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Inoculant arbuscular mycorrhizal fungi compatibility test using sweet corn plants on peatlands

Dwi Zulfita*, Surachman, Rahmidiyani

Agrotechnology Study Program, Faculty of Agriculture, Tanjungpura University, Indonesia

* Corresponding author: dwi.zulfita@faperta.untan.ac.id

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ABSTRACT

Corn is a food ingredient that is widely consumed by Indonesian people. The purpose of this study is to determine the compatibility of AMF isolates from several host plants with the yield components of sweet corn on peatlands. The field experiments were carried out with a randomized block design (RCBD) with 5 treatments and 3 replications. The treatments referred to are m0 (without AMF inoculation), m1 (AMF inoculum from the host Pueraria Javanica), m2 (AMF inoculum from the soybean plant host), m3 (AMF inoculum from the corn plant host) and m4 (AMF inoculum from the sorghum plant host). Observations were made on mycorrhizal infections, absorption of N, P, K nutrients, and plant yield components including weight per ear with weight, weight per ear without husk, ear length, ear diameter, and ear weight per plot. The data acquired from the observation were statistically analyzed using analysis of variance (F test), while further tests were done with Duncan's multiple distance test (DMRT). The results showed that AMF inoculant derived from maize rhizosphere is most compatible with corn plants compared to AMF inoculant from rhizosphere sorghum, P.javanica, soybeans, and without inoculation. AMF inoculant from maize rhizosphere can increase root infection, absorption.

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INTRODUCTION

Peatlands are a potential area for the development of food crops, including corn. The area of peat land in West Kalimantan is 1,608,000 ha or 10.92% of the area of the province (Central Statistics Agency, 2019). One of the main obstacles to developing peatlands for crop cultivation is the low availability of P, K, Ca, and Mg nutrients as well as some microelements such as Cu, Zn, Al, Fe, and low Mn. High C/N ratio and soil acidity (Yenni, 2012).

In the effort to utilize the use of peatlands, maize was chosen as an experimental crop. One of the reasons is that the government has been focusing its attention on this plant by expanding the planting area, especially targeting marginal lands such as peatlands. However, until today the average corn production is still low. This is due to several constraints on peatlands, including low fertility and high soil acidity due to the decomposition of organic matter which produces organic and inorganic acids that accumulate in the soil (Hakim *et al.*, 1986). Therefore, it is necessary to prepare the peatlands before utilizing it to plant crops.

This opens up opportunities for the use of Arbuscular Mycorrhizal Fungi (AMF) in maize cultivation. AMF plays an important role for the host plant to expand the absorption area of root hairs through the formation of mycelium around the roots. The formation of mycelium around the roots will increase home range volume so that the ability of plants to absorb water and nutrients is better than plants that do not have AMF (Hanafiah, 2001). Mycorrhizal fungi get a supply of organic carbon compounds from their host plants for growth and development and on the other hand, the fungi help the host plant absorb nutrients and water from the soil so that plants grow better (Rini *et al.*, 2020; Cavagnaro, 2008).

The symbiosis of mutualism between AMF and the host occurs due to the presence of root exudates. Bertham (2006) explains that plants will release root exudates in the form of flavonoid compounds to form a symbiosis with AMF. Meanwhile, in the case of peat, the available P content is low. The available P can be increased by utilizing AMF so that phosphorus fertilization can be more efficient (Trisilawati and Yusron, 2008). AMF can increase dissolved P through organic acids and the enzyme phosphatase produced. AMF can also repair dissolved P so that it can enter into the external hyphae of AMF. An important part of the mycorrhizal system is the mycelium outside the roots which plays a role in nutrient absorption for plants.

According to Zuhry *et al.* (2008), immobilized P uptake can be increased through root extension approaching P. The presence of AMF can increase the ability of roots to absorb nutrients and water to support plant growth and development. According to Nurhayati (2012), the main function of hyphae is to absorb water from the soil, then P that accumulates in external hyphae will immediately be converted into polyphosphate compounds in the presence of the enzyme phosphatase.

AMF is able to associate with almost 90% of higher plant species (Cruz, Ishii, and Kadoya, 2000) but each AMF strain has different abilities in increasing plant growth (Tian et al. 2004). Thus, it is necessary to select AMF isolates that are compatible with the cultivated plants. AMF is symbiotic with responsive host plants and has many roots (Simanungkalit 2004). Seasonal plants such as maize and sorghum are highly compatible hosts for endomycorrhizae (Simanungkalit 2004, Hapsoh 2008) so these two plants are considered suitable hosts for endomycorrhizal spore propagation (Widiastuti 2004).

The results of the research by Rini and Rozalinda (2020) which tested the graminae (maize and sorghum) and legume (*Centrosema pubescens* and *Calopogonium mucunoides*) groups as host plants showed that the graminae group was more suitable for mycorrhizal production. From previous experiments, it is not known whether using AMF isolates from several host plants with maize will be compatible with the yield components of sweet corn on peatlands. This study aims to determine the compatibility of AMF isolates from several host plants to the yield components of sweet corn on peatlands.

RESEARCH METHODS

Research Design

This research is a field experiment conducted with a randomized block design (RCBD). The treatments included:

m_0 = without AMF inoculation)
m_1 = AMF inoculum from the host *Pueraria Javanica,*
m_2 = AMF inoculum from the soybean plant host
m_3 = AMF inoculum from the corn plant host
m_4 =AMF inoculum from the sorghum plant host

There were 5 treatments with 5 replications and four sub-samples. Observations were made on root infections, nutrient uptake of N, P, K, and yield components including ear weight without ear, ear weight with ear weight, ear weight per plot, ear length, and ear diameter. Observation data were analyzed statistically using analysis of variance (F test). Finally, further tests were conducted using Duncan's multiple distance test (DMRT).

Population and Samples

This research took place from May 10th, 2021 to October 15th, 2021. The research was conducted on farmers' land located in Rasau Jaya II Village, Rasau Jaya District, Kubu Raya Regency.. The materials used were in the form of Bonanza sweet corn seeds, peatlands with hemic maturity level, Zeolite, NPK fertilizer 16: 16: 16, dolomite lime, chicken manure 20 tonnes ha-1 fertilizer, Banlate M-45 fungicide, paper bags, plastic bags, polybags 25 cm x 20 cm in size black, seeds of corn, soybeans, Pueraria Javanica and sorghum as host plants, mycorrhizae from the rhizosphere of pineapple plants, 10% KOH, 1% HCl, root staining solution (Glycerol, Lactic Acid and Trypan blue), and equates.

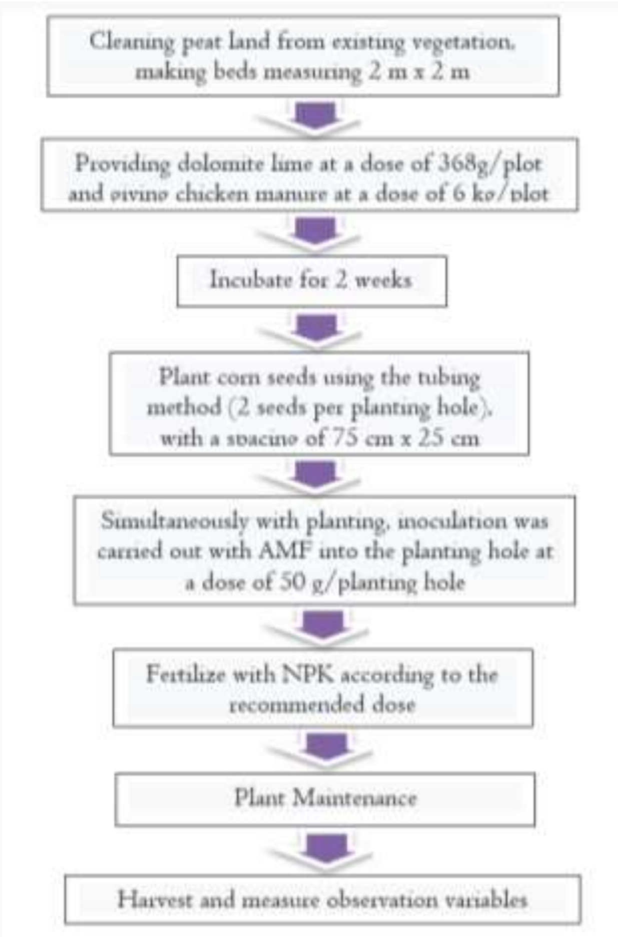

Figure 1. Flowchart of Research Implementation

Instruments

This research used various types of tools to produce data according to the procedures. The tools used in this research were hoes, machetes, blades, ropes, rulers, meters, scales, ovens, moisture testers, and documentation tools.

Procedures

After the land is cleared, a plot is made with a size of 2 m x 2 m, with a distance between the plot of 0.5 m and a height of 30 cm. Dolomite lime and chicken manure were given 2 weeks before planting with the respective doses of 368 g / plot and 6 kg/plot. Corn seeds were planted by burying them with a spacing of 75 cm x 25 cm. Inoculation with mycorrhizae was carried out at planting time at a dose of 50 g / plant. NPK fertilizer is given according to the recommended dosage. Meanwhile, plant maintenance included watering, weeding, planting, and preventing pests and diseases. Harvesting is carried out when the plant meets the harvest criteria, such as having hair that is blackish brown, dry, and cannot be broken down, the tip of the ear is fully filled, and the color of the seeds is shiny yellow. The flow diagram of research implementation can be seen in Figure 1.

Data Analysis

Observation data were analyzed statistically using analysis of variance (F test). Finally, further tests were conducted using Duncan's multiple distance test (DMRT).

RESULTS

The results of variance on root infection, N, P, and K nutrient uptake showed that inoculation with various inoculum sources had an effect on root infection, N, P, and K nutrient uptake (Table 1).

Table 1. Root infection, N nutrient uptake, P nutrient uptake, and K nutrient uptake of maize plants treated with various AMF inoculant sources.

Source of FMA Inoculant	Root Infection (%)	Hara N uptake (g)	Hara P uptake (g)	Hara K uptake (g)
Without Inoculation	38.00 b	0.40 d	40.44 e	45.30 e
Pueraria Javanica	64.30 a	0.78 c	73.10 c	78.63 c
Soy	39.70 b	0.63 c	63.54 d	63.26 d
Corn	68.20 a	3.53 a	100.31 a	147.25 a
Sorghum	63.70 a	1.36 b	90.23 b	99.57 b
CV (%)	6.10	11.87	5.09	6.68

Note:
The number in the column followed by the same letter means that it does not differ according to Duncan's multiple distance test at 5% level.

The results of variance on the yield components showed that inoculation with various sources of inoculums affected ear weight, ear weight without ear, ear length, and ear diameter but did not affect ear weight per plot (Table 2).

DISCUSSION

Table 1 shows that the treatment of various AMF inoculant sources was significantly different against root infection, N uptake, P uptake, and K uptake. From the significantly different variables, the highest value was found in AMF inoculant treatment of maize rhizosphere and significantly different from another rhizosphere AMF inoculant treatment (without inoculation, *P.javanica*, soybean, and sorghum) on the N uptake, P uptake, and K uptake variables but on root infection variables, AMF inoculant treatment of maize was not significantly different from AMF inoculant treatment of *P. javanica*, sorghum rhizosphere. This means that AMF inoculant treatment from the rhizosphere of maize, sorghum, and P. javanica is more responsive to root infections. The highest root infection occurred in AMF inoculant from maize rhizosphere, although it was not significantly different from AMF inoculant root infection from rhizosphere sorghum and *P. javanica* but significantly different from AMF inoculant root infection from soybean rhizosphere and without AMF inoculation.

There is a very strong relationship with a moderate-high degree of association between root infection and N nutrient uptake (r = 0.679), P nutrient uptake (r = 0.882), and K nutrient uptake (r = 0.825). The higher the root infection, the higher the N nutrient uptake, P nutrient uptake, and K nutrient uptake. The increase in plant N, P, and K uptake affected plant metabolism which resulted in an increase in maize plant dry weight.

Table 2 shows that corn plants treated with AMF inoculant from maize rhizosphere and sorghum produced weight per cob weighted which was not different but different from AMF inoculation treatment from *P.javanica* rhizosphere, soybeans, and without AMF inoculation. Corn plants treated with AMF inoculant from corn rhizosphere produced the heaviest cob with weight compared to other AMF inoculant sources and without AMF inoculation.

Table 2. Weight per ear with weight, weight per ear without weight, ear weight/compartment, ear length, and ear diameter of corn plants treated with various AMF inoculant sources

Source of FMA Inoculant	Weight per cob weighted (g)	Weight per ear without weight (g)	Cob/plot weight (kg)	Cob length (cm)	Cob diameter (cm)
Without Inoculation	411.55 c	279.90 b	9.72	19.40 c	3.02 c
Pueraria Javanica	472.60 b	318.35 a	10.04	20.95 ab	4.43 ab
Soy	464.10 b	317.80 a	9.94	20.35 b	3.91 b
Corn	506.85 a	345.25 a	10.18	21.59 a	5.06 a
Sorghum	493.25 ab	342.95 a	10.14	21.12 a	4.51 ab
CV (%)	5.10	5.93	3.37	2.55	14.16

Note:
The number in the column followed by the same letter means that it does not differ according to Duncan's multiple distance test at 5% level.

There is a very strong relationship with the moderate-high degree of association between P nutrient uptake with weight per ear and weight (r = 0.679), weight per ear without weight (r = 0.882), and ear weight per plot (r = 0.825). The higher the P nutrient uptake, the higher the weight per ear with husk, the weight per ear without husk, and the weight per ear of the cob/compartment.

Table 2 also shows that corn plants treated with AMF inoculant from the rhizosphere of maize, sorghum, and *P. javanica* produced ear lengths and ear diameters that were not different but different from AMF inoculation treatment from soybean rhizosphere and without AMF inoculation. Corn plants treated with AMF inoculant from maize rhizosphere produced corncobs that were longer and larger than those treated with other AMF inoculant sources and without AMF inoculation.

CONCLUSION

AMF inoculant derived from maize rhizosphere was most compatible with maize plants compared to AMF inoculant from rhizosphere sorghum, *P.javanica*, soybeans, and without inoculation. AMF inoculant from maize rhizosphere can increase root infection, the best absorption of N, P, K nutrients, and yield components of sweet corn on peatlands.

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