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The role of arbuscular mycorriza fungi (AMF) on water stress on soybean yield

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Abstract

The study was to analyze the role of Arbuscular Mycorriza Fungi (AMF) on water stress on soybean yield (*Glycine max* L. *Merril*). The study was conducted in screen house Experimental farm and Biology Soil laboratory in Agriculture Faculty Syiah Kuala University, from June 21 until October 10, 2016. Randomized design was arranged with 3 replications and 2 factorial. Factor AMF is M_0=without AMF and M_1=40 g^{-1}AMF. Factor water stress is I_1 = watering every 1 day; I_2= watering every 3 days; I_3 = watering every 5 days; I_4 = watering every 7 days; I_5 =watering every 9 days; I_6 = watering every 11 days; I_7 = watering every 13 days; I_8= watering every 15 days; I_9 = watering every 17 days; I_{10}= watering every 19 days. Parameter generative of soybean are, the total pods account, a number of pods packed; heavy of pods; dry weight of root; dry weight top plant; dry weight of beans and a number of beans. The result showed that the doces of AMF 40 g $plant^{-1}$significantly influence generative soybean contrast to control (without AMF). Soybean can be adapted in watering every 5 days.

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Introduction

Soybean is used for material of industry. In Aceh, soybean is one of the best commodities which may has a fairly economical prospect that can influence the development of economic at the moment and in the future. Aceh has massive land to plant the soybean but the availability of land is inceptisol.

This soil has characteristics of poor nutrients but if it is well managed, soybean will be rised. This Inceptisol can be controlled by using Arbuscular Mycorriza Fungi (AMF) (BPS, 2015).

Arbuscular Mycorriza Fungi is fungi which has symbiotic mutualism with plant roots. Plants given Arbuscular Mycorriza Fungi will grow better than plant without Arbuscular Mycorriza Fungi. According to Brundett (2002) the principle of these fungi is roots infection. Fungi will expand the absorption nutrient and water uptake which is to support growth and yield during drought stress.

Water deficiency can reduce the availability of nutrients for plants because the amount of water in the soil will affect concentration of nutrients in soil and the rate of movement of nutrients through the diffusion and transfor mass (Soheil, 2011).

Plants given Arbuscular Mycorriza Fungi is more resistant on water deficiency than plants without AMF. The research of Quilambo (2003) stated that AMF used as an alternative plan for soil that suffer water stress and poor nutrients. So, the aims of study were to identify the extent to which Arbuscular Mycorriza Fungi is able to support soybean yield on water stress at inceptisol.

Materials and methods

Place of study

The research was conducted at Screen House of experimental farm and Soil Biology Laboratory of Agriculture Faculty, Syiah Kuala University. Aceh, Indonesia. The study was investigated from June 21 until October 2016. Temperature 34 ^{o}C.

Media planting

Inceptisol was used as planting medium obtained at Blang Bintang Air Complex, Aceh Besar District. Soil sampling technique is conducted composite method. the based of soil analysis, inceptisol has a sandy loam soil texture, with texture class G or clay type and pH 4.90 and pH-KCL is 4.13. C organic 0.49; N total is 0.13. P_2O_5 and K_2O_5 reserves are not available.

For P available 0.15 Mg kg^{-1}, base cation exchange has Ca is 4,43 Cmol kg^{-1}. Mg is 0.50 Cmol kg^{-1}. K is 0.08 Cmol kg^{-1}. Na is 0.18 Cmol kg^{-1}. For the value of cation exchange capacity (CEC) is 12.80 Cmol kg^{-1}. While the saturation base has a value of 40.39%, for the potential acidity based on the value of Al is not known while the value of H is 0.16 Cmol kg^{-1} with electrical conductivity that is 0.16 mscm^{-1} low organic material. polybags used had 20 cm diameter and weight of 10 kg^{-1}. The total of polybags 240 pieces.

Soybean Plants

The seeds used were varieties of Agromulyo, obtained from West Java. Seeds embedded into the ground as many as 5 seeds. Growth seeds was maintained for 21 full days. There were 240 sample.

Arbuscular Mycorriza Fungi (AMF)

This research used 2 type of Arbuscular Mycorriza Fungi, Glomus SP and Acaulospora obtained from Soil and Plant Biology laboratory of Agriculture Faculty, Syiah Kuala University.

There were 2 levels of Arbuscular Mycorriza Fungi treatment without AMF and 40 g doses of AMF.

Treatment of water stress

Treatment of drought stress was conducted once. There were 10 levels of treatment of water stress, I_1 = watering every 1 day; I_2 = watering every 3 days; I_3 = watering every 5 days; I_4 = watering every 7 days; I_5 = watering every 9 days; I_6 = watering every 11 days; I_7 = watering every 13 days; I_8 = watering every 15 days; I_9 = watering every 17 days; I_{10} = watering every 19 days.

Maintenance

Maintenance includes watering, fertilizing, weeding. Full watering was done to keep the plants for 21 days before getting water stress treatment. While fertilization was conducted to add nutrient for plants. fertilization application was done 2 times at the age of 15 HST and 30 HST.

The fertilizer used was a pearl NPK fertilizer with a dose of 20 g of planting.

Statistical analysis

Data analysis was using microsoft excel window 2010. Software for Anova and pearson's correlation between parameter, at probability level of 5%.

This study used Randomized Block Design (RAK) with 3 replications and consisted of 2 factors.

Parameters

The parameters was the examined on generative content, the total pod counts; number of packed pods; heavy pods; dry weight of root; dry weight top of plants; dry weight of soybean and number of dry soybeans.

The total pod counts

The observation of the total pod count did on harvest. Pod counted overall.

Number of packed pods

Number of packed pods also counted on harvest. The pod contains separated with a void pod and then the number of packed pods can be counted.

Heavy pods

The heavy pod separated with a void pod and then the weight of the heavy pod weighed using an analytical scale. The units used are grams.

Dry weight of roots

roots dried by using the oven for 48 hours with a temperature of 60 ^{o}C then dry weight of roots weighed using an analytical scale.

Dry weight top of plants

Top of plants dried by using the oven for 48 hours with a temperature of 60 ^{o}C than dry weight on top of plants weighed using an analytical scale. The units used are grams.

Number of dry soybeans

The pods dried in the sun for 3 days then the pod is peeled and take the seeds. The number of dry beans can be counted.

Dry weight of soybeans

Beans dried in the sun for 3 days then the pod is removed and take the seeds. Dry weight of bean number of dry beans can be counted.

Results and discussion

Result

Arbuscular Mycorrizal Fungi (AMF)

Table 1. illustrated has a significant effect on generative of soybean including on the total pod counts; number of packed pods; heavy pods; dry weight of root; dry weight top of plants; dry weight of soybean and number of dry soybeans.

Tabel 1. The result soybean generative including total pod counts; number of packed pods; heavy pods; dry weight of root; dry weight top plant; number of dry beans and dry weight of bean by AMF.

Treatment	Total pod count	Number packed pod	Heavy pod	Dry weight of root	Dry weight top plant	The number of beans	Dry weight of beans
M_0	21,87 a	21,37 a	7,77 a	2,65 a	5,89 a	39,07 a	3,27 a
M_1	24,40 b	23,93 b	8,53 b	3,46 b	7,42 b	45,20 b	3,81 b
significant	**	**	**	**	**	**	**

**= more significant. M_0=without AMF and M_1=40 g^{-1}AMF.

Table 1 showed that giving AMF 40 g plant^{-1} (M_1), will produce total pod counts; number of packed pods; heavy pods; weight of root; dry weight top plant; dry bean weight and number of dry beans are better than without AMF (M_0).

Water stress

Tables 2 showed has a significant effect on generative of soybean including on the total pod counts; number of packed pods; heavy pods; dry weight of root; dry weight top of plants; dry weight of soybean and number of dry soybeans.

Table 2. The result soybean generative including total pod counts; number of packed pods; heavy pods; dry weight of root; dry weight top plant; number of dry beans and dry weight of bean by water stress.

Treatment	Total pod count	Number packed pod	Heavy pod	Dry weight of root	Dry weight top plant	The number of beans	Dry weight of beans
I_1	25,33f	24,67 f	7,86 b	6,69e	7,86d	48.83 g	4,03 d
I_2	25,67f	24,67 f	8,99 d	6,60e	8,81g	48.83g	4,00 d
I_3	26,83g	25,17 g	9,57f	6,84f	9,39i	50.17 h	4,09 d
I_4	24,83e	24,17 e	9,16 e	6,79f	9,31h	42.50 f	3,90 d
I_5	23,50d	23,33 d	8,49 c	6,10e	8,70f	42.33 f	3,74 d
I_6	21,83c	21,67 c	8,40 c	5,54d	8,40e	41.33 e	3,79 d
I_7	21,50c	21,50 c	7,74 b	4,80c	7,74c	38.67 d	3,37c
I_8	19,67a	19,67a	7,62 b	4,78c	7,73c	38.17 c	3,00 b
I_9	20,33b	20,33 b	6,96 a	4,08b	6,96b	37.17 b	2,92ab
I_{10}	21,33c	21,33 c	6,76 a	2,89a	6,76a	33.33 a	2,56 a
significant	**	**	**	**	**	**	**

**= more significant. water stress is I_1 = watering every 1 day; I_2= watering every 3 days; I_3 = watering every 5 days; I_4 = watering every 7 days; I_5 =watering every 9 days; I_6 = watering every 11 days; I_7 = watering every 13 days; I_8= watering every 15 days; I_9 = watering every 17 days; I_{10}= watering every 19 days.

The result has a big effect on soybean yield, If water stress period is longer it may result failure crop. Soybean able to survived on watering every 5 days (I_3), while different treatment on soybean generative reveal that the result was decreased. The lowest value is found on watering every 19 days (I_{10}) on soybean generative including heavy pods; dry weight of root; dry weight top of plants; dry weight of soybean and number of dry soybeans, except on the total pod count and number of packed pods.

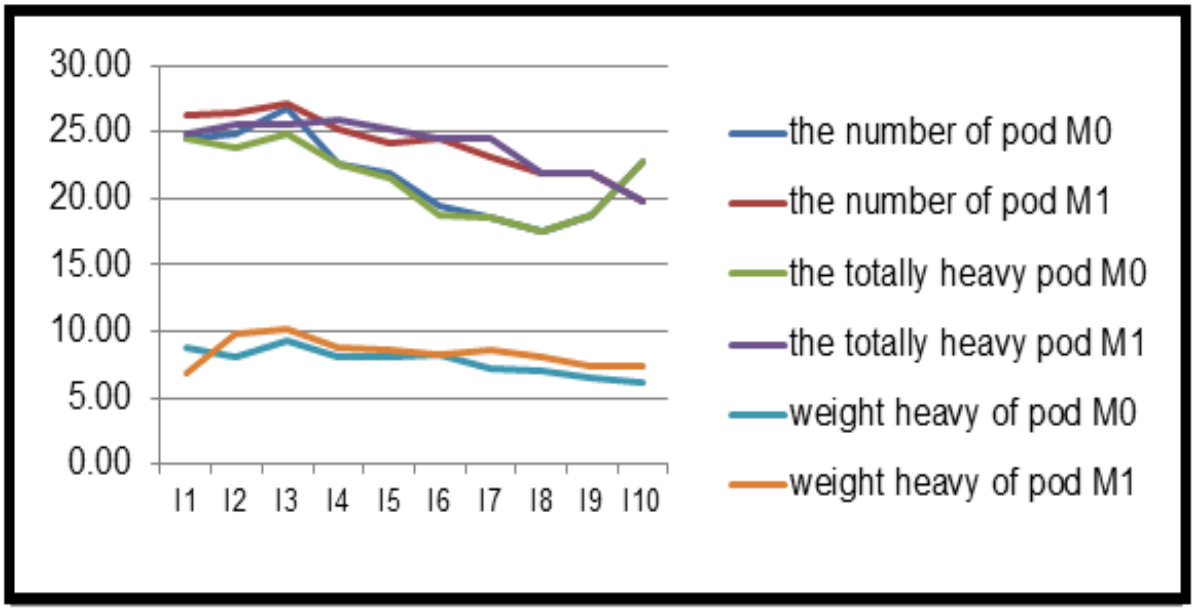

Fig. 1. The result of Interaction between AMF and water stress on generative compound, the total pod count and number of packed pod and heavy pod.

Interaction between Arbuscular Mycorriza Fungi and water stress

Fig. 1, 2 and 3. showed has a significant effect on interaction of generative of soybean including on the total pod counts; number of packed pods; heavy pods; dry weight of root; dry weight top of plants; dry weight of soybean and number of dry soybeans. The best combination between *Arbuscular* Mycorriza Fungi and water stress are treatment 40 g doces *Arbuscular* Mycorriza Fungi and watering every 5 days (M_1 I_3). While the lowest of combination between Arbuscular Mycorriza Fungi and water stress are treatment without Arbuscular Mycorriza Fungi and watering every 19 days (M_0 I_{10}). Different treatment between them was produced a low soybean yield.

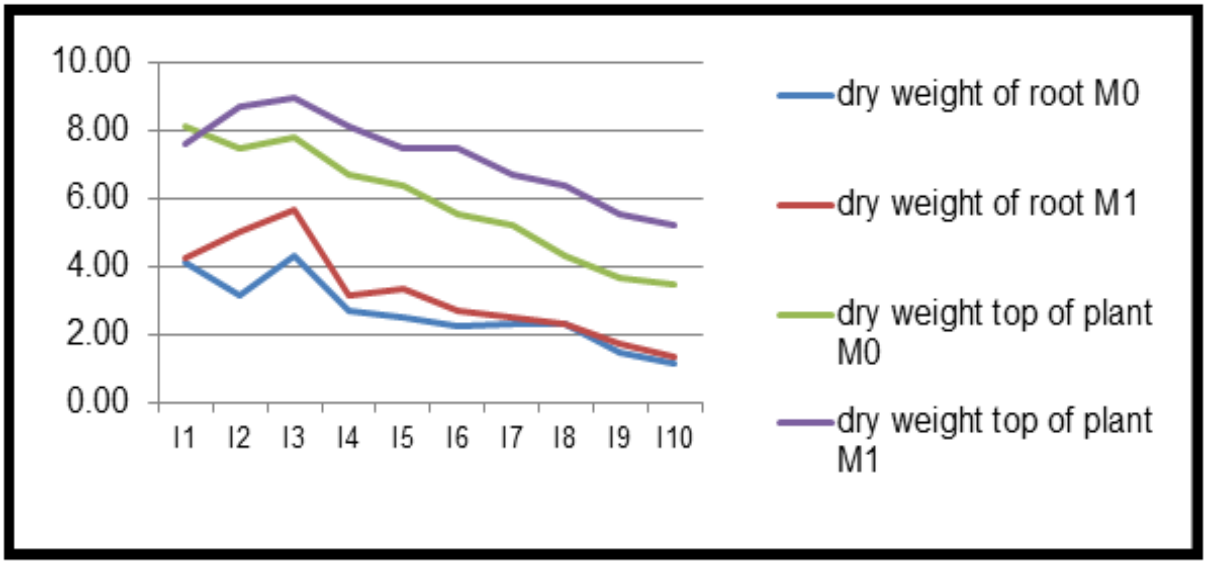

Fig. 2. The result Interaction between AMF and water stress on generative compound, dry weight of root and dry weight on top plant.

Discussion

Arbuscular Mycorrizal Fungi (AMF)

All previous reaseacher indicated that beneficial role of AMF symbiosi increasing of plant yield was maily associated to better uptake nutrient (Bolandnazar *et al.*,2007; Colla *et al.*, 2015). By using *Arbuscular Mycorrizal Fungi (AMF)* would give impact to the soybean yield. It can be proved that *Arbuscular Mycorrizal Fungi* has symbiotic mutualism with soybean roots. According to Christhoper, *et al.,* (2008) *Arbuscular Mycorrizal Fungi* has hypha to absorb nutrient to support it's growth (thermozhi, *et al.,* 2011). the research of Songachan *et al.,* (2011) showed the AMF is more effective to used in poor nutrient land.

Water stress

The result has a big effect on plant growth, If water stress period is longer it may result failure crop.

The study of schatman (2008), the influence on water stress will decrease the elasticity of the cell. Turgor pressure, the activity of photosynthesis, the production of carbohydrates may cause worst crop.

Avre *et al.,* (2011) reported that plants will be adapted to drought stressed by using controlled mechanism. According to Taiz and Zeiger (2002) that the water decrease content tested due to drought stress was that suffer from by using controlled roots. While the availability of the water is not increased. Plants is water deficits will make osmotic adjustments, such as by increasing the dissolved compound that lead to decreased of the osmotic potential of the cell and allowed ground water to enter the plant cell.

Interaction between Arbuscular Mycorriza Fungi and water stress

Interaction between AMF and water stress indicated that positive effect on soybean yield.

Previous result reveal that on water stress, with AMF can increased tolerance of soybean to drought stress. Arbuscular Mycorriza Fungi acts as a facilitator in absorbing nutrients and water in conditions that suffer from drought stress. the resulting crop was more resistant toward drought stress.

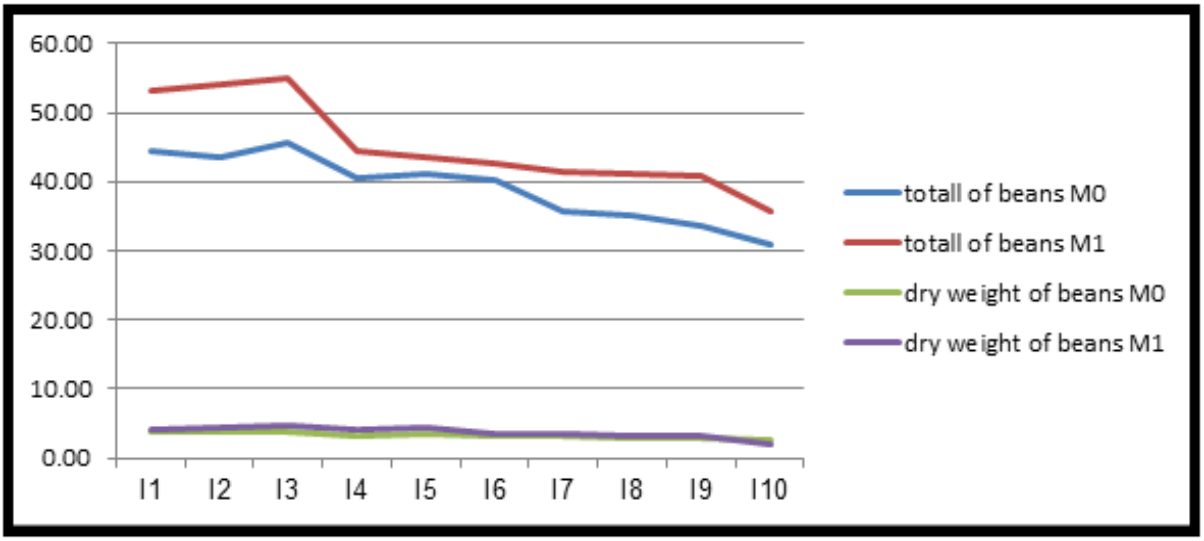

Fig. 3. The result of Interaction between AMF and water stress on generative compound, the number of beans and dry weight of beans.

The study of Harwani *et al* (2006) reported that using the AMF for soybean can increased soybean yield. The research of Jalaluddin (2005) reveal that a doses of 40 g of AMF^{-1} ha plant is increased its yield. The study of the Junfeng *et al.*, (2010) on peanut and Carenho *et al.,* (2007) on wheat, maize described if root infected by AMF, the plant growth better than without AMF.

The AMF can maxmimally absorbtion of nutrient. The research of Quilambo (2003) stated that AMF used as an alternative plan for soil that suffer water stress and poor nutrients.

Conclusion

Doses 40 g AMF^{-1} has a significant effect on generative growth. Water stresses are found in watering every 5 days. There has interaction between the two treatments on the total pod number; number of packed pods; heavy pods; dry weight of root; dry weight top plant; the number of dry beans and dry beans weight. The best combination is 40 doses Arbuscular Mycorriza Fungi and watering every 5 day.

Recommendations

Arbuscular mycorriza fungi can be used on all types of agricultural crops, agroforestry, plantions and horticulture to support yield of plant on drought conditions and land of poor nutrient.

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