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### RESEARCH ARTICLE

## THE ROLE OF ARBUSCULAR MYCORRHIZAL FUNGY (SCLEROCYSTIS SP) AND LEVEL OF WATER SUPPLY TO PLANT GROWTH CITRONELLA GRASS (ANDROPOGON NARDUS L.) IN ULTISOL.

N. Herawati<sup>1</sup>, G. Rani, A. Armansyah and W. Warnita.

Department of Agrotechnology, Faculty of Agriculture, Andalas University, Padang, Indonesia.

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#### Abstract

Citronella grass (*Andropogon nardus* L.) is an essential oil producing plant from the Gramineae. The research was conducted at the Greenhouse, Faculty of Agriculture, Universitas Andalas, Padang, from October 2017 to January 2018. The research aimed to obtain the best interaction between FMA *Sclerocystis* sp. and the level of water given, to get the best effect of the *Sclerocystis* sp. FMA, and to get the best effect of the level of water supply for the growth and yield of citronella grass. The study was arranged in Factorial in a Completely Randomized Design (CRD) consisting of 2 factors. The first factor was giving of FMA which consisted of two levels, namely without FMA and *Sclerocystis* sp. FMA. The second factor was the level of water supply which consists of 100%, 75%, and 50% field capacity. Each treatment was repeated 3 times. Data were analyzed by analysis of variance if F-count was greater than F-table, followed by DNMRT test at 5% level. The results showed that there was an interaction between the giving of FMA *Sclerocystis* sp 85 grams and the level of the water supply of 50% field capacity to the growth and yield of citronella grass. The combination was able also to increase canopy dry weight and root canopy ratio. The giving of FMA *Sclerocystis* sp affects the growth and yield of citronella grass. Giving the water level capacity for 100%, 75%, and 50% field capacity did not affect the growth and yield of citronella grass.

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#### Introduction:-

Plant citronella (*Andropogon nardus* L.) is a plant essential oil as a raw material for the fragrance soap, disinfectant, perfume, increased octane fuel, cosmetics, pharmaceutical, and other industries. Citronella used botanical pesticide raw materials and revegetation of mined lands.

In world trade essential oil is known for two types, namely Sri Lanka (lenabatu) and Java types (mahapengiri). Mahapengiri type citronella is considered native to Indonesia because many are cultivated on the island of Java, in the area producing citronella essential oil of about 95%. Other areas that produce essential oils, namely North Sumatra and Aceh. In the province of West Sumatra, has not been widely cultivated crop. Sawahlunto and Solok area is an area of land cultivation citronella. Quality essential oils produced Mahapengiri type has met the Indonesian National Standard (SNI) 06-3953-1995 with a minimum of 35% sitronellal levels and minimum geraniol

**Corresponding Author:-Netti Herawati.**

Address:-Department of Agronomy, Faculty of Agriculture, Andalas University, Padang, Indonesia.

85% and does not contain any foreign substances [1] While essential oils contain high levels of type lenabatu citronellal geraniol 15% and 55-65%.

The yield of essential oil produced by the plant citronella cultivated on dry land can only produce essential oil yield of around 0.8-1.0%. This shows that the low yield results produced by the plant citronella essential oil yield compared with that produced by patchouli which is around 2 to 4.23% [2], and clove 8.6% [3]

Kardian [4] states citronella can grow in less fertile, even in the deserts, being able to adapt to their environment, and do not require special care. Ultisol is one kind of marginal land in Indonesia which has a wide distribution reach 45.794 million ha, or about 25% of the total land area of Indonesia daru [5]. According to BPS data [6], of the total dry land area located in Indonesia just 19,000 hectares, or approximately 0.012% planted by a citronella.

According to Prasetyo and Suriadikarta [7] Dry land has many limitations including high soil acidity, pH ranges from average <4.50, high Al saturation, deficiency of phosphorus (P) because they bind tightly to the aluminum (Al), poor content nutrient especially P, K, Ca and Mg, and low organic matter content. Another way to do and does not damage the environment in increasing the growth and yield in the cultivation of citronella is the provision of water and the use of fungi Mycorrhizal Fungi (AMF).

Type FMA will be different - different to infect the root system of each plant. According to Smith and Read [8] the suitability of the FMA with host plants starting with fungal spores response to root for their signals in the form of flavonoids from plant root exudates. If there is a match between the two it will form a symbiosis. One of the parameters to improve the success rate of symbiosis between the FMA with the host plant, namely the existence and development of the FMA indicated by the percentage of infected root [9]. Prayudyaningsih and Sari [10] adds that the symbiosis between mycorrhizae with plants can be detected by the AMF infection rate in the roots of plants. Sawas one among the types of FMA is *Sclerocystis* sp. FMA can also adapt to the environmental conditions that are less suitable for its growth, and the FMA can also be developed as a biological fertilizer to improve crop growth and yield. Besides the benefits of the FMA for plant growth and development as its host, is to increase the absorption of nutrients from the soil, as a biological barrier against pathogen infection roots, improving drought resistance and increase growth hormone boosters [11].

Limitations of water on plant growth environment will lead to supply shortages of water in the root zone. There are plants that are able to adapt drought stress and there are not depending on the type of plants. According to Anjum et al. [12] how to adapt plants to drought varies depending on the type of plant and the stage of plant development. The availability of water affects plant growth. Mycorrhiza is one kind of organism which enhances the absorption of water through the hyphae - hifanya. Mycorrhizal applications with extensive mycorrhizal jelalah penyerapan water will increase and improve plant growth including serh fragrant.

This research aims to get interaction is the best between the provision of FMA *Sclerocystis* sp and the level of provision of water on the growth and yield of citronella, gained influence FMA *Sclerocystis* sp best on the growth and yield of citronella and get the effect of the level of giving the best water on the growth and yield of citronella fragrant.

### **Materials and Methods:-**

This research was conducted in the Greenhouse, Faculty of Agriculture, University of Andalas Padang Limau Manis, in October 2017 to January 2018. The height of 250 m above sea level.

The materials used in this study are the seeds of plants citronella varieties G3, Ultisol, inoculant FMA *Sclerocystis* sp many as 100 spores in 85 grams of the form of a mixture of sand with plant roots, distilled water, 10% KOH, HCl 2%, and Trypan blue Of 0.05% (0.5 g Trypan blue in 450 mL of glycerol + 50 ml of HCl 1% + 500 ml of distilled water), While the tool used is a polybag size 35 x 25 x 30 cm, plastic bags, rubber, tape measure, a hoe, a standard pole 5 cm, analytical balance, weighing 10 kg, caliper, slide, cover glass, glass beaker, newsprint, paper labels, film canisters, buckets size 5 L, scissors, knife, stapler, tweezers, camera, water barrels, gallons, hygrometer, stationery.

The design used in this experiment was a factorial pattern in a completely randomized design (CRD), which consists of two factors with three replications. The first factor is the provision of mycorrhiza with two stage treatment that

tanpa FMA and FMA *Sclerocystis* sp. The second factor is the level of provision of water with three levels of treatment are: 100% field capacity (11.4 kg), 75% field capacity (11.1 kg), 50% field capacity (10.7 kg).

Altogether there are 18 units of trial and every one experimental unit, there are 6 plants for a total of 108 plants around the plant crop. The samples used were 5 plants / units taken at random experiment. Data were analyzed by ANOVA with F test at 5% level. If F count was significantly different treatment it will proceed with further test DNMR at 5% level. The data obtained is displayed in the form of tables and graphs.

Implementation of the experiment begins with the preparation of media. Growth media used in this study is an experimental garden Ultisol dryland agriculture faculty of Andalas University, Limau Manis, Padang. Land is taken from the upper soil to a depth of about 0-20 cm, then cleaned of root crops and weeds. After the wind dried for 1 week soil sieved with sieve 2 mess, then ground the oven with a temperature of 60 to 70°C which aims to sterilize the soil. Sterile soil already put into polybag size of 15 kg. Polybags filled with soil weighing 10 kg. Each polybags labeled in accordance with the treatment.

Citronella seedlings taken from the nursery Balitro Laiang Solok. All root crops that grow on stalks lemon grass is cut, then the leaf blade also cut about 5 cm from the stem, the book of stem disisakan of 5 books, which is above the guide rod is cut as high as 25 cm. The seedlings are then cleaned with water. AMF inoculum preparation *Sclerocystis* sp.

FMA *Sclerocystis* sp derived from the Laboratory of Plant Physiology, Faculty of Agriculture Department of Agriculture UNAND. FMA inoculant is used in the form of river sand, spores, hyphae and root pieces is the result of a single spore culture propagation. The amount of inoculant given depends on the density of spores per gram of inoculant. Each inoculant FMA has a density that is not the same, for the calculation that each spore inoculant have relatively the same, namely 100 spores per inoculant.

FMA *Sclerocystis* sp weighed 85 grams, is inserted into the planting hole at a depth of 5 cm, evenly distributed around the plant roots, the amount of inoculant given by standardizing the number of 100 spores. Then planted by entering the lemon grass stalks as deep as 5 cm into the planting hole. Thereafter covered with soil and compacted. Then doused with water until moist soil conditions.

Giving the pretreatment level water administration was conducted at 30 days after planting. The rate of water supplied is 100% KL KL KL 75% and 50%. Land used is weighing 10 kg, initial soil analysis to field capacity soil weighing 10 kg is 1.4 L, to the level of water provision KL 100% supplied water as much as 1.4 L, while 75% are given water KL 1.1 L and for KL 50%, ie by 0.7 L water conditions the planting medium is maintained in accordance with the state of treatment every day. The water used is sterile distilled water, it aims to minimize contamination of the FMA by other fungi from outside the treatment.

## Results and Discussion:-

### Plant height

The observation of citronella plant height after statistical analysis showed that the interaction between the FMA and the provision of water supply to the high level of citronella plant. Added citronella plant height is only affected by the provision of FMA. Data presented in Table 1.

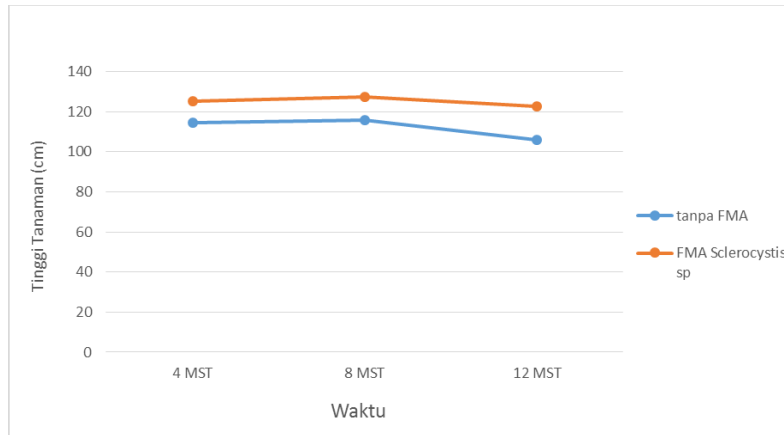
**Table 1:-**High Crop Marked Serai Wangi FMA and Provision of Water Levels Age 12 MST

Giving FMA	Giving Water Levels			Average
	100%	75%	50%	
	----- cm -----			
without FMA	114.33	115.67	105.83	111.94 b
<i>Sclerocystis</i> sp	125.33	127.17	126.67	125.05 a

CV = 6.17%

The figures in the same column followed by different small letters are significantly different according to DNMR test 5%.

In Table 2 it can be seen that the provision of FMA *Sclerocystis* sp produces a higher plant height is 125.05 cm higher than without the FMA, that is 111.94 cm. This indicates that the administration of the FMA can help the roots absorb nutrients from the soil through yarn - yarn hyphae that needs water and nutrients to the plant citronella met. According to Setiadi et al., [13] bermikoriza plants will grow better than plants without AMF. Furthermore Husin et al., [14] states the principle of work of the FMA is infecting the host plant root system, producing a tangle of hyphae intensively so that the plant containing the FMA will be able to increase capacity in the absorption of nutrients. This will increase the rate of vegetative growth of the plants, including plant height citronella. AMF colonization level on citronella obtained include high percentages by grade category FMA infection at the root by Mosse [15] which is the average ranged from 66.67 to 73.33. The number and level of spores inoculated colonization is a factor that affects the growth and development of the FMA as well as affect the relationship with the host plant. Differences in plant responses to AMF is closely connected with the infection rate. Inoculation of mycorrhizal spores were able to help the absorption of nutrients for plants, by creating networks of hyphae on the root which helps the roots absorb nutrients [16]. High growth citronella plant are affected by FMA administration and provision of water level can be seen at 1.



**Figure 1:** High Plant Serai Wangi on granting *Sclerocystis* sp FMA and FMA At Level Giving Without Water

Figure 1 shows a high growth rate of plants is highest in *Sclerocystis* sp FMA administration when compared with the treatment without AMF. This shows the difference in height growth citronella plant. Moreover, if viewed for the type Mahapengiri, plant height ranged from 111.94 cm - 127.17 cm are good to plant citronella. The result shows that the administration of FMA *Sclerocystis* sp able to affect the absorption of nutrients from the plant aged 4. This is due to the positive effects of AMF inoculation on plant growth. One effect of AMF colonization is increased uptake of P caused by FMA ability of the soil to absorb P translocated to the roots of the host plant [17]. According to Rengganis et al. [18] root development due to the FMA that heighten interception roots in the absorption of nutrients and water. The treatment level of provision of water to the plant height citronella was not statistically significantly different (Table 1). This is due to that the citronella plant is a plant tolerant to stress. Water absorption greater by plants bermikoriza also carries nutrients easily dissolved and carried away by the flow of time, such as N, K and S, so the absorption of nutrients through the mass flow, the absorption of P can be increased due to the hyphae FMA secrete an enzyme phosphatase capable of releasing P from the bonds of specific, so the element of P available to plants. According to Ketut et al., [19] that the citronella plant is a plant that can grow in extreme conditions such as nutrient-poor soils, alkaline soils, steep slopes and degraded forests.

#### Number Of Leaves

The observation of the amount of citronella leaves after statistical analysis shows that there is no interaction between the FMA to the level of the provision of water to the number citronella plant leaves. Increase the number of leaves of the plant citronella rely on handouts FMA, both at the level of the lowest water supply of 50%, 75% and as high as 100%. Data presented in Table 2.

**Table 2:-**Number of Leaves Given Serai Wangi plant FMA and Provision of Water Levels Age 12 MST

Giving FMA	Giving Water Levels			Average
	100%	75%	50%	
	-----sheet-----			
without FMA	14.83	13.17	11.17	13.05 b
<i>Sclerocystis</i> sp	18.17	18.50	18.50	18.39 a

CV = 8.90%

The figures in the same column followed by different small letters are significantly different according to DNMR 5%.

In Table 2 it can be seen that the provision of FMA *Sclerocystis* sp generate average number citronella plant leaves high of 18.39 cm, significantly different from those without the FMA is 13.05 cm. This is supported by statements Setiadi [20] establishes FMA intensively interwoven hyphae, which spread in the soil to absorb nutrients, especially phosphate in an unavailable becomes available. In addition, external hyphae FMA can also increase the uptake of other nutrients like N, K, Mg, Zn, Cu, B and Mo. absorption of nutrients for the plants, by creating networks of hyphae on the root which helps the roots menyerap nutrients [16]. The main role of mycorrhiza is the ability to increase the uptake of P [21].

Gardner [22], states that the increase of the number of leaves of the plant are influenced by genetic factors and environmental factors. The rate of increase in the number of leaves affected by the nutrient absorbed by plants. Nutrients in the plant serves as a basic ingredient in the formation of energy for cell division so that it can form a new leaf. Growth in the number of leaves is closely associated with plant height, which increased plant height without being followed by the increasing number of segments and books cause no increase in the number of leaves of the plant. Stems are composed of segments spanning between books stems where leaves attach. The number of books and a segment equal to the number of leaves, all three have the same origins.

### Number Of Puppies

The observation of the number of seedlings citronella after statistical analysis showed that the interaction between the FMA and the provision of water supply levels to the number of seedlings citronella. Number of seedlings citronella dominated by granting FMA is given, which showed significantly different results. Data are presented in Table 3.

**Table 3:-**Number of Puppies Given Serai Wangi plant FMA and Provision of Water Levels Age 12 MST

Giving FMA	Giving Water Levels			Average
	100%	75%	50%	
	-----rod-----			
without FMA	2.50	2,67	2.17	2.45 b
<i>Sclerocystis</i> sp	3.00	3.33	3.16	3.16 a

CV = 7.85%

The figures in the same column followed by different small letters are significantly different according to DNMR 5%.

In Table 3 shows that administration of FMA *Sclerocystis* sp produces an average number of tillers highest citronella rod 3.16, whereas the treatment without stem FMA is 2.45. Seen in the above table that the growth in the number of tillers with FMA treatment *Sclerocystis* giving a faster sp ranging from 3.00 cm - 3.33 cm, compared with no FMA. This indicates that the FMA *Sclerocystis* sp good symbiosis with the host plant. Because of their suitability *Sclerocystis* sp FMA with root exudates released by the plant roots citronella.

These results indicate that the type FMA has the potential to increase the number of seedlings than other types of FMA. FMA has the ability to suppress the loss of nutrients from the soil by increasing nutrient interception zone and prevent the loss of nutrients due to the washing process by water [23]. This suggests that the FMA *Sclerocystis* sp,

an FMA suitable for plant growth citronella, so the plant can absorb more nutrients that affect the growth number of tillers.

**Tajuk- Ratio Roots**

The observation of the canopy ratio citronella roots statistical analysis shows that there is interaction between the FMA and the level of treatment provision giving good water conditions water supply at the lowest level that is 50%, 75% and as high as 100%. Data presented in Table 4.

**Table 4:-**Ratio Heading Root Given Serai Wangi plant FMA and Provision of Water Levels Age 12 MST

Giving FMA	Giving Water Levels		
	100%	75%	50%
without FMA	Gram -----		
	1.81 b A	1,77 c B	1.87 a B
<i>Sclerocystis</i> sp	1.78 b B	1.97 a A	1.97 a A

CV = 1.07%

The numbers on the same line followed by the same lowercase letters and numbers in the same column followed by the same capital letter not significant according to DNMRT 5%.

In Table 4 shows that there is interaction between the FMA administration with some level of water supply to the plant roots canopy ratio of citronella. It can be seen that the average ratio of root headers by administering *Sclerocystis* sp FMA shows the ratio of root crop canopy highest field capacity 75% and 50%, ie 1.97 grams, and the lowest at 100% of field capacity, namely 1.78 grams, while different FMA real without showing the highest ratio of editorial roots at 50% of field capacity, namely 1.87 grams, and the lowest at 75% of field capacity is 1.77 grams.

At the level of water provision does not affect the growth of plant roots canopy ratio citronella. Added canopy ratio citronella plant roots ranged from 1.77 grams 1.97 grams. This is because the ratio of roots header is a parameter to determine the pattern of growth in plants assimilate distribution, the ratio root header depending on the species, age and environmental conditions [24].

The ratio of root canopy is an important factor in plant growth which reflects the ability of the absorption of nutrients and metabolic processes that occur in plants. The results show the root shoot dry weight of water and nutrient uptake by roots translocated into the plant canopy. Root header value ratio indicates how much of photosynthesis which accumulates in the plant parts. The result of more photosynthesis translocated to the header section of the goto the plant roots. In addition the ability of roots to absorb water and nutrients contribute to determine the growth and development of tanama.

Ultisol poor in nutrients and biological fertilizers applied mycorrhiza, without the provision of basic fertilizer assuming assist ratio roots header. According to Gardner et al. [22] the value of the ratio of the root editorial suggests that the resulting large canopy. However, the canopy and root growth can be run in a balanced manner, so that the value ratio can not determine the root taajuk optimum growth. Value ratio roots header intended to compare the distribution of growth between the canopy and the roots. This is in accordance with the opinion of Sitompul and Guritno [25] states that the same root has an important role with the title in plant growth, if the editorial role in the process of photosynthesis, the root function provides nutrients and water needed in the metabolism of plants. According to Budi et al [9] NPA high value due to the provision of mycorrhizal inoculum thus more photosynthetic area allocated to the shoots than in the roots. Spores of mycorrhizal inoculation effect on the uptake of P-canopy plant [26].

**The root colonization by AMF *Sclerocystis* sp**

Colonization percentage of observational data presented in the form of descriptive (Table 5). Table 5 below explains that the FMA are giving root infection, whereas no root infection does occur FMA root infection.

**Table 5:-**The root colonization by AMF on Serai Wangi Marked with FMA and Provision of Water Levels Age 12 MST.

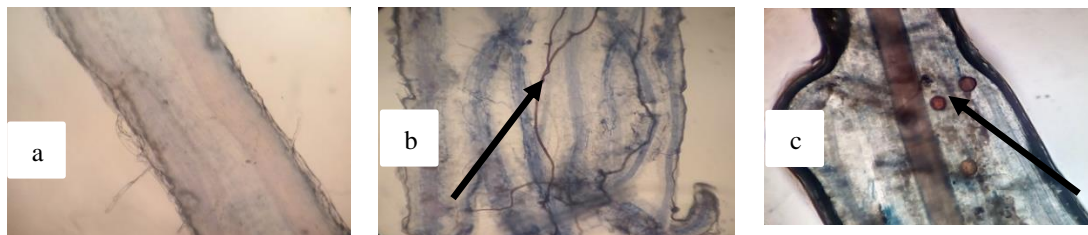
Giving	Giving Water Levels
--------	---------------------

FMA	100%	75%	50%
without FMA	----- % -----		
	0	0	0
<i>Sclerocystis</i> sp	60.00	66.67	70.00

In Table 5 shows that plants without FMA shows no signs are colonized with a percentage of 0% or criteria included low, while in treatment FMA *Sclerocystis* sp at different levels of the water supply shows the average percentage of colonization ranges from 60-70% or including high criteria. Criteria effectiveness degree mycorrhizal infection can be found in appendix 5.

From various levels of water provision, FMA *Sclerocystis* sp citronella infect plant roots that have the highest value in the TOS 50% showed an average of infected root *Sclerocystis* sp FMA as much as 70.00%. This indicates that the FMA more spores formed at the time of the occurrence of drought stress by forming external threads on rooting hyphae citronella.

Husin et al., [14] stated FMA developments are not so affected by soil moisture, however, are severely affected by soil water content is the growth and development of the host plant. The symbiosis between the FMA *Sclerocystis* sp plants help plant resistance to withstand keadaaan water stress, especially on dry land. Bermikoriza roots are able to take more water, to meet the needs of plants. besides the temperature also becomes one of the factors that determine the growth and development of the FMA. FMA to develop normally at a temperature of 350 C. The fungal infection increased with concomitant rise in temperature to a certain extent. FMA maximum infection occurs in suu *Sclerocystis* sp 300 - 330C.



**Figure 2:-**Infection citronella plant roots by FMA *Sclerocystis* sp.(a) uninfected roots (b) hyphae (c) vesicular

Roots infected by the FMA characterized by hyphae-hyphae, vesicular and arbuscular (Figure 4). Hyphae are the most important morphological structure of the FMA for their ability to enhance the plant's roots homerange internal inang.hifa is hyphae penetrate into the cortex from one cell to another, while the external hyphae occur if the internal hyphae grow from the cortex through the epidermis.According Suwarniati [27] that administration of mycorrhizal spores that help plants to meet nutritional needs, through hyphae were able to reach the nutrients that can not be reached by the roots of plants, so plants can grow adequate nutrient requirements.

Greater water uptake by plants bermikoriza also carry a soluble nutrients and carried away by the flow of time, such as N, K and S so as to improve the absorption of nutrients. Fungi also issued a phosphatase enzyme capable of releasing P from the bonds of specific so that it becomes available to plants.According to research Erona [28] states that the presence of the FMA inplant growth system affects the root morphology. The morphology of the plant roots is important to maximize the nutrient pernyerapan, because the root system with a ratio of surface area and a high volume will be more efficient crawl extensive planting medium volume.

Spore inoculation mycorrhizal root colonization were able to influence the case, the higher the mycorrhizal spores were inoculated, the higher the degree of association with mycorrhizal roots. According to Malini and Jais [29] that mycorrhizal able to assist in the improvement of plant nutrients by infecting the roots of plants and create networks of hyphae to reach the nutrient that is not covered by the plant, so that the nutrient needs will be fulfilled with the help of mycorrhizal.

Vesicular a fungal structures derived from internal hyphae swelling in the terminal and intercalary, mostly oval, and contain fatty compounds in large numbers so that a backup food storage organ. In certain circumstances vesicular act as spores that serves to maintain the life of mushrooms [30] Vesicular usually formed more outside of the cortex in areas that are old infections, and is formed after the formation of arbuscular. If the supply of the host plant decreases metabolic, food reserves that will be used by fungi so vesicular will degenerate. Not all the FMA to form vesicular in the host plant roots. While arbuscular is branching hyphae structures such as small trees in the cortex of the roots of the host.

### Conclusion:-

1. The interaction between the administration of 85 grams of the FMA *Sclerocystis* sp and the level of water giving 50% of Field Capacity on growth and yield is the dry weight of the canopy and canopy ratio citronella plant roots.
2. Giving FMA *Sclerocystis* sp affect the growth and yield of citronella.
3. Provision of water supply capacity of the Field level 100%, 75% and 50% had no effect on the growth and yield of citronella.

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