pastura Vol. 2 No. 1 : 41 - 48
ISSN : 2088-818X

EFFECT OF DROUGHT STRESS AND ADDITION OF ARBUSCULA MYCORRHIZAL FUNGI (AMF) ON GROWTH AND PRODUCTIVITY OF TROPICAL GRASSES (*Chloris gayana, Paspalum dilatatum,* and *Paspalum notatum*)

Pebriansyah A., Karti, P.D.M.H and Permana, A.T.

ABSTRACT

Grasses productivity is affected by soil water availability. Arbuscular Mycorrhizal Fungi (AMF) was innoculated to support plant to overcome drought stress during its growth. The aim of this study was to understand the role of Arbuscular Mycorrhizal Fungi (AMF) to support growth and the production of grasses in drought stress condition. Three species of tropical grasses : *Chloris gayana, Paspalum notatum,* and *Paspalum dilatatum* were used. The research used completely randomized design with 4 treatments consisting of M0S0 = without AMF and daily watering, M0S1 = without AMF and without watering; M1S0 = with mycorrhiza and daily watering; M1S1 = with AMF and without watering. and 5 replications. The four treatments research were as follows; Each type of grasses were obsereved in a separate study. The result showed that AMF played significant role in improving growth and root dry weight biomass of *Chloris gayana* in drought condition. *Paspalum notatum* is the most adaptive grass in the drought condition. Chloris gayana has the growth and a better production than *Paspalum dilatatum*.

Keywords : forage, Chloris gayana, Paspalum dilatatum, Paspalum notatum, Arbuscular Mycorrhizal Fungi (AMF), drought stress

PENGARUH CEKAMAN KEKERINGAN DAN PEMANFAATAN FUNGI MIKORIZA ARBUSKULA (FMA) TERHADAP PERTUMBUHAN DAN PRODUKTIVITAS RUMPUT TROPIK (*Chloris gayana, Paspalum dilatatum,* and *Paspalum notatum*)

ABSTRAK

Produktivitas rumput dipengaruhi oleh ketersediaan air tanah. Fungi mikoriza arbuskula (FMA) diinokulasikan pada tanaman untuk membantu mengatasi cekaman karena kekeringan sepanjang pertumbuhannya. Tujuan penelitian ini adalah untuk memahami peran FMA untuk mendukung pertumbuhan dan produksi rumput dalam kondisi tercekam karena kekeringan. Percobaan menggunakan tiga spesies rumput tropik: *Chloris gayana, Paspalum notatum,* dan *Paspalum dilatatum*. Rancangan Acak Lengkap dengan 4 perlakuan terdiri atas: M0S0 = tanpa FMA dan disiram setiap hari, M0S1 = tanpa FMA dan tanpa penyiraman; M1S0 = dengan FMA dan disiram setiap hari; M1S1 = dengan FMA dan tanpa penyiraman, percobaan diulang 5 kali. Setiap jenis rumput diamati dalam percobaan yang terpisah. Hasil penelitian menunjukkan bahwa FMA memegang peranan penting dalam meningkatkan pertumbuhan, berat kering akar dan pupus *Chloris gayana* dalam kondisi tercekam. Pertumbuhan dan produksi rumput *Chloris gayana* lebih tinggi daripada *Paspalum dilatatum*. *Paspalum notatum* adalah rumput tropik yang paling tahan terhadap cekaman akibat kekeringan.

Kata kunci: Chloris gayana, Paspalum dilatatum, Paspalum notatum, fungi mikoriza arbuskula (FMA), cekaman kekeringan.

INTRODUCTION

The livestock sector development can not be separated from the provision of high quality forage and forage sustainable. More than 60% of feed consumed by ruminants is a forage, either in fresh or in dried form. Green fodder can be grasses, legumes or other types of leaves. The types of forage can be administered alone or mixed with grass or legume be given only in the form of grass.

The forage is one source of forage for grazing and appropriate use as forage cut because of its ability to regrow after the cutting or grazing. Tropical grasses consisting of *Chloris gayana, Paspalum dilatatum* and *Paspalum notatum* is a grass that is tolerant to drought stress (Nahak, 2011). In addition to maintain grass growth through continuous vegetative regrowth after harvest. At this time the availability of grass can not be seen to meet the needs of the quantity and quality. Availability of feed grass that is still lacking is mainly influenced by soil conditions, climate and water availability.

Water is needed for plant growth in large numbers. Availability of water in the soil is largely determined by the frequency and distribution of rainfall affects the state of ground water and nutrient supply. Water shortage is one of the main problems for the growth and development of a plant. Shortage of water internally at the plant resulted in a decrease direct and magnification of cell division. In the vegetative growth stage, the

ISSN 2088-818X

water used by plants for cell division and enlargement manifested in the increase in plant height, diameter magnification, multiplication leaf, and root growth (Sasli, 2004).

At this time in Indonesia forage crops can be developed on the dry soil conditions. Haryadi and Yahya (1988) describes drought stress in plants can be caused by two things: (1) lack of water in the root zone, (2) the rate of evapotranspiration is higher than the rate of water absorption by roots of plants that need high water on the leaves. Plants experiencing drought stress are stunted, due to the availability of water in plants and soil affect soil nutrient uptake by plant roots.

One of alternative that can be applied to several types of plants cultivated in water stress is overcome by the use arbuskula mycorrhizal Fungi (AMF) on the plant. The symbiosis between AMF and its host plant is a symbiotic mutualism (mutually beneficial). This symbiosis involves the provision of fotosintat by the host for the fungus and host plant otherwise acquire nutrients and water from the ground taken by the AMF.

On this association did not lead to infection of the roots of disease. Karti (2005) explains that the role of AMF addition to improving nutritional status of plants, may also increase drought resistance. Rungkat (2009) explains that the mycorrhizal plants usually grow better than plants that do not mycorrhizal. Mycorrhizae have a role for growth and crop production, namely: a) increase the absorption of nutrients, b) protect host plants from the damaging effects caused by drought stress, c) be able to adapt quickly to the contaminated soil, d) can protect plants from root pathogens e) can improve the productivity of the soil and stabilize soil structure of the soil. In the tropical grass plants on the growth of mycorrhizal influence is also quite good. Objective of the present study was to know the effects of drought and the addition of AMF on growth and productivity arbuscula some tropical grasses *Chloris Gayana, Paspalum dilatatum* and *Paspalum notatum*.

MATERIALS AND METHODS

Location and Time Studies

The research was conducted at the Faculty of Animal Sciences Greenhouse Agrostologi IPB, Agrostologi Laboratory, Laboratory of Dairy Cattle Nutrition, Faculty of Animal Science, Bogor Agricultural University. Implementation of the study began in July 2010 to July 2011.

The material

Materials used in this study include: Pols *Chloris gayana, Paspalum notatum*, *Paspalum dilatatum*, Latosol soil, and NPK fertilizer KCl, and FMA laboratories obtained from the Forest and Environmental Biotechnology Research Center of Biological Resources LPPM IPB. Equipment used scales, pots, watering tools, pieces of stone, plastic, shovel soil, brown envelopes, scissors, solatip, ruler and oven.

Procedure

Preparation of the type of grass

Three types of grass that is, *Chlorisgayana*, *Paspalum notatum, Paspalum dilatatum*, each 20 pols.

Media Preparation and Planting

As a growing media used Latosol soils from areas Darmaga by taking the upper soil layer at a depth of 0-20 cm. The land is mixed with manure evenly with comparison 9:1 (v / v), which is as much as 4.5 kg of soil and manure as much as 0.5 kg.

Cultivation

Grass grown in pots capacity of 5 kg soil, each pot were planted four individuals POLS grass. Before planting the treatment given by the addition of FMA as much as 20 grams each plant pot (pot that gets to the addition of mycorrhizal). Plants were grown for one month in advance before getting the watering treatment. After growing well, it can begin treatment is to be watered and not watered. Doses of NPK fertilizer after the plants grow for a month is 3 grams each plants pot.

Drought treatment

Before the drought treatment began, all the pots to get the same treatment that is watered once a day. Then the pots were plastic mulch formed spherical with a diameter of ± 35 cm to cover the surface of the pot. In the not watered treatment (S1) taped plastic mulch around the pots watered while on treatment (S0) is a gap that is taped to facilitate the process of watering. Treatment began on the next day and counted as H0. In the S0 treatment watering pot every morning while the S1 treatment is not done watering until the plants die and this means that the treatment is stopped and then harvesting.

Maintenance

Maintenance includes watering plants, cleaning of weeds and the eradication of pests and diseases. Watering is done once a day in the morning. Cleaning weeds is done manually by pulling the weeds. Pest spraying done when the plants exposed to pests. Spraying pesticides made from organic materials, namely direct contact with the working system of the pests that attack the grass so it does not leave a residue that can affect the plants during the study.

Harvest

Harvesting is done after all the treatment plants are not watered (S1) in a state of permanent wilting point. Then all the crops are harvested in all treatments to obtain the crown and root dry weight and it will be roasted.

Observation

Observations were made every four days by measuring the vertical height increment of plants and soil sampling to measure soil moisture content.

Design and Analysis of Data

Experimental design

This research used Completely Randomized Design (CRD) comprised 5 treatments with 4 replicates. Type of grass used, namely *Paspalum notatum, Paspalum dilatatum, Chloris gayana*. Each type of grass do research separately.

The treatment used in this study include:

M0S0 = without mycorrhiza and watered every day
M0S1 = without mycorrhiza and not watered
M1S0 = with mycorrhizal and watered every day
M1S1 = with mycorrhizal and not watered

Model

Statistical model used is as follows:

$Yij = \mu + + \rho i \ \varepsilon ij$

Description:

i = 1, 2, 3, 4
j = 1, 2, 3, 4
Yij = The observations of the ith treatment and jth test
m= the average value of common
ρi = Effect of i-th treatment
εij = Effect of error

Observed variables

Variables observed in this study are: plant height, number of tillers, soil water content, root infection, dry weight of the canopy, the dry weight of roots, drought sensitivity index.

Higher Plants: Measurement of the vertical height increment of the crop plant starts above ground level until the end of the plant by using the measuring tape.

Vertical height increment of plants = Tt - T0

Description:

T0 = initial vertical plant height (cm)
Tt = the end of the vertical height of plant (cm)

Increase in plant height was measured by straightening the leaves, then measure from the ground up to the longest leaf.

Number of Puppies: Puppies calculated if there are leaves that open perfectly on every kind of grass.

The water content of soil: soil samples were taken as much as 5 g in each plant pot and then put in oven 105 ⁰ C for 24 hours. Afterwards Weigh samples after oven. Water content obtained from the weight of the sample before it is inserted into the oven after the oven is reduced sample weight divided by weight of the sample after oven then multiplied by 100%.

Description:

W0 = weight of soil samples before oven
Wt = weight of soil samples after oven

Infection Roots: The number of infections measured by the percentage of roots infected by the hyphae. To calculate the number of roots infected with AMF first performed root staining technique developed by Phyllip and Hayman (1970). Performed by staining the roots of the roots are washed and cut into pieces and put in a tube, then added 10% KOH solution and the tube closed. After 24 hours of KOH was removed and replaced with new ones and then allowed to stand for 24 hours. The roots were washed and filtered with a filter and then cut into pieces 5 cm long, inserted into the tube and left for 24 hours after the addition of 2% HCl solution. The solution was replaced with a destaining solution left for 24 hours and stored in film canisters.

To calculate the infection of roots, cut roots with a length of 1 cm was taken as many as 10 pieces, then placed in a glass preparations and covered with a cover glass. In order not to shake given PVLG, if not, can be calculated, the infected roots can be stored in the refrigerator. The percentage of infected roots can be viewed using a stereo microscope with the following formula:

Steem and Root Dry Weight: Measurement of the canopy and root dry weight at the end of the experiment, for the purposes of the crown and roots by oven at 70⁰ C for 48 hours, after which the rod was weighed. Canopy and root dry weight gained expressed in units of grams / pot.

Drought Sensitivity Index: Tolerance of grass plants to drought stress assessed by drought sensitivity index (S) by the formula (Fischer and Maurer, 1978): S = (1-Y/Yp) / (1-X/Xp), Y = value grass species in response to drought stress treatment (S1), Yp = the average response of four types of grass in drought stress treatment (S1), X = the value of the response to the treatment of a type of grass watered every day (S0), Xp = the average response average of four types of grass in the treatment watered every day (S0). Variables of each grass species classified into tolerant (T) if the ISK 0.5; somewhat tolerant (AT) if 0.5 <ISK 1.0, and sensitive (P) to drought stress if UTI> 1.0. After determining the level of tolerance, then performed the scoring of the level of tolerance to the rule as follows: P = a score of 0, AT = 1 and T score = score 2. The results of the scoring calculation is then multiplied by the scoring of the day with the rules: H24 = score 1, score 2 = H32, and H44 = score of 3.

Data Analysis

Data obtained from various studies were analyzed using analysis (Analysis of Variance, ANOVA) and if there is a difference followed by Duncan's multiple comparison test (SAS Program 9.1).

RESULTS AND DISCUSSION

General Observations Research

In this study several types of grass plants is observed Paspalum notatum, Paspalum dilatatum, Chloris Gayana, and planted with seedlings / POLS. Plants grow well in the early growth before getting treatment because they still get the same treatment that is watered every day, it is intended that the plants grow up in conditions that are ready to be drought stress treatment.

The observations on the plant was stopped when the plants get drought stress treatment has undergone a permanent wilting point caused by drought stress is characterized by the occurrence of withering in the leaves (yellow leaves) and then fall off, then followed by a decay in the trunk. Condition of permanent wilting point, namely the condition of the soil water content

ISSN 2088-818X

where the roots of plants begin to no longer able to absorb water from the soil so the plants have withered in the sense of permanent re-refractory despite adequate amounts of water added. In plants that have *Chloris Gayana*treatment permanentwilting drought stress experienced by day-32 whereas in *Paspalum notatum plants,* and *Paspalum dilatatum* suffered permanent wilt on day-44 and to-24. Plants have a permanent wilt was different, can be seen in Table 1.

Table 1. Permanent wilt each grasses

Grasess Variety	Permanent wilt (Days on)-
Paspalum dilatatum	24
Chloris gayana	32
Paspalum notatum	44

Description: Every type of grass do a separate study.

Based on the observations indicate a permanent wilt *Paspalum notatum* plants had a longer drought than other grasses. State of the greenhouse temperature during the study ranged between 23° C-33° C. On the morning of the greenhouse temperature ranged between 23° C-27° C, with an average temperature of 25° C. In this time greenhouse temperatures ranged from 29° C-35° C, with an average temperature of 33° C, while in the afternoon greenhouse temperatures ranged from 25° C-30° C, with an average temperature of 26° C.

Effect of Treatment of Groundwater Levels

Soil moisture content describes the amount of available water is absorbed by plants for growth to an extent where the water becomes available and the plants have withered. Average percent soil moisture content of the grass *Paspalum notatum, Paspalum dilatatum, and Chloris Gayana* can be seen in Table 5. Average soil moisture content data in Table 5 is the soil water content data at the time of harvest, meaning that the soil moisture data are the data treatment of soil moisture content at permanent wilting point conditions M1S1 and M0S1 treatment.

Based on the results of variance treatment gave a significant influence (P <0.01) on soil water content in the grass *Paspalum notatum, Paspalum dilatatum,* and *Chloris Gayana* Effect of treatment of the average percent soil moisture content can be seen in Table 2.

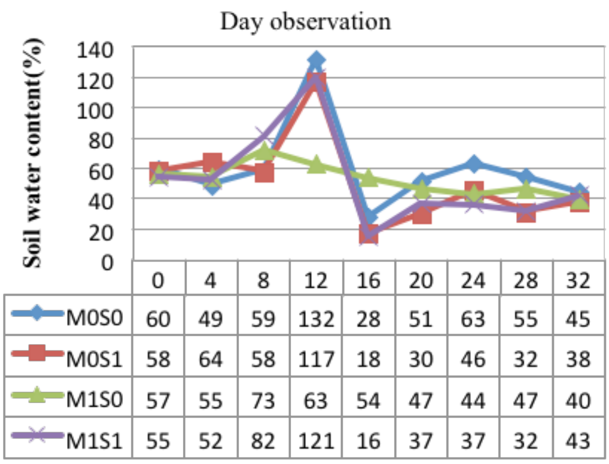


Figure 1. Effect of Soil Moisture Treatment of Plants *Chloris Gayana*: M0S0 = no mycorrhizal and watered every day; M0S1 = without mycorrhizal and not watered. M1S0 = with mycorrhizal and watered every day; M1S1 = with mycorrhizal and not watered

Table 2. Effect of Treatment of Soil moisture means Persentage Soil moisture (%)

Treatment	*Chloris gayana*	*Paspalum notatum*	*Paspalum dilatatum*
M_0S_0	36,0±8.0^{A}	66.9±2.5^{A}	38.1±15,2^{A}
M_0S_1	27,9±5.0^{C}	26.2±1.1^{C}	10.4±4.3^{C}
M_1S_0	39,9±8.1^{A}	65.3±3.8^{A}	42.4±8.0^{A}
M_1S_1	27,2±10.5^{B}	32.5±4.7^{B}	27.7±6.6^{B}

Description: Different letters in the same column indicate significantly different effect(P0, 01). M0S0: Without mycorrhizal and watered every day; M0S1: Without mycorrhizal and flushing; M1S0: The mycorrhizae and watered every day; M1S1: With the mycorrhizal and not watered. Different plant conducted a separate study.

Based on the results of variance treatment gave a significant influence on soil water content (P <0.01) on grass *Chloris gayana, Paspalum notatum, Paspalum dilatatum*. The highest value of the average percent soil moisture content on the treatment indicated by the treatment of M0S0 and M1S0 on Chloris Gayana (36.0% and 39.9%), Paspalum notatum (66.9% and 65.3%), and Paspalum dilatatum (38, 1% and 42.4%), this suggests that the sprinkling of water every day at the grass plant can increase the water content in the soil. In addition, in Table 5 shows that the treatment of M1S1 and M1S0 treated has less water availability when compared with treatment of M0S1 and M0S0, this proves that the administration of mycorrhizae in grass crops would make the plant more effectively in the absorption of water from the soil by plant roots that have been infected by the mycorrhizal so that less water is available. Evapotranspiration effect on soil water availability, evapotranspiration is a combination of evaporation from the soil surface and transpiration of plants through the roots of plants evaporates into the atmosphere to the leaf stem (BMG, 2006). According Djondronegoro *et al*., (1989), crop production is strongly influenced by the availability of such water comes from rainfall.

Treatment effect on soil water content of plants *Chloris gayana*, M0S0 treatment gives the highest value of soil water content on day 12, whereas treatment M1S0 provide the highest value on day 16 to day 20 (Figure 1), this suggests that the increasing influence of mycorrhizal soil water content after a few days on infected plants.

The treatment effect on *Paspalum dilatatum* plants to soil water content on the treatment observation showed the highest value on day 12, whereas the lowest treatment occurred on day 24 at M0S0, M0S1, M1S0, and M1S1 (Figure 2), it indicates that the response levels the highest water Paspalum dilatatum plants occurred on day 12 and the lowest water levels near the permanent wilting point.

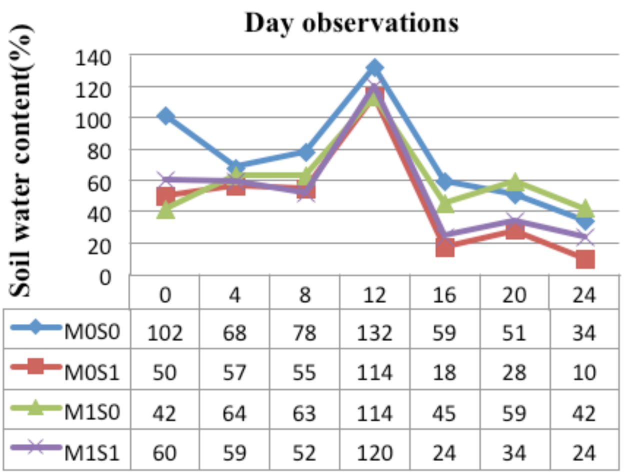


Figure 2. Effect of Soil Moisture Treatment of Paspalum dilatatum plants Description: M0S0 = no mycorrhiza and watered every day; M0S1 = without mycorrhizal and not watered. M1S0 = with mycorrhizal and watered every day; M1S1 = with mycorrhizaland not watered.

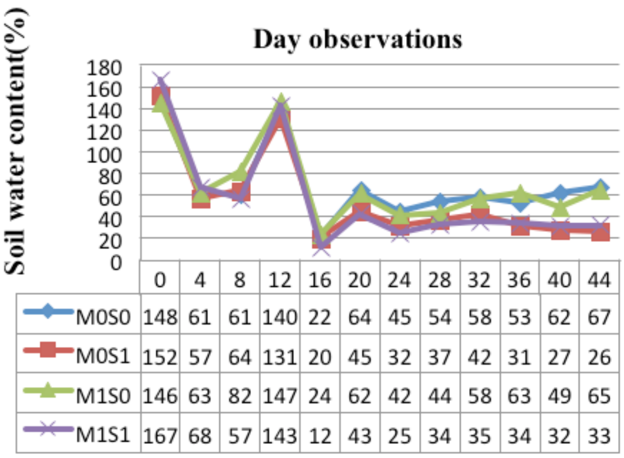


Figure 3. Effect of Soil Moisture Treatment of Paspalum notatum Crop-Description: M0S0 = no mycorrhiza and watered every day; M0S1 = without mycorrhizal and not watered. M1S0 = with mycorrhizal and watered every day; M1S1 = with mycorrhizal and not watered

Effect of Treatment on High Added Vertical Plants

Growth is a process in size can not return to the origin (irreversible) which includes the volume and mass accretion. One of the growth parameters are commonly observed in plant height, with a high accretion know it can be seen growing plants. Effect of treatment of high average vertical accretion of plants can be seen in Table 3.

Table 3. Effect of Treatment of Vertical Mean High Added Plants

Treatments	Average height of plants (cm)		
	Chlorisgayana	*Paspalumnotatum*	*Paspalumdilatatum*
M_0S_0	17,6 ± 1,7^{A}	68,5 ± 6,4^{AB}	97,63 ± 8,18^{AB}
M_0S_1	16,1 ± 0,9^{A}	69,7 ± 5,4^{A}	94,90 ± 5,98^{AB}
M_1S_0	17,6 ± 3,3^{A}	61,0 ± 5,7^{B}	101,40 ± 3,39^{A}
M_1S_1	14,3 ± 1,2^{B}	67,5 ± 5,8^{AB}	88,43 ± 4,65^{B}

Description: Different letters in the same column indicate significantly different effects(P0, 01). M0S0: Without mycorrhizal and watered every day; M0S1: Without mycorrhizal and flushing; M1S0: The mycorrhizae and watered every day; M1S1: With the mycorrhizal and not watered. Different plant conducted a separate study.

The results of measurements of the average height of plants in each treatment showed different results on each plant (Figure 1, 2, and 3). Based on the results of variance treatment gave a significant influence on plant height (P <0.01) on grass *Chloris gayana*, *Paspalum dilatatum, Paspalum notatum*. The largest value of average height to the treatment plant is shown by the successive treatment of M1S0 (101.40 cm) in Paspalum dilatatum and treatment M1S0 (61.0 cm) in *Paspalum notatum* and M0S0 (17.6 cm) in *Chloris Gayana*, this suggests that administration of mycorrhizal and sprinkling water on the grass every day can increase plant height.

Table 3 shows that the provision of *Paspalum dilatatum* better respond to the treatment of plant height when compared with the grass Paspalum notatum *Chloris Gayana* and although the average height of grass *Chloris gayana* lower than both. *Chloris gayana* have a greater height when compared with other grass (*Paspalum notatum* and *Paspalum dilatatum*) This is because *Chloris gayana* a grass Chloris berstolon and grow upright. (Mcllroy, 1977).

Karti (2005) explains that a decline in the rate of vertical height of plants due to lower soil water content and vice versa which is an increase in the high accretion verikal plants on soil water content of 85% of field capacity. Thus, plant growth particularly plant height is strongly influenced by the availability of water in the soil.

Mapegau (2006) states that plant growth is strongly influenced by water stress conditions, the plant will decrease the high increase in water stress conditions. In addition, the average height of plants treated mycorrhizal administration (M1S0 and M1S1) on the grass Paspalum dilatatum plants have higher average better when compared with treatment without giving mycorrhizal (M0S0 and M0S1), this proves that the administration can help the growth of high mycorrhizal plant.

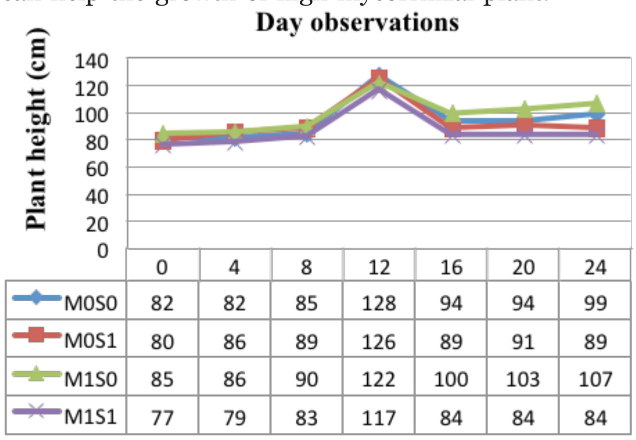
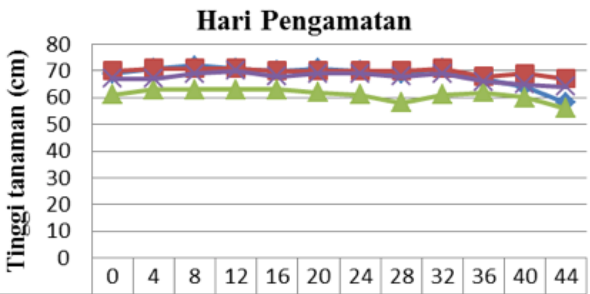


Figure 4. Effect of Treatment of High Crop Paspalum dilatatum. Description: M0S0 = no mycorrhiza and disiriam every day; M0S1 = without mycorrhizal and not watered. M1S0 = with mycorrhizal and watered every day; M1S1 = with mycorrhizal and not watered.

ISSN 2088-818X



	0	4	8	12	16	20	24	28	32	36	40	44
M0S0	69	71	72	71	70	71	70	69	71	67	64	58
M0S1	70	71	71	71	70	70	70	70	71	68	69	67
M1S0	61	63	63	63	63	62	61	58	61	62	60	56
M1S1	67	67	69	70	68	69	69	68	69	66	65	64

Figure 5. Effect of Treatment of High Crop Paspalum notatum. Description: M0S0 = no mycorrhiza and watered every day; M0S1 = without mycorrhizal and not watered. M1S0 = with mycorrhizal and watered every day; M1S1 = with mycorrhizal and not watered

Sasli (2004) explains that mycorrhizae may help the absorption of nutrients from the soil so that the process of plant growth particularly plant height can run optimally.

Table 4. Effect of Treatment on Number of Pols

Treatment	The Amount of pols		
	Chloris gayana	*Paspalum notatum*	*Paspalum dilatatum*
M_0S_0	21,4±6,1^A	13,8±6,4^A	18,2±5,5^A
M_0S_1	2,4±2,3^B	1,6±1.7^C	4,0±1,2^B
M_1S_0	20,8±2,8^A	16,0±6,8^A	14,6±3,5^A
M_1S_1	2.2±2,7^B	3,6±2,3^B	6,4±0,9^B

Describe: Different letters in the same column indicate significantly different effects(P0, 01). M1S0: The mycorrhizae and watered every day; M1S1: With the mycorrhizal and not watered; M0S0: Without mycorrhizal and watered every day; M0S1: Without mycorrhizal and not watered. Different plant conducted a separate study

The number of seedlings of plants describe the growth rate in each type of grass that is computed if there are leaves completely open, Based on the results of variance treatment gave a significant influence on soil water content (P <0.01) on grass *Chloris gayana, Paspalum notatum, Paspalum dilatatum* the highest average number of seedlings to the treatments indicated by the treatment of M0S0 and M1S0 on *Chloris Gayana* (21.4 and 20.8), *Paspalum notatum* (13.8 and 16.0) and *Paspalum dilatatum* (18.2 and 14.6), this suggests that the sprinkling of water every day at the grass plant can increase the number of suckers on each type of grass. In addition, in Table 4 can be seen that the treatment of M1S1 and M1S0 treated average number of chicks that have more than M0S1 and M0S0 treatment, especially at the grass Paspalum notatum. The number of chicks is influenced by the ability of plants to absorb nutrients from the soil. Mycorrhizal infection can improve phosphorus uptake and plant growth (Mosse, 1981).

Effect of Treatment of editorial and Root Dry Weight

Dry matter production is a very important variable to predict potential production plant and used as a guideline to determine the level of growth and development of plants (Salisbury and Ross, 1995).

Table 6. Effect of treatment on shoot and root dry weight.

Treatment	Shoot dry weight (gram/pot)		
	Chlorisgayana	*Paspalumnotatum*	*Paspalumdilatatum*
M_0S_0	34,5 ± 9,3^A	34,1 ± 7,2^A	24,3 ± 6,5^A
M_0S_1	12,5 ± 3,7^B	8,2 ± 12,9^B	15,2 ± 0,7^B
M_1S_0	40,1 ±9,0^A	29,4 ±15,1^A	22,5 ±3,4^A
M_1S_1	8,9 ±3,5^B	12,1 ±5,6^B	12,4 ±5,2^B
	Root dry weight (gram/pot)		
Treatment	*Chlorisgayana*	*Paspalumnotatum*	*Paspalumdilatatum*
M_0S_0	1,9 ± 1,0^B	6,0 ± 1,2^A	2,2 ± 1,1^A
M_0S_1	1,0 ± 0,2^C	2,3 ± 0,4^B	2,0 ± 0,2^A
M_1S_0	3,7 ±0,7^A	4,9 ±2,3^A	2,2 ±1,0^A
M_1S_1	0,9 ±0,5^C	2,9 ±0,4^B	1,9 ±1,1^A

Describe: Different letters in the same column indicate significantly different effects(P0, 01). M1S0: The mycorrhizae and watered every day; M1S1: With the mycorrhizal and not watered; M0S0: Without mycorrhizal and watered every day; M0S1: Without mycorrhizal and not watered. Different plant conducted a separate study

Dry weight of steam

The value of the dry weight of grass *Chloris gayana* canopy, *Paspalum notatum, Paspalum dilatatum* and can be seen in Table 6. Based on the results of variance treatment gave a significant influence on the dry weight of the canopy (P <0.01) on grass *Chloris gayana, Paspalum notatum*, and *Paspalum dilatatum*. The largest value of the average dry weight of the canopy to the treatment shown by treatment of the grass *Chloris Gayana* M1S0 (40.1 grams), *Paspalum notatum*, (29.4 grams) and *Paspalum dilatatum* (22.5 grams). This suggests that administration of mycorrhizal and sprinkling water on the grass every day can increase the dry weight of the canopy. The results (Table 6) showed that drought stress can reduce the dry weight of the canopy so that plant growth can be said to be decreased in the presence of drought stress in plants.

Mapegau (2006) explain that growth of the plants are very sensitive to water deficit because it deals with the loss of turgor and turgiditas can stop the division and cell enlargement resulting in a smaller plant. In addition, this will also affect the production of these plants.

In Table 6, giving the *Chloris Gayana* mycorrhizae can increase the plant dry weight. This suggests that administration of mycorrhizae can increase the dry weight of the canopy. According Rungkat (2009) mycorrhizae can enhance the absorption of nutrients in the infected plants, so that growth and crop production can be increased.

Dry weight of roots

Dry weight of grass roots *Chloris gayana, Paspalum notatum, Paspalum dilatatum* and can be seen in Table 6. Based on the results of variance treatment gave a significant influence on root dry weight (P <0.01) grass of *Chloris gayana, Paspalum notatum*, and *Paspalum dilatatum* to the dry weight of roots. The largest value of the average dry weight of roots to the treatment shown by treatment of the grass *Paspalum notatum* M1S0 (4.9 grams), *Chloris Gayana* (3.7 grams) and

Paspalum dilatatum (2.2 grams). These results indicate that administration of mycorrhizal and watering every day can increase the dry weight at the grass roots.

The results showed that the treatment given the dry weight of mycorrhizal roots will have a greater when compared to the dry weight of mycorrhizal roots without given (Table 6). This is supported by research conducted by the President and Yahya (2003), an increase in root dry weight of legume cover crops on soil (*Calopogonium mucunoides, Calopogonium ceurelieum, Centrosema pubescens* and *Pueraria javanica*) given mycorrhizae. According Sasli (2004) Direct role of mycorrhizal roots is helpful in improving the absorption of water from the soil into the roots, because it can expand the surface of mycorrhizal roots in water uptake from the soil. Water is absorbed from the soil to be used by plants for cell division and enlargement, one of which manifested in the growth of roots, namely the increasing degree of branching and root diameter.

In Table 6, it can be seen that the roots will dry weight decreased in drought stress conditions. According Sasli (2004) the lack of water internally at the plant resulted in a decrease direct cell division and enlargement. This has led to a decrease in root dry weight due to water stress. Sasli (2004) plants growing in drought conditions would reduce the number of stomata, thereby reducing the rate of water loss. Stomata closure will lead to net CO_2 uptake in leaves was reduced in parallel (simultaneously) during the drought. Impact, the carbon assimilation process disrupted as a result of low availability of CO_2 in chloroplasts because water stress that caused the closing of the stomata so that the rate of photosynthesis is inhibited and the formation of carbohydrates will decrease. This results in decreased dry weight of roots, stems and leaves on the plant.

Effect of Treatment of Infection Percent Root Mean

The main role is to provide mycorrhizal phosphorus for plant roots are exposed to infection, because phosphorus is an element that is not a car in the soil. (Turk *et al*, 2006). In Table 7, the average percent root infection was highest in the grass *Paspalum dilatatum* M1S1 shown by the treatment (73.4%) and lowest M0S0 shown by the treatment (9.6%). The grasses of *Chloris gayana, Paspalum notatum, Paspalum dilatatum* and the highest average percent root infection demonstrated by treatment M1S1 (60.2%, 68.8% and 73.4%), while the lowest average percent infection at the grass roots of *Chloris gayana* and*Paspalum dilatatum* M0S1 shown by the treatment (9.8% and 10.6%) while in the grass Paspalum notatum M0S1 shown by the treatment (14.8%). These results indicate that, overall, the grass plants are getting treatment M1S0 and M1S1 expected increase in the average percent root infection compared with treatment of M0S0 and M0S1. This indicates that the available soil water conditions and the conditions of drought stress inoculation (delivery) will increase mycorrhizal infection in plant roots by mycorrhiza, with the percent root infection different in each type of grass plants.

Table 7. Effect of Treatment of Infection Percent Root Mean

Treatment	Root infection percentage (%)		
	Chloris gayana	Paspalum notatum	Paspalum dilatatum
M_0S_0	14,8 ± 6,83^B	20,4 ± 8,7^C	9,6 ± 2,9^B
M_0S_1	9,8± 4,66^B	14,8 ± 2,4^C	10,6± 2,3^B
M_1S_0	51 ± 13,11^A	53,2± 16,3^B	68,4 ± 3,6^A
M_1S_1	60,2 ± 17,25^A	68,8± 9,7^A	73,4 ± 10^A

Note: Different letters in the same column indicate significantly different effects(P0, 01). M0S0: Without mycorrhizal and watered every day; M0S1: Without mycorrhizal anflushing; M1S0: The mycorrhizae and watered every day; M1S1: With the mycorrhizal andnot watered. Different plant conducted a separate study.

Setiadi (1999) explains that the diversity values reflect differences in the intensity of root infection at the root of each symbiosis that occurs. The intensity of infection is influenced by factors such as host susceptibility to infection, climate, and soil. Differences in the amount of carbon compounds provided by the host plant is also a root cause of the infection rate different at each plant. In addition, Delvian (2006) explains that there are several factors that influence the formation of mycorrhizae in the soil, the soil phosphorus status, soil acidity (pH), salinity, temperature and humidity.

Mycorrhizae can absorb and remove phosphorus (P) from the soil into plant roots (Rungkat, 2009). Turk et al. (2006) says that the main role is to provide mycorrhizal phosphorus for plant roots are exposed to infection, because phosphorus is an element that is not a car in the soil. In addition to phosphorus, mycorrhizae are also able to absorb some nutrients such as Nitrogen (N), potassium (K), Magnesium (Mg), zinc (Zn), Copper (Cu), calcium (Ca), iron (Fe), Cadmium, Nickel and Uranium. Therefore, the observation of the number of mycorrhizal infection in plant roots is one way to determine the ability of plants to absorb nutrients needed by the host plants. The higher the level of mycorrhizal infection in plant roots, the more benefits to be derived from plants are mycorrhizal infection.

Sensitivity to drought stress index

Calculation of sensitivity to drought stress index is used to obtain the level of plant tolerance to drought stress grasses. Index of sensitivity to drought stress in grass each variable is calculated based on soil moisture content, higher vertical accretion of plants, canopy dry weight, dry weight of roots and root infection. Value index of sensitivity to drought of each grass can be seen in Table 8.

Table 8. Sensitivity to drought stress

Variables	Grasees		
	Chloris gayana	*Paspalum notatum*	*Paspalum dilatatum*
KAT	T	T	T
PTVT	P	T	P
BKT	P	T	AT
BKA	AT	T	T
IA	T	AT	AT
Nilai ISK	5	9	6
Nilai Hari	2	3	1`
Total Nilai	10	27	6

Description: sensitivity to drought stress index is calculated based on the variables of Ground Water Levels (KAT), High Added Vertical Plants (PTVT), Heavy Dry Feature (BKT), root dry weight (BKA) and root infection (IA). T = tolerant if the value of IS ≤ 0.5, AT = somewhat tolerant if 0.5 <IS ≤ 1.0, P = sensitive if it IS> 1.0.

From Table 8 it can be seen that the grass *Chloris gayana* variable soil moisture content, dry weight of the canopy and root infection of tolerant and sensitive to drought stress, whereas the root dry weight variables somewhat tolerant of drought, for variable height vertical accretion of plants sensitive to drought stress .

At the grass *Paspalum notatum* variable soil water content, high vertical accretion ofplants, canopy dry weight and dry weight of roots tolerant to drought, while the variable root infection somewhat tolerant of drought. At the grass *Paspalum dilatatum* variable soil water content and dry weight of roots tolerant of drought, for variable canopy dry weight and root infection is somewhat tolerant of drought, while the variable height vertical accretion of plants sensitive to drought stress.

The results of the sensitivity index calculations showed that plants of tropical grass, with a total value of the grass *Paspalum notatum* highest with a value of 27, followed by the *Chloris gayana*to the value of 10, and *Paspalum dilatatum* to the value 6, indicating that plants tolerant Paspalum notatum has the most value good when compared with the other two grass species.

REFERENCE

Astuti, A. & S. Dewi. 2008. Mekanisme air pada tumbuhan. Sains.http:/ /earlmate.files.wordpress.com/2008/06/ mekanisme-air-pada-tumbuhan1. pdf.[4Juli 2011].

[BMG] Badan Meteorologi dan Geofisika.2006. Petunjuk Pembuatan Pemetaan Neraca Air Lahan.BMG Pusat. Jakarta.

Brundrett, M., N. Bougher, B. Dell, T. Grave & N. Malajezuk. 1996. Working with Mycorrizha in Forestry and Agriculture. Australian Centre for International Agriculture Research (ACIAR).Cambera.

Buckman, N.T. & N.C Brady. 1974. The Nature and Properties of soil, 8th ed. Mac Millan Publishing Co.Inc. New York, London, 638 hal.

Bundrett, M. 2000. Introduction to mycorrhiza. CSIRO Forestry and Forest Products: P 1-3

Delvian. 2006. Peranan ekologi dan agronomi Cendawan Mikoriza Arbuskula. http:// repository.usu.ac.id/bitstream/123456789/1089/1/06005281.pdf. [27 November 2010].

Dewi, R.I. 2007. Peran, prospek dan kendala dalam pemanfaatan endomikoriza. Fakultas Pertanian. Universitas Padjajaran. Bandung. http:// pustaka. Unpad. ac. id/ wpcontent/ uploads /2009/06/makalah peran_endomikoriza.pdf. [5Juli 2011].

Djondronegoro, Said, H., & W. Prawiranata. 1989. Dasar-dasar Fisiologi Tumbuhan. Jurusan Biologi – Fakultas Matematika dan Ilmu Pengetahuan Alam. IPB. Bogor.

Fischer, R. A. & R. Maurer. 1978. Drought resistance in spring wheat cultivars I: grain yield responses. Aust. J. Agric. Res.(29) : 897-912.

Haryadi, S. S,.&S.Yahya. 1988. Fisiologi Cekaman Kekeringan. PAU. Bioteknologi Institut Pertanian Bogor, Bogor.

Haryati. 2003. Pengaruh cekaman air terhadap pertumbuhan dan hasil tanaman. Fakultas Pertanian, Universitas Sumatera Utara. Medan. http://repository. usu.ac.id/ bitstream/123456789/7345/1/hslpertanianharyati2.pdf. [4Juli 2011].

Karti, P.D.M.H. 2005. Pengaruh pemberian cendawan mikoriza arbuskula terhadap pertumbuhan dan produksi rumput *Setaria Splendida* Stapf yang mengalami cekaman kekeringan. Med. Pet. 28: 37-45.

Khaerana, M. Ghulamahdi, & E. D. Purwa kusumah. 2008. Pengaruh cekaman kekeringan dan umur panen terhadap pertumbuhan dan kandungan xanthorrhizol temulawak (*Curcuma xanthorrhiza*roxb.). Bul. Agron. 36. 3: 241 – 247.

Lakitan, B. 1995.Dasar-dasar Fisiologi Tumbuhan.PT. Raja Grafindo Persada. Jakarta.

Mapegau. 2006. Pengaruh cekaman air terhadap pertumbuhan dan hasil tanaman kedelai (*Glycine max* L. Merr). J. Ilmiah Pertanian Kultura 41 (1).

Mcllroy, R.J. 1977. Pengantar Budidaya Rumput Tropika (Terjemahan) Fakultas Peternakan IPB, Bogor.

Moore, Geoff. 2006. Perennial pastures for Western Australia. Department of Agriculture and Food Western Australia. Bul. 1 : 46-90.

Mosse, B. 1981. VAM Research for Tropical Agriculture. Hawaii Institute of Tropical Agriculture and Human resources, 82p.

Munns, R., 2002. Comparative physiology of salt and water stress.Plant Cell and Enviroment.25: 29-250.

Nahak, O. R. 2011. Respon morfofisiologi rumput pakan terhadap cekaman kekeringan yang diinokulasi FMA (Fungi mikoriza arbuskula). Tesis. Sekolah Pascasarjana, Institut Pertanian Bogor, Bogor.

Newman, yoana. 2010. Paspalum notatum overview and management. Patent publication number SS-AGR-332. http:// edis.ifas.ufl.edu/ag342. [27 Januari 2011].

Nurhayati. 2002. Penambahan pembenah tanah dan mikroorganisme tanah terhadap rumput Setaria splendida Staff pada tanah podsolik merahkuning. Skripsi. Ilmu Nutrisi dan Makanan Ternak, Fakultas Peternakan,Institut Pertanian Bogor, Bogor.

Philips J. M. & D. S. Hayman. 1970. Improved procedures for clearing roots and staining paracitics and vesicular-arbuscular mychorrhizal fungi for rapid assessment of infection. Transactions of the Brithish Mycological Soc 55 : 158-160.

Reksohadiprodjo, S. 1985. Produksi Tanaman Hijauan Makanan Ternak Tropik. BPFE.Yogyakarta.

Rungkat, J. A. 2009. Peranan MVA dalam meningkatkan pertumbuhan dan produksi tanaman. J. Formas 2 (4) : 270-276.

Rusmin, D., Sukarman, Melati, & H. Maharani. 2002. Pengaruh cekaman air terhadap pertumbuhan bibit empat nomor jambu mente (*Anacardiumoccidentale*. L.). J. Littri 8 (2).

Salisbury, F. B. & C. W. Ross. 1995. Fisiologi Tumbuhan. Ed 4th. Terjemahan: Diah R. L. dan Sumaryono. Institut Teknologi Bandung. Bandung.

Sasli, I. 2004. Peranan Mikoriza Vesikula Arbuskula (MVA) dalam peningkatan resistensi tanaman terhadap cekaman kekeringan. Disertasi. Sekolah Pascasarjana. Institut Pertanian Bogor, Bogor.

Setiadi, Y. 1999. Status penelitian pemanfaatan cendawan mikoriza arbuskula untuk rehabilitasi lahan terdegradasi. Dalam.Prosiding Seminar Nasional Mikoriza I. Bogor 15-16 Nopember 1999.

Turk, M. A., T. A., Assaf, K. M. Hameed, & A. M. Al-Tawaha. 2006. Significance of micorrhizae. World Journal of Agricultural Sciences 2 (1) : 16-20.

USDA. 1975. Soil Taxonomy a Basic System of Soil Classification for Making and Interpretation Soil Surveys. Soil Survey Staff. Agriculture Handbook No. 436.

Utama, M. Z. H. & S.yahya. 2003. Peranan mikoriza vesikula arbuskula, rhizobium dan asam humat pada pertumbuhan dan kadar hara beberapa spesies legume penutup tanah. Bul. Agronomi 31 (3) : 94-99.

Yogaswara, A. 1977. Seri-seri tanah dari 7 tempat di Jawa Barat. Jurusan Tanah, Fakultas Pertanian. Institut Pertanian Bogor.