.id/Record/IOS5831.123456789-19562

Kolo, A., & Raharjo, K. T. P. (2016). Pengaruh Pemberian Arang Sekam Padi dan Frekwensi Penyiraman terhadap Pertumbuhan dan Hasil Tanaman Tomat (Lcopercicon esculentum Mill. *Savana London*, *1*(3), 102–104. https://media.neliti.com/media/publications/237654-effect-of-rice-husk-charcoal-and-waterin-570a9fa3.pdf

Lukiwatid, D. R., & Simanungkalit, R. D. M. (2002). Dry matter yield, N and P uptake of soybean with Glomus manihotis and Bradyrhizobium japonicum. *17th Word Congress of Soil Science*, 14–21. https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=60b3ae5e77398e45e084c16919b5f886807d5453

Muis, R. (2016). *Efisiensi Pemupukan Fosfor Menggunakan Isolat FMA Lokal untuk Meningkatkan Produktivitas Kedelai di Lahan Pasang Surut*. Institut Pertanian Bogor. https://inlislite.ipb.ac.id/opac/pencarian-sederhana?action=pencarianSederhana&katakunci=+Pascasarjan&ruas=Pengarang&bahan=Semua+Jenis+Bahan&fAuthor=&fPublisher=&fPublishLoc=&fPublishYear=&fSubject=Forage+plants++Soybean&fBahasa=

Muis, R., Ghulamahdi, M., Melati, M., Purwono, & Mansur, I. (2013). Diversity of arbuscular mycorrhiza fungi from trapping using different host Plants". *Basic and Applied Research (IJSBAR*, *27*, 158–169. https://www.gssrr.org/index.php/JournalOfBasicAndApplied/article/view/5696

Musafa, M. K., Aini, L. Q. L. Q., & Prasetya, B. (2015). Peran mikoriza arbuskula dan bakteri Pseudomonas fluorescens dalam meningkatkan serapan P dan pertumbuhan tanaman jagung pada andisol. *Jurnal Tanah Dan Sumberdaya Lahan*, *2*(2), 191–197. https://jtsl.ub.ac.id/index.php/jtsl/article/view/129

Nasr, M., & Negm, A. M. (2023). *Cost-efficient Wastewater Treatment Technologies: Engineered Systems* (Vol. 118). Springer Nature.

Nosheen, S., Ajmal, I., & Song, Y. (2021). Microbes as biofertilizers, a potential approach for sustainable crop production. *Sustainability*, *13*(4), 1868. https://doi.org/10.3390/su13041868

Nurbaity, A., Abbott, L. K., Juniper, S. da. R., & A. (2005). *Organic Matter Affects Some Properties of a Saline Soil in Western Australia*. Proceeding of International Salinity Forum.

Permono. (2015). Potensi Lahan Kering Nusa Tenggara Barat untuk Produksi Benih Kedelai. http//nokukuh, wordpress.com. *Diakses Tanggal*, *12*.

Purba, R. (2015). Kajian aplikasi pupuk hayati pada tanaman padi sawah di Banten. *Pros Sem Nas Masy Biodiv Indon*, *1*(6), 1524–1527. https://smujo.id/psnmbi/article/download/1320/1277/1204

Rawat, J., Saxena, J., & Sanwal, P. (2019). Biochar: a sustainable approach for improving plant growth and soil properties. *Biochar-an Imperative Amendment for Soil and the Environment*, 1–17.

Sari, R. R., & Ermavitalini, D. (2014). Identifikasi Mikoriza dari Lahan Desa Cabbiya, Pulau Poteran, Sumenep Madura. *Jurnal Sains Dan Seni ITS*, *3*(2), E67--E70. https://doi.org/10.12962/j23373520.v3i2.6907

Shrivastava, G., Ownley, B. H., Augé, R. M., Toler, H., Dee, M., Vu, A., Köllner, T. G., & Chen, F. (2015). Colonization by arbuscular mycorrhizal and endophytic fungi enhanced terpene production in tomato plants and their defense against a herbivorous insect. *Symbiosis*, *65*, 65–74. https://link.springer.com/article/10.1007/s13199-015-0319-1

Simanungkalit, R. D. M. (2003). Teknnologi Cendawan Mikoriza Arbuaskular: Produksi Inokulan dan Pengawasan Mutunya. In *Makalah Seminar Mikoriza*.

Sukmawati, S., Adnyana, I. M., Supraptha, D. N., & Busaifi, R. (2022). Effect of MVA Indigenous Isolates and Types of Planting Media on Growth and Result of Corn Plant on Dry Land Central Lombok. *Jurnal Penelitian Pendidikan IPA*, *8*(SpecialIssue), 112–116. https://doi.org/10.29303/jppipa.v8iSpecialIssue.2470

Thomas, L., & Singh, I. (2019). Microbial biofertilizers: types and applications. *Biofertilizers for Sustainable Agriculture and Environment*, 1–19. https://link.springer.com/chapter/10.1007/978-3-

030-18933-4_1

Tuheteru, F. D. (2003). *Aplikasi asam humat terhadap sporulasi CMA dari bawah tegakan alami Sengon [skripsi*. Institut Pertanian Bogor.

Tumanggor, T. P. (2006). *Potensi Sisa Media Jamur Kuping sebagai Pupuk Organik pada Tanaman Tapak Dara (Chataranthus roseus (L.) G.DON). Skripsi Fakultas Pertanian Universitas Muhammadiyah Jakarta*.

Vaidya, G. S., Shrestha, K., Khadge, B. R., Johnson, N. C., & Wallander, H. (2007). Study of biodiversity of arbuscular mycorrhizal fungi in addition with different organic matter in different seasons of kavre district (Central Nepal. *Scientific World*, *5*(5), 75–80. https://doi.org/10.3126/sw.v5i5.2660

,