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Rice Resistance-Treated with Endophyte Fungi Against Drought Stress

Rangga Yuspradana[a]*, Suryo Wiyono[b], Rahayu Widyastuti[c]

[a,c]*Department of Soil Science and Land Resources, Faculty Of Agriculture, Bogor Agricultural University, Dramaga, Bogor 16680, Indonesia*

[b]*Department of Plant Protection, Faculty Of Agriculture, Bogor Agriciultural University, Dramaga, Bogor 16680, Indonesia*

Abstract

Drought problem is a major inhibiting factor for the crops producing and growing, one of them rice plants that require a lot of water supply. Endophyte fungi a potential for increasing plant resistance against drought. This study aims to determine the endophyte fungi enhancing growth of rice plants in drought stress conditions with three treatments of field capacity. Type of endophyte fungi used in this study is *Acremonium* sp., *Curvularia* sp., *Penicillium* sp., and *Nigrospora* sp. We compare some growth and biological parameters such as germination capability, ability of colonization, stomatal density, plant height and number of tillers, plant weight, root length, root volume, ratio root : shoot and leaf color. Statistical analysis using a two-factor randomized block design. The result showed that endophyte fungi treatment increased stomatal density, plant height, number of tillers, dry weight, root length, root volume, dry root weight, and leaf color index when compared with endophyte treatment in low water capacity treatment. The treatment of endophyte fungi *curvularia* sp. gave the highest results on the parameters of stomatal density, dry weight of stem, root length, root dry weight significantly different from treatment without endophytes. in contrast, the parameters of the number of open stomata are not significantly different with no endophytes so that the fungi can increase help rice plant to growth in under drought stress conditions.

Keywords: rice plant; drought stress conditions; endophyte fungi; growth and biological parameter.

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* Corresponding author.

1. Introduction

Drought is a major constraining factor for crop production and is a serious problem in many countries [1]. Rice crop is one of the plants that have many environmental factors that affect growth, one of them lack of water. consequently the production of rice was decreased and the challenge now is due to the high temperature and difficulty of access to water may result in a decrease in evapotranspiration and the resulting decline in the production of plants at once can lead to death in rice [2]. Drought in rice plants reduce plant growth, biomass plants, the rate of photosynthesis, Conductance of stomata, and the water content in the plant relationships in the metabolism of starch manufacture [3].

The utilization of microbes has been done in many sectors, for example in agriculture, industry, and health has been widely applied. The benefits of using microbes is cheap, renewable, and without damage to the environment. One type of microbe is the endophyte fungi. the most common microbes found in the soil is the fungi of one of them endofit fungi. The advantage is that the endophyte fungi may symbiotic mutualism with the host obtaining the nutrients to complete its life cycle from its host plant, whereas the host plant obtains protection against plant pathogens from the compounds produced by endophyte fungi [4]. this is reinforced by the statement of [5] in the presence of endophyte fungi in plant tissues will provide benefits for crops, i.e increased crop tolerance for heavy metals, increased drought resistance, suppress pest attacks, and systemic resistance to pathogenic stress.

Research on endophyte fungi that has been done is the endophyte fungi that infect plants *Festuca arundinacea* can increase the total biomass of leaves and roots as well as lowering the Ni metal content of 20% in the dry soil and exposed metal Ni [6]. In addition, the results [7] that the endophyte fungi isolated from plant *Suaeda salsa* can improve photosynthetic pigments in leaves of rice plants. The fungi can also efficiently use the water needed in photosynthesis and can reduce the risk of oxidative damage caused by Pb metal by increasing antioxidant enzymes. endophyte fungi *Penicillium Resedanum* isolated from red pepper plant (*Capsicum annuum L.*) increase leaf area, chlorophyll content, the amount of interest, and production of pepper plants than plants not infected with endophyte fungi. This is because the content of capsaicin in chilies were significantly higher in the infected plant endophyte fungi so it can increase the tolerance of plants to abiotic stress [8]. One solution that can be offered in dealing with drought stress is biotechnology approach using endophyte fungi that can potentially be applied to upland rice plants so it is expected to increase the level of stress tolerance of plants against drought. Therefore, the need for research on endophyte fungi capable of affecting host plants so that it can be more tolerant to dry conditions that help overcome the problem of lack of water during the planting season, especially in rice plants. This study aims to determine the endophyte fungi enhances growth of rice plants in drought stress conditions with three treatments of field capacity compare to the control. It is hoped that this study can show the potential of endophyte fungi so that it can be applied to rice plants and other plants in the condition of water shortage in drought stress environment.

2. Material and Methods

2.1 Description of The Study Site

The study conducted in July 2016 to November 2016 in Soil Biotechnology Laboratory, Department of Soil Science and Land Resources and Plant Mikology Laboratory, Department of Plant Protection, Faculty of Agriculture, Bogor Agricultural University (Indonesia).

Test of influence of some endophyte fungi on dry environmental conditions and growth of seedlings of upland rice crops was conducted in Cikabayan Bogor Agricultural University experimental garden.

2.2 Tools and Materials

The tool used in this research is the ocular micrometer, scales, oven, stereo microscope, leaf color chart, and research support tools both in the laboratory and in the field. The material used in this study is the isolate fungi

collections (*Acremonium* sp., *Penicillium* sp., *Nigrospora* sp., and *Curvularia* sp.) derived from the plant clinic Department of Plant Protection, Bogor Agricultural University, seed crops of upland rice (Inpago 9 variety), poly bags, fertilizer, and PDA media (Potato Dextrose Agar).

2.3 Experimental Design

The experimental design used was Group Randomized Design of the factorial pattern to test the experimental unit consisting of two factors. The first factor is the water content consisting of 3 levels and the second factor is the inoculation of endophyte fungi consisting of 5 levels. The treatment details are as follows:

First factor: Water content

- A1 = The wet condition are treated with water giving 100% of field capacity.
- A2 = Moderate condition that is treated with the water supply to 50% of field capacity.
- A3 = Dry condition are treated with a water supply 25% of field capacity

Second factor: Inoculant of endophyte fungi

- B0 = No endophyte fungi inoculation (control)
- B1 = With inoculation of endophyte fungi *Acremonium* sp.
- B2 = With inoculation of endophyte fungi *Curvularia* sp.
- B3 = With inoculation of endophyte fungi *Nigrospora* sp.
- B4 = With inoculation of endophyte fungi *Penicillium* sp.

2.4 Parameter Of Research

2.4.1 Leaf Color

The color of the leaves of the rice plant at age 30 day after transplanting. 10 disease free hills were selected at random observed by using Leaf Color Chart (LCC) with category 1-5.

2.4.2 Germination Capability

Germination capability was performed after inoculate of endophyte fungi into rice seed (%) before capacity field treatments (3 days after inoculated seed). The aim is to know the percentage of seeds that grow between endophyte and control treatments. The results can be formulated by ISTA [9] as follows:

$$SG = \frac{\sum n}{\sum N} \times 100\%$$

Information :

SG: Percentage seed germination

∑n: Number of seeds germinated

∑N : Total number of seed

2.4.3 Colonization Capability

The ability of colonization of endophyte fungi (%) can be seen in the leaves, stems and roots of upland rice plants At 15 days after planting. The experiment was conducted by observing infections caused by the fungi by the method of reisolation [10].

The experiment was carried out by: root of upland rice plants treated with endophyte fungi aged 30 days after planting then cleaned from soil and washed with sterile aquades 3 times. The root isolation was done randomly at the root, the lateral root, the root hair, and the root tip as much as 9 pieces, while the isolation on the stem was taken 5 cm from the base of the stem to observe the pattern of endophyte fungi spread on the stem, then the root was inserted in a temperature water bath 54^{o} C. Thereafter measured using a stereo microscope. The results can be formulated as follows:

$$PC = \frac{\sum n}{\sum N} \times 100\%$$

Information :

PC: Percentage colonization

∑n: Number of plant infected by endophyte fungi

∑N: Total Number of Plant

2.4.4 Stomatal Density and number of open stomata

Observations density of stomata (mm^2) were made at the age of 45 days after Planting. Observations were made on the young leaves that have grown up in sections 2-3 of shoots at 9.00 AM [11]. The number of open stomata calculated manually using an ocular micrometer. Calculations performed per unit area mm^2. Furthermore, the density of stomata in mm^2 is calculated by the formula:

$$SD = \frac{\text{[illegible]}}{\text{[illegible]}}$$

Information :

$\sum n$: Number of stomata observed

W : Wide field of view in a glass object (K = 0,9625)

2.4.5 Plant height and number of tillers

Measurement of plant height using ruler (cm) from the base of the stem to the youngest shoot on harvesting, while the number of tillers by looking at the number of tillers growing around plant each poly bag at 50 days after planting.

2.4.6 Weight of the plant

Measurement of weight plant (g/poly bag) using digital scales at 50 days after planting. After that, the fresh plant is put on oven for 72 hours in 60^o C for measurement of dry plant weight.

2.4.7 Root Length, root volume, weight root, and root shoot ratio

Measurement of all root parameter performed at 50 days after planting. Root length is calculated by using a ruler (cm), To measure the root volume using a measuring cup (ml) of water and then inserting the root piece and recording the difference in water volume change before and after the root is included indicating the value of the root volume.

Measurement of root dry weight was measured by inserting fresh roots into the oven for 72 hours at 70^oC. Data root shoot ratio obtained by dividing the dry weight of the roots with the dry weight of the root.

Data analysis

Data were analyzed using Factorial test two factors at 95% confidence level. If there is a real difference, a further test of treatment with Duncan test will be conducted at a 5% level.

3. Results and Discusion

3.1 Leaf Colour

Leaf color on rice plants is strongly influenced by water and nutrient elements of nitrogen in plants. According to research [12] treatment of drought stress decreases the efficiency of nitrogen absorption by plants so that the effect on the leaves of rice so as to reduce the rate of photosynthesis in the leaves

Table 5: Effect of the interaction endophyte treatment with the water content of the leaf color

Treatment	Leaf Color (unit)	Category
Soil Moisture 25 % FC		
Without endophyte	2	Yellowish
Acremonium sp.	2.5	Yellow rather green
Curvularia sp.	2.5	Yellow rather green
Nigrospora sp.	2.5	Yellow rather green
Penicillium sp.	2.5	Yellow rather green
Soil Moisture 50 % FC		
Without endophyte	2.7	Green slightly yellow
Acremonium sp.	2.7	Green slightly yellow
Curvularia sp.	2.7	Green slightly yellow
Nigrospora sp.	2.7	Green slightly yellow
Penicillium sp.	2.7	Green slightly yellow
Soil Moisture 100 % FC		
Without endophyte	3.7	Light green
Acremonium sp.	3.7	Light green
Curvularia sp.	3.7	Light Green
Nigrospora sp.	4.3	Green
Penicillium sp.	4.6	Old green

The treatment levels of 100% FC treated endophyte fungi *Penicillium* sp. has the brightest leaf color compared with other treatments on the 100% treatment of FC, whereas in the 50% FC treatment there is no difference in leaf color, but at the treatment of 25% FC with endophyte treatment have different color than other fungi treatments In Table 5. At low water levels the rice plants given endofit fungi treatment have more green color than the treatment without endophytes. The green color of the rice leaves is largely derived from stomata commonly used in photosynthesis. The presence of more stomata in the treatment of endophyte fungi increases the rate of photosynthesis. [13] suggest that high levels of photosynthesis may trigger adjustment of osmotic pressure to compensated for the effects of water shortages in plants.

3.2 Germination Capability

The endophyte fungi *Curvularia* sp have a rice plant germination percentages higher than other endophyte treatment and without endophyte can be seen in table 1. These results are supported by research [14] that the treatment of endophyte fungi possessed higher germination biomass, especially the root portion compared with no endophyte treatment.

Table 1: The effect of endophyte fungi on the percentage of germination of rice plants

No	Endophyte	Germination (%)
1	tanpa endofit (control)	85
2	*Acremonium* sp.	90
3	*Curvularia* sp.	**95**
4	*Nigrospora* sp.	90
3	*Penicillium* sp.	90

Description: the number that is bold is the largest result of the observation parameters.

The use of endophyte Fungi inoculants may increase the percentage of germination up to 95% compared with endophyte treatment with 85% germination percentage. This is supported by [15] wheat seeds are inoculated mycorrhizal fungi arbuscular *Glomus intraradices* BEG72, *Glomus mossae* and fungi endophyte *Trichoderma atroviride* MUCL 45 632 can speed up the germination of seeds, in addition to the fungi endophyte able to increase the germination of the rice seed due to fungi endophyte with produce hormone IAA (indoleacetic acid) [16]

3.3 Colonization Capability

The results of the test in Figure 1 show that rice plants treated with the highest drought stress (25% FC {field capacity}) levels of colonization ability will also be low at the root. While on the stem and leaf the ability of endophyte Fungi colonization tends to be high at 50% FC treatment. Statement [17] suggest that colonization of arbuscular mycorrhizal fungi decreases at the root when the Aluminum content is high in the soil because Al is phytotoxic to endophyte fungi.

The highest fungi colonization in the root is *Penicillium* sp., in the shoot is *Acremonium sp.,* and in the leaves *acremonium* sp., *Curvularia* sp., and *Penicillium* sp. in Figure 1. Research results [18] *Penicillium* sp. is an endophyte Fungi that can adapt in various places and is able to adapt to extreme pH, temperature, and redox potential. in addition, the results of research [19] Fungi *Acremonium* sp. able to colonize the roots, stems, and leaves of rice plants with a colonization rate of up to 60%. In the driest treatment (25% FC) the ability of colonization of endophyte fungi at the same in root is at 25% of colonization percentage. While the highest colonization in shoot obtained *Nigrospora* sp., Then the highest colonization leaf obtained by treatment of *Curvularia* sp., and *Penicillium* sp. The research result [20] Fungi *Nigrospora* sp. most commonly found in plant stem parts compared to leaves and roots when water deprivation. In addition *Nigrospora* sp. experienced inhibition of colonization due to the reduced number of spores produced during humid circumstances, [21] observed that the number of endophyte fungi spores *Nigrospora* sp decreases dramatically during the rainy season of 1522 cm^2 to 306 cm^{2}. The Fungi *Penicillium* sp. has a high degree of colonization on the leaves,

[22] reported the endophyte Fungi *Penicillium* sp. Isolated from some parts of the rice plant has the highest colonization presentation on the lower leaf of 9 isolates compared to the other fungi. In addition to *the Penicillium* sp., Endophyte Fungi *Curvularia* sp, also obtains the highest colonization. Research [23] showed that the *Curvularia* sp. have a higher colonization on leaves of *arbor-tristis Nyctanthes* on leaves of 13 isolates compared to the shoot by 7 isolates.

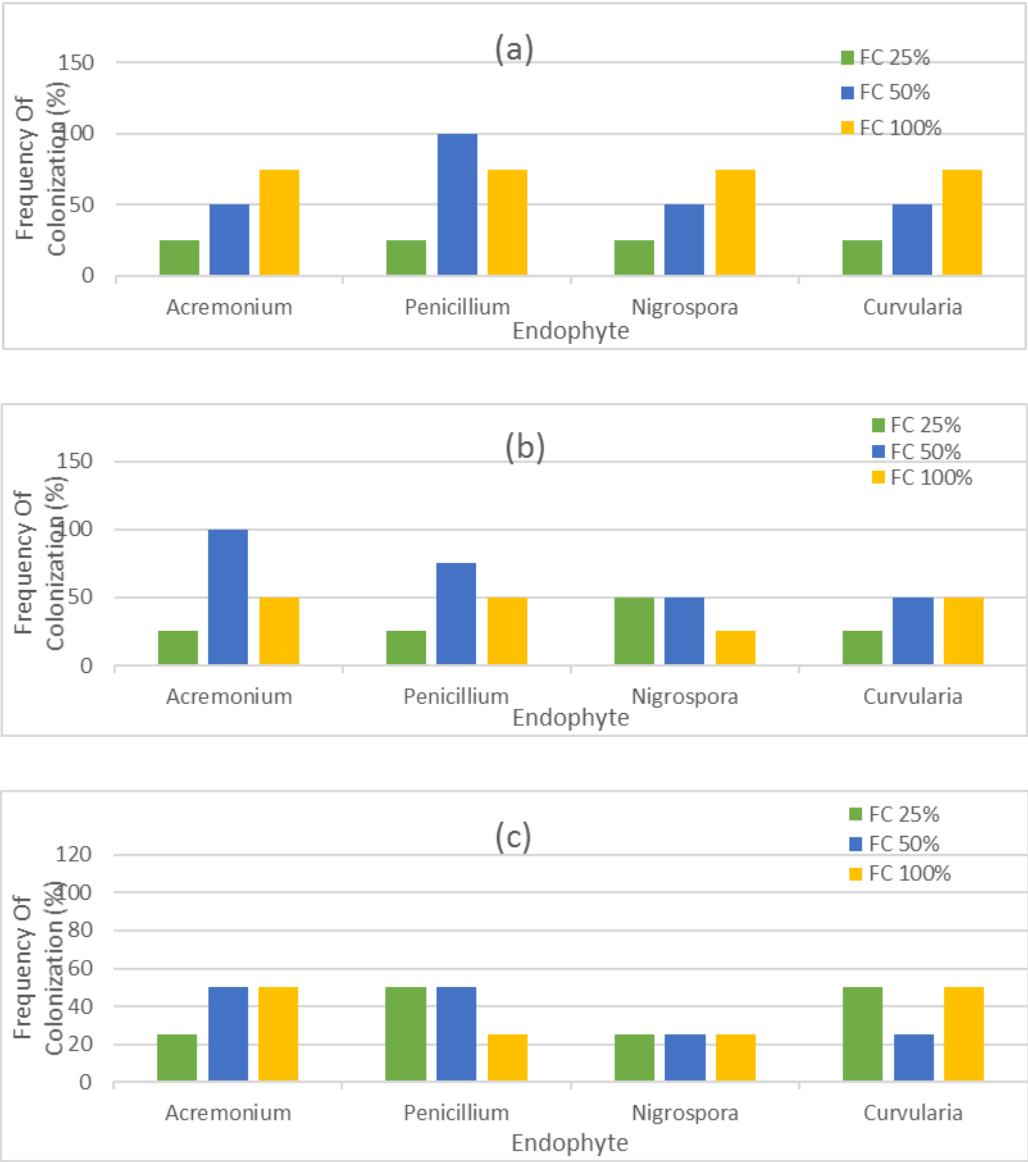

Figure 1: The ability of endophyte fungi colonization at root (a), shoot (b) and leaf (c) at different field capacities

3.4 Stomatal Density and Number Of Open Stomata

Table 2 shows the treatment of endophyte fungi increasing the amount of stomatal density, but lowering the amount of open stomata at low moisture content. However, at sufficient moisture the amount of stomatal density and stomata count is equally increased compared to endophyte treatment and without endophytes.

Table 2: The effect of the interaction of soil moisture and fungi endophyte on stomatal density, plant height and number of tillers

Treatment	Stomata density (cm^2)	Open stomata ($/cm^2$)	Plant height (cm)	Number of tillers (tiller/polybag)
Soil Moisture 25 % FC				
▪ Without endophyte	391,59 ^{g}	307 ^{f}	59,33 ^{g}	7,00 ^{f}
▪ Acremonium sp.	422,17 ^{fg}	248 ^{g}	64,27 ^{f}	9,00 ^{e}
▪ Curvularia sp.	**440,26 ^{f}**	**311 ^{f}**	65,67 ^{ef}	9,00 ^{e}
▪ Nigrospora sp.	399,24 ^{g}	219 ^{gh}	**67,30 ^{e}**	**9,33 ^{de}**
▪ Penicillium sp.	435,67 ^{f}	188 ^{h}	64,13 ^{f}	9,00 ^{e}
Soil Moisture 50 % FC				
▪ Without endophyte	599,59 ^{e}	**752 ^{c}**	72,57 ^{d}	9,33 ^{de}
▪ Acremonium sp.	636,69 ^{cd}	687 ^{d}	75,47 ^{cd}	**10,00 ^{bcde}**
▪ Curvularia sp.	650,96 ^{cd}	741 ^{c}	76,30 ^{c}	9,67 ^{cde}
▪ Nigrospora sp.	618,85 ^{de}	607 ^{e}	**77,40 ^{bc}**	9,67 ^{cde}
▪ Penicillium sp.	**655,54 ^{c}**	617 ^{e}	75,10 ^{cd}	9,67 ^{cde}
Soil Moisture 100 % FC				
▪ Without endophyte	694,78 ^{b}	1186 ^{b}	80,13 ^{ab}	10,67 ^{abcd}
▪ Acremonium sp.	**755,41 ^{a}**	**1304 ^{a}**	82,47 ^{a}	11,33 ^{ab}
▪ Curvularia sp.	742,68 ^{a}	1311 ^{a}	83,07 ^{a}	11,00 ^{abc}
▪ Nigrospora sp.	727,39 ^{a}	1313 ^{a}	**83,30 ^{a}**	**12,00 ^{a}**
▪ Penicillium sp.	755,67 ^{a}	1327 ^{a}	82,43 ^{a}	11,00 ^{abc}

Description: the bold number is the largest result of the observation parameters. Figures written in the same letter on the same line show results that are not significantly different based on the DMRT test at a real 5% level. Treatment *Curvularia* sp. produce the highest stomatal density on the treatment of 25% of field capacity treatment FC while *Penicillium* sp. in the treatment of 50% was significantly different from treatment *Nigrospora* sp. and without endophytes treatment. While treatment *Acremonium* sp. Resulting in the highest stomatal density in 100% field capacity treatment, otherwise the lowest of stomata density is without endophyte treatment was compared with treatment with endophyte fungi in all treatments. In table 2 it can be concluded that rice crops treated with endophyte fungi affect stomatal density higher in response to drought by generating fitohormon such as ABA (*Absidic Acid*). The results of the study [24] suggests the hormone ABA in the leaves can increase the number of stomata density of the plant *Arabidopsis thaliana (L.)*. Endophyte Fungi are known to also produce IAA hormone. *Curvularia geniculate* able to produce the highest IAA hormone by 40 ug / ml on day 13 after incubation with a dose of 5 mg tryptophan [25] in which the IAA hormone can produce chlorophyll a and b are the highest in the plant *Catharanthus roseus* by 2.3 mg / gLFW at IAA concentration of 200 ppm of research [26] and the Fungi *Penicillium menonorum* have chlorophyll content was higher by 38% compared to plants without endophyte only 32% [27]. The number of a open stomata on endophyte treatment *Curvularia* sp. with a water content of 25% FC high compared to most other treatments and significantly different from the treatment *Acremonium* sp., *Nigrospora* sp., and *Penicillium* sp. This indicates that the *Curvularia* sp. still increasing the number of open stomata compared to treatment without endophytes. At 50% moisture content of FC the largest number of open stomata obtained treatment without endophytes. While on treatment 100% FC highest number of open stomata is the treatment of endophyte *Acremonium* sp. endophyte treatment is able to influence the mechanism of open-close stomata for respiration in the process of photosynthesis as a response depending on environmental conditions. Respiration is the process of photosynthesis is reduced if the condition of low moisture content [28].

3.5 Plant Height and Number Of Tillers

The results of plant height and number of tillers can be seen in Table 2. Treatment of 50% FC and 100% FC is not significantly different, but on the treatment of 25% of plant height and number of tillers are significantly different. Treatment *Nigrospora* sp. showed the highest plant height was significantly different from the treatment *Acremonium* sp., *Penicillium* sp., and treatment without endophyte According to the research [29] *Ammophila Arenaria* plants inoculated with the Fungi *Acremonium strictum* higher than plants without the endophyte. The highest number of tillers achieved by *Nigrospora* sp. This is consistent with studies [30] in barley plants with endophyte fungi treatments showed a greater number of tillers than endophyte treatments. This is because the endophyte Fungi capable of increased plant height and number of tillers either by producing siderophores, fix nitrogen from the air and produce phytohormones [31;32]

3.6 Dry Weight Plant

On a dry weight plant (Table 3), treatment *Curvularia* sp. having the highest dry at 25% FC treatment and significantly different from the treatment of endophyte *Acremonium* sp.and *Nigrospora* sp., and without endophyte, whereas the 50% FC treatment was significantly different from the treatment *Acremonium* sp., *Nigrospora* sp., *Penicillium* sp., and without endophyte treatment. In the treatment of 100% FC endophyte treatment *Nigrospora* sp. showed the highest dry weight than other treatments and significantly different from the treatment of endophyte *Acremonium* sp., *Penicillium* sp., and without endophyte. In Table 3 shows that endophyte treatment is able to increase the dry weight compared to plants without endophytes. Endophyte treatment can increase nutrient uptake through external hyphae than plants without endophytes. Reference [33] suggest that endophyte treatment may increase N, P, K, Ca, and Mg nutrients and increase stomatal conductivity compared with plants without endophytes. This is due to endophyte fungi *Penicillium* sp. and *Phoma* sp. capable of producing fitohormon *gelomerata* ABA (*Absidic Acid*), SA (*Salicylic Acid*), and JA (*Jasmonic acid*) that can help plants to drought stress [34].

3.7 Root Length, root volume, weight root, and root shoot ratio

Table 3 shows the root length parameter, treatment *Curvularia* sp. has the highest root length at 25% FC was significantly different from treatment FC *Nigrospora* sp., *Penicillium* sp., and without endophyte whereas 50% FC significantly different from the treatment of *Penicillium* sp. and without endophytes. The results of the study [35] obtained results that two varieties of maize DKB 390 and BRS 1030 drought treatment gave lower long root yield by 27,398 cm and 48,132 cm in no endophyte treatment compared with treatment with endophyte fungi amounted to 69,208 cm and 64,515 cm. Table 3 also shows that treatment *Acremonium* sp. has the highest root volume in the treatment of 50% and 100% of FC treatment while *Curvularia* sp. at the treatment of 25% FC. research [25] resulted were inoculated plants with *Curvularia geniculate* higher root length at 44.15 cm compared to treatment without endophyte 38,12 cm, and is able to produce the hormone IAA and capable of dissolving nutrients not available P into nutrients that can used by plants. Data root dry weight and the ratio of roots per canopy can be seen in Table 3. The treatment no endophyte have highest at 25% and 100% FC. While treatment *Acremonium* sp. at 50% FC.

Table 3: Effect of endophyte Fungi treatment to the treatment field capacity at the plant dry weight, root length, root volume, root dry weight, and the ratio of roots per shoot

Treatment	**Dry Weight Shoot (g/polibag)**	**Root Length (cm)**	**Root Volume (ml)**	**Dry Weight Root (g/cluster)**	**Ratio Root shoot**
Soil Moisture 25 % FC					
▪ Without endophyte	21,31 j	12,43 h	20,58 c	18,80 d	**0,91 abc**
▪ Acremonium sp.	22,73 i	14,30 def	21,19 bc	19,39 cd	0,81 bcd
▪ Curvularia sp.	**24,13 h**	**14,63 cde**	**25,63 abc**	**23,50 abc**	0,86 abcd
▪ Nigrospora sp.	23,83 h	13,67 fg	23,40 abc	21,42 bcd	0,80 cd
▪ Penicillium sp.	21,90 j	13,23 gh	20,51 c	18,90 d	0,81 abcd
Soil Moisture 50 % FC					
▪ Without endophyte	24,43 g	13,10 gh	25,90 ab	23,76 ab	0,96 ab
▪ Acremonium sp.	27,60 f	14,43 cdef	**26,90 a**	24,69 ab	**0,98 a**
▪ Curvularia sp.	**29,73 d**	**14,63 cde**	27,66 a	**25,31 ab**	0,86 abcd
▪ Nigrospora sp.	28,93 e	14,20 ef	26,75 a	24,48 ab	0,96 ab
▪ Penicillium sp.	28,30 e	13,23 gh	25,20 abc	23,17 abcd	0,93 abc
Soil Moisture % FC					
▪ Without endophyte	34,37 c	14,53 cde	27,20 abc	24,91 ab	**0,82 bcd**
▪ Acremonium sp.	36,00 b	**17,57 a**	**28,70 a**	**26.26 a**	0,78 cd
▪ Curvularia sp.	38,20 a	16,07 b	28,43 a	26,02 a	0,81 bcd
▪ Nigrospora sp.	**38,30 a**	15,27 c	28,16 a	25,78 ab	0,78 cd
▪ Penicillium sp.	36,63 b	15,10 cd	27,83 a	25,20 ab	0,72 d

The results of the study [36] Fungi *Acremonium strictum* strain MJN1 able to increase root dry weight of rice plants for 34% of treatment without endophyte. Further research [37] stated endophyte Fungi *Curvularia* sp. strain NRRL 30 910 were able to increase the biomass of roots, stems, leaves at a temperature of 30 ˚ C - 45 ˚ C compared with plants without endophyte.

Description: the number that is bold is the largest result of the observation parameters. Figures written in the same letter on the same line show results that are not significantly different based on the DMRT test at a real 5% level.

Table 3 also shows that treatment without endophytes have highest root shoot ratio at 25% and 100% of FC while *Acremonium* sp treatment at 50% FC treatment. This indicates that the treatment of endophyte Fungi *Acremonium* sp. capable of being used in drought water conditions. The results of [38] suggest that under water shortage most of the assimilates obtained from photosynthetic sources will be distributed to plant roots so that plant roots can grow longer to meet water requirements.

4. Conclusion

from the results of research that has been done, it is found that the endophyte fungi *Curvularia* sp. able to increase the highest plant growth compared to other endophyte fungi treatments and without endophyte treatment in drought stress. the second of these studies can be seen that the endophyte fungi *Nigrospora* sp. can increase stomatal density, plant dry weight, root length and dry weight of plant roots are significantly different when compared with endophyte treatment in drought-stressed environments.

5. Constrain/limitation

Constraints in this study is to determine the amount of water dose given every day is done by weighing polybag every 3 days due to using the principle of gravimetry. limitation in this study is that this research only until the vegetative phase is expected later can be done until the generative phase to know the production of rice grain between endofit treatment compared with control treatment.

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