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Evaluation of Arbuscular Mycorrhizal Fungi Inoculum on Production and Nutrient Content of *Pennisetum purpureum*

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ABSTRACT

Land for forage planting is mainly on marginal land such as acid soil. However, the constraint is the low levels of phosphorus (P) that can inhibit forage production. Arbuscula mycorrhizal fungi has been known as a biological fertilizer because the fungi can help the absorption of phosphorus (P) on the root so that can improve the forage production and quality of nutrients. This study was aimed to utilize and evaluate the use of arbuscular mycorrhizal fungi inoculum in forage production and nutritive value of *Pennisetum purpureum*. The experiment used a completely randomized design with two factors (2 x 4) and 4 replications. The first factor was type of AMF inoculum (A and B) and the second factor was doses of AMF (D1= 0.5 kg/planting hole, D2= 1 kg/planting hole, D3= 1.5 kg/planting hole, and D4= 2 kg/planting hole). Control treatment was carried out separately. The result showed that the highest shoot dry weight production was on AD2 and significantly different (P<0.05) from BD1 and control. There was no interaction between type and dose of inoculum on shoot dry weight production and nutrition value. The inoculum A significantly increased (P<0.05) shoot dry weight production (34.04%), crude protein content (10.21%), phosphorus uptake (40%), N content (10.53%), N uptake (38.10%), and protein production (40.15%) of *P. purpureum*, compared to inoculum B. It can be concluded that AMF inoculum type A was the best inoculum for forage production.

Keywords: arbuscular mycorrhizal fungi (AMF), latosolic soil, Pennisetum purpureum, forage production

INTRODUCTION

The problem which has been faced on forage production is marginal land such as acid soil. Constraints in acid soils are low nutrient supply especially P, low base saturation and cation exchange capacity. Phosphorus (P) is the most limiting nutrient after nitrogen (N) for crop growth in many countries. Mycorrhizas (M) have a potential role in increasing soil P supply and reducing the dependence on expensive fertilisers (Heydari & Maleki, 2014). Arbuscular mycorrhizal fungi (AMF) improve the plant mineral nutrition in particular the acquisition of phosphorus and some nitrogen and minor nutrients. Arbuscular mycorrhizal fungi are soil microorganisms that establish mutual symbiosis with the majority of higher plant, are fundamental for plant nutrition and soil fertility, and represent a living bridge for translocation of water and nutrients to the host plants (Van-der Heijden & Horton, 2009). AMF are important soil organisms as a biofertilizer providing a direct physical link between soil and plant roots. Therefore, the utilization of arbuscular mycorrhizal fungi becomes one of supporting factors for forages grown on acid soil.

The roles of Arbuscular mycorrhizal fungi in acid soil can enhance the supply and absorbtion of P nutrient which is generally very low in this land such as N (NH_4^+ or NO_3^-), K and Mg, and also can enhance micro nutrient absorption in acid soil such as Cu, Zn, Mn, B, and Mo (Smith & Read, 2008). The symbiosis of plant and AMF is known as a biological fertilizer because it can help the plant to enhance the uptake of nutrient such as P, increase disease resistence, and water relations (Smith & Read, 2008; Karti *et al*. 2012, Sowmen *et al*., 2012). The AMF inoculation significantly increases the production of herbage, dry weight of shoot, and nutrient status (P, Zn, and Fe) compared to non-inoculated plants (Chaudhary *et al*., 2008). Colonization of AMF increased the plant dry mass, phosphorus (P), and nitrogen (N) concentrations in the roots, stems, and leaves of *P. japonica* when the AMF were applied with natural and sterilized soil compared to when were applied only in sterilized soil and in natural soil separately. Another advantage of AMF is to host plant where the plants with infected roots can be more survived during dried condition and water deficit. Roots infected by AMF have hyphae that can absorb water more efficient, so that the plant will be tolerant and can grow on dried condition. Karti *et al*. (2012) and Sowmen *et al.* (2012) reported that AMF application during drought condition could improve relative water contents of leaves in *Stylosanthes seabrana* and *Macroptillium bracteatum*. The AMF can be used as an alternative strategy to substitute half of fertil-

izer utilization for plant especially for plants grown in the drought condition. The research was aimed to utilize and evaluate the utilization of arbuscular mycoorhizal fungi inoculum on forage production and nutritive value of *Pennisetum purpureum.*

MATERIALS AND METHODS

Inoculum Preparation

The AMF inoculum used in this study was obtained from previous study. The inoculum production was conducted about 4 months and used a starter consisted of *Glomus manihotis, Glomus etunicatum, Gigaspora margarita,* and *Acaulospora tuberculata* that were obtained from the Forest and Environmental Biotechnology Laboratory. Inoculum A was produced using *Centrosema pubescens* as a host plant, whereas inoculum B was produced using *Pueraria javanica.* The number of spores per 50 g of A an B inoculums were 156.33 and 105, whereas root infections were 98.21% and 97.21%, respectively. Infected propagules from A and B inoculums were about 217.8 (10^4) and 101.6 (10^4), respectively. Host plant, spore number, root infection, and infected propagules from A and B inoculums are presented in Table 1.

Land Preparation, Cultivation, and Nurtured

Land used in this research was latosolic soil with pH= 4.5, C organic= 1.06%, N= 0.09%, P= 3.5 ppm, K= 6 mg/100 mg, and CEC= 14.68. The soil was not fumigated. The stems cuttings were used as planting materials and consisted of 2 nodes and 3 internodes. The stems cuttings were planted with a spacing of 1 × 1 m. The plots size was 9.5 × 4.5 m. The total number of plots was 32 consisted of inoculum (2) x dose of AMF inoculum (4) x replications (4). Control treatment was carried out separately with 4 replications.

The inoculum were given in planting holes. The planting was conducted in the evening to prevent the plant stress. Only one stem cutting that was planted in each hole. Plants were nurtured approximately 3 months and weeding was eradicated every day. Watering was conducted every day based on field capacity.

Harvesting and Drying

The plants were harvested at the age of 3 months. The forages were dried under the sun for 2 days and then dried by using the oven with temperature of 70°C for 2 days.

Variables Measured

Shoot dry weight production was obtained by cutting the shoot at the boundary between the roots and stems (1-2 cm from the top surface of the soil), and then dried in the sun for 2 days and further dried by using the oven with temperature of 70°C for 2 days. The percentage of inoculation effectiveness on growth and yield was calculated for shoot dry weight production (IEg) by using the following formula (Ortas, 2012): IEg= [(+M Shoot dry weight production) – (–M Shoot dry weight production)] / (+M Shoot dry weight production).

Proximate analysis, to measure crude fat, crude protein, crude fiber contents, was conducted by using AOAC method (AOAC, 2005), while the nitrogen content analysis was conducted by using Kjeldahl method (AOAC, 2005). Phosphorus content analysis was conducted by using a micro colorimetric method for the determination of inorganic phosphorus (Taussky & Shorr, 1953). Nitrogen and phosphorus uptakes were calculated from the average of nitrogen and phosphorus contents multiplied by the average of shoot dry weight production. Crude protein production was calculated from the average crude protein content multiplied by the average shoot dry weight production.

Treatments

This research was conducted with 2 factors. The first factor was the type of AMF inoculum and the second factor was dose of AMF inoculum. The first factor consisted of 2 levels i.e., inoculums A and B. The second factor consisted of 4 levels i.e., D1= 0.5 kg/planting hole, D2= 1 kg/planting hole, D3= 1.5 kg/planting hole, and D4= 2 kg/planting hole. The control treatment was carried out separately with 4 replications.

Experimental Design

Experimental design used in this research was a completely randomized design with 2 x 4 factorial pattern with 4 replications. The control treatment was carried out separately. Obtained data were analyzed with *analysis of variance* (ANOVA), and data with significantly different response were then further tested with Duncan Multiple Range Test.

RESULTS

Shoot Dry Weight Production and Inoculation Effectiveness of *Pennisetum purpureum*

The shoot dry weight productions of *P. purpureum* in response to various types and doses of AMF inoculum are presented in Tables 1 and 2. The shoot dry weight production of *P. purpureum* without AMF inoculation (control) was significantly different ($P<0.05$) from those inculated with AMF inoculum A at a dose of 1 kg/planting hole (AD2), and was not significantly different from the other treatments. There was no interaction effect between the type and the dose of AMF inoculum on shoot dry weight production. Dose of AMF inoculum did not significantly affect shoot dry weight production. However, shoot dry weight production of *P. purpureum* inoculated with AMF inoculum A was higher ($P<0.05$) than that of inoculated with AMF inoculum B. The shoot dry weight production of *P. purpureum* inoculated with AMF inoculum A showed more effective features. Inoculation effectiveness (IE) of AMF inoculum A was higher than that of inoculum B (Table 3).

Nutrition Value of *Pennisetum purpureum*

The nutrients contents such as ash, crude fat, crude fiber, crude protein, and Nitrogen free extract indicated the forage quality (Puteri *et al.,* 2015). The effects of AMF inoculum on crude fat, crude protein, and crude fiber contents of *P. purpureum* are presented in Table 2. The was no interaction between the type and dose of AMF inoculum on crude fat, crude protein, and crude fiber contents of *P. purpureum*. There was no significant effect of dose of inoculum on crude fat, crude protein, and crude fiber contents of *P. purpureum*. The AMF inoculum A produced a higher crude protein (P<0.05) compared to AMF inoculum B. However, there was no significant effect of type of inoculum on crude fat and crude fiber contents.

Nitrogen and phosphorus contents, nitrogen and phosphorus uptakes, as well as protein production are presented in Table 3. There was no interaction beetwen the type and dose of AMF inoculum on nitrogen and phosphorus content, Nitrogen and Phosphorus uptake, and protein production of *P. purpureum*. The AMF inoculum A produced a higher (P<0.05) nitrogen content, nitrogen and phosphorus uptake, and protein production of *P. purpureum* compared to AMF inoculum B. However, dose of AMF inoculum did not affect nitrogen and phosphorus content, nitrogen and phosphorus puptake, and protein production of *P. purpureum*.

Table 1. Shoot dry weight production of *Pennisetum purpureum* inoculated with various types and doses of arbuscular mycorrhizal fungi (AMF) inoculum

Treatment	Shoot dry weight production (g/bunch)
Control	43.96 ± 8.32 [b]
AD1	79.30 ± 22.40 [ab]
AD2	135.35 ± 81.10 [a]
AD3	114.45 ± 55.38 [ab]
AD4	118.20 ± 67.93 [ab]
BD1	45.15 ± 4.04 [b]
BD2	85.85 ± 25.53 [ab]
BD3	70.13 ± 13.83 [ab]
BD4	93.90 ± 31.22 [ab]

Note: A= AMF inoculum A (using *Centrosema pubescens* as a host plant), B= AMF inoculum B (using *Pueraria javanica* as a host plant), D1= dose of AMF inoculum 0.5 kg/planting hole, D2= dose of AMF inoculum 1 kg/planting hole, D3= dose of AMF inoculum 1.5 kg/planting hole, D4= dose of AMF inoculum 2 kg/planting hole. Means with different superscripts in the same column differ significantly (P<0.05).

DISCUSSION

Shoot Dry Weight Production

The the use of AMF inoculum A at a dose of 1 kg/planting hole (AD2) produced the highest shoot dry weight production (135.55 g). The shoot dry weight production of *P. purpureum* inoculated with AMF inoculum A at a dose of 1 kg/planting hole and was significantly different (P<0.05) from those inoculated with AMF inoculum B at a dose of 0.5 kg/planting hole (BD1) (45.15 g) and control (43.96 g); shoot dry weight production increased by 66.69% and 67.57%. Shoot dry weight production of *P. purpureum* inoculated with AMF inoculum A was higher (34%) than those inoculated with AMF inoculum B. The increased shoot dry weight production could be due to a higher spore number (155.33/50 g) and infected propaguale (217.8×10^4) in *P. purpureum* inoculated with AMF inoculum A than AMF inoculum B (Table 4). According to Karti *et al.* (2012), under well-

Table 2. Shoot dry weight production, inoculation effectivity and fat, crude protein, and crude fiber percentages of *Pennisetum purpureum* inoculated with various types and doses of arbuscular mycorrhizal fungi (AMF) inoculum

Variables	Type of AMF inoculum	Dose				
		D1	D2	D3	D4	Average
Shoot dry weight production (g/bunch)	A	79.30±22.40	135.35±81.1	114.45±55.38	118.2±67.93	111.83±28.65[a]
	B	45.15± 4.04	85.85±25.53	70.13±13.83	93.90±31.22	73.76±12.14[b]
	Average	67.72±17.02	110.55±46.36	92.29±29.38	106.05±25.96	
Inoculation effectivity (%)	A	44.56	67.52	61.59	62.81	59.12
	B	2.64	48.79	37.32	53.18	35.48
	Average	23.6	58.16	49.45	58	
Crude fat (%)	A	1.48±0.62	1.20±0.14	0.91±0.21	1.24±0.27	1.21±0.21
	B	1.44±0.62	1.30±0.28	1.08±0.48	1.21±0.45	1.26±0.14
	Average	1.46±0.62	1.25±0.10	1.00±0.19	1.23±0.13	
Crude protein (%)	A	12.17±1.85	12.55±1.03	11.71±1.69	10.97±0.76	11.85±0.68[a]
	B	10.55±0.84	10.34±0.90	10.85±1.11	10.81±0.22	10.64±0.24[b]
	Average	11.36±0.71	11.45±0.09	11.28±0.41	10.89±0.38	
Crude fiber (%)	A	23.78±2.39	24.59±0.72	24.70±1.30	24.46±2.79	24.38±0.96
	B	25.13±1.82	24.91±2.18	21.38±1.10	24.21±1.78	23.91±0.45
	Average	24.46±0.40	24.75±1.03	23.04±0.14	24.34±0.71	

Note: A= AMF inoculum A (using *Centrosema pubescens* as a host plant), B= AMF inoculum B (using *Pueraria javanica* as a host plant), D1= dose of AMF inoculum 0.5 kg/planting hole, D2= dose of AMF inoculum 1 kg/planting hole, D3= dose of AMF inoculum 1.5 kg/planting hole, D4= dose of AMF inoculum 2 kg/planting hole. Means with different superscripts in the same column differ significantly (P<0.05).

Table 3. Nitrogen, nitrogen uptake, phosphor, phosphor uptake, and protein production of *Pennisetum purpureum* inoculated with various types and doses of arbuscular mycorrhizal fungi (AMF) inoculum

Variables	Type of AMF inoculum	Dose				
		D1	D2	D3	D4	Average
Nitrogen (%)	A	1.95±0.30	2.01±0.16	1.87±0.27	1.76±0.12	1.9±0.11 [a]
	B	1.69±0.13	1.65±0.14	1.74±0.18	1.73±0.03	1.7±0.04 [b]
	Average	1.82±0.18	1.83±0.25	1.81±0.09	1.75±0.02	
Nitrogen uptake (%)	A	1.54±0.50	2.61±1.56	2.13±1.1`	1.76±0.12	2.1±0.44 [a]
	B	0.93±0.13	1.42±0.46	1.21±0.23	1.62±0.54	1.3±0.30 [b]
	Average	1.24±0.26	2.02±0.78	1.67±0.62	1.69±0.30	
Phosphor (%)	A	0.23±0.06	0.24±0.09	0.19±0.03	0.24±0.02	0.23±0.02
	B	0.18±0.06	0.21±0.05	0.20±0.04	0.20±0.06	0.20±0.01
	Average	0.18±0.01	0.23±0.03	0.20±0.01	0.22±0.03	
Phosphor uptake (%)	A	0.19±0.08	0.30±0.17	0.22±0.11	0.29±0.17	0.25±0.05 [a]
	B	0.08±0.02	0.18±0.03	0.14±0.04	0.18±0.04	0.15±0.01 [b]
	Average	0.14±0.04	0.24±0.10	0.18±0.05	0.24±0.09	
Protein production (g)	A	9.65±3.12	16.33±9.76	13.34±6.95	13.09±7.70	13.1±2.78 [a]
	B	4.77±0.65	8.89±2.91	7.56±1.43	10.14±3.34	7.84±1.26 [b]
	Average	7.21±1.75	12.61±4.84	10.45±3.90	11.62±3.08	

Note: A= AMF inoculum A (using *Centrosema pubescens* as a host plant), B= AMF inoculum B (using *Pueraria javanica* as a host plant), D1= dose of AMF inoculum 0.5 kg/planting hole, D2= dose of AMF inoculum 1 kg/planting hole, D3= dose of AMF inoculum 1.5 kg/planting hole, D4= dose of AMF inoculum 2 kg/planting hole. Means with different superscripts in the same column differ significantly (P<0.05).

Table 4. Spore number, root infection, and infected propagules of inocula A and B

Type of AMF inoculum	Host plant	Spore number (50 g)	Root infection (%)	Infected propagules (25 g inoculant)
A	*Centrosema pubescens*	156.33±45.76	98.21±3.11	217.8 (104)
B	*Pueraria javanica*	105.00±24.43	97.21±2.15	101.6 (104)

Note: AMF= arbuscular mycorrhizal fungi, A= AMF inoculum A (using *Centrosema pubescens* as a host plant), B= AMF inoculum B (using *Pueraria javanica* as a host plant).

watered conditions, shoot dry weight of *S. seabrana* inoculated with AMF inoculum were higher than that of without AMF inoculum. Plants inoculated with AMF inoculum showed an increased shoot dry weight production about 30%. Arbuscular mycorrhiza fungi (AMF) play a very important role in enhancing the plant growth and yield due to the increased supplies of P and N to the host plant (Table 3). The mycorrhiza potential could mobilise P from soils with low P status and enhanced colonization and P uptake by plant (Heydari & Maleki, 2014). The inhibition of photosynthesis due to Pi deprivation resulted in photosynthetic-carbon assimilation and carbon-partitioning processes (Rychter & Rao, 2005). Nitrogen involved in photosynthesis consists of 2 parts. The first part is soluble protein dominated by the enzyme ribulose 1,5-bisphosphate (RuBP) carboxylase. The second part is protein in the thylacoid membranes of the chloroplast. The photosynthesis activity per unit of nitrogen increases with the increased nitrogen contents (Evans, 1989). P and N limitations are important components of photosynthetic nutrient relations in white pine grown in five soils and suggest that both P and N and their proportions must be considered in the analyses of photosynthesis-nutrient relations (Reich & Schoettle, 1988). The high P and N contents in plant inoculated with inoculum A would increase photosynthesis so that the shoot dry weight production would increase.

Forage Nutrition Value of *Pennisetum purpureum*

There was no interaction between the type and dose of AMF inoculum on crude fat content. Crude fat content of *P. purpureum* obtained in this study was 0.91%-1.48%. This result was lower compared to previous result (2.25%) (Winarto *et al*., 2013). The low value of crude fat content in this study could be due to the older harvesting age of the plant (3 months or 90 days). Ideally, elephant grass is harvested at the age of 45-60 days to obtain a high production with a good nutritional content.

There was no interaction between the type and dose of AMF inoculum on crude fibre content of *P. purpureum*. The highest crude fibre content (25.13 %) was found in *P. purpureum* inoculated with the AMF inoculum B at a dose of 0.5 kg/planting hole. The crude fiber contents found in this study were lower compared to the other results reported by the other researchers i.e., 30.2% (Novianti *et al*., 2014), 32.86% (Winarto *et al*., 2013), and 34.94% (Munasik *et al*., 2012). However, the crude fiber content obtained in this study was in normal value.

The results showed that inoculum A was more effective than inoculum B in improving nitrogen content, nitrogen uptake, phosphor uptake, and protein production of elephant grass (P<0.05) (Table 3). The higher effectivity of the inoculum A than inoculum B was due to the differences in the proportion of species that contrib-

utes to this effect (specific selected AMF type libraries such as *Glomus etunicatum*). Nitrogen contents of AMF inoculum A were higher than AMF inoculum B because propaguale infected and spore number of AMF inoculum A were higher (Table 4) that stimulated the hyphae to grow rapidly for further uptaking of nutrients such as N and P. The total P, K, N, and Ca macronutrients contents were higher in mycorrhizal seedlings compared to non mycorrhizal seedlings in control and salt stress treatment (Abbaspour, 2016), because the capacity of AMF external hyphae to take up and the AMF internal hyphae to deliver the nutrients such as P, $NH4^+$, NO_3^-, K, Ca, SO_4^{2-}, Cu, Zn, and Fe to the plant (Marschner & Bell, 1994). AMF can transfer N to their host plants (Leigh *et al*., 2009; Herman *et al*., 2012) and this process can reduce the use of N fertiliser since plants inoculated with AMF inoculum can obtain and derive higher N (Azcón *et al*., 2008). AMF can acquire inorganic N from soil and transfer it to their associated host plant and the amounts transferred varies widely, even in similar experimental systems (Leigh *et al*., 2009; Hodge & Storer, 2015;). AM fungi not only can play a direct role for assimilation of N but also may represent an effective way to limit N losses from an ecosystem if the colonization level was high (Sarkara *et al*., 2016).

One of the criteria in determining the nutritional quality of forage is the crude protein content. The crude protein content of *P. purpureum* in this study ranged from 10.34% to 12.55% (Table 2). Crude protein content in this study was higher compared to previous results i.e., 8.86% (Adrianton, 2010); 9.8% (Winarto *et al*., 2013) and 11.02%-12.42% (Lee *et al*., 2016). The crude protein content of *P. purpureum* were affected by the type of AMF inoculum. Addition of inoculum A significantly ($P<0.05$) increased the crude protein content of *P. purpureum* compared to inoculum B. The high content of crude protein in elephant grass plants inoculated with inoculum A showed that the quality of inoculum A was better than inoculum B because inoculum A increased crude protein about 10.12%. Among the advantages of AMF inoculum is its high effectiveness in increasing plant nutrient uptake that positively correlates with the increased productivity of host plants. Hyphae branch in the root system of plant inoculated with AMF inoculum can increase the capacity of nutrients absorption such as phosphor and nitrogen (Karti *et al*., 2012). *P. purpureum* inoculated with AMF inoculum A had higher nitrogen content than those inoculated with AMF inoculum B (Table 3). Nitrogen content and nitrogen uptake from inoculum A were higher than inoculum B by 10.53% and 38.10%, respectively. Nitrogen is a part of the crude protein. The increased nitrogen content and nitrogen uptake correlate well with the increased crude protein.

There was a significant difference ($P<0.05$) in protein production in *P. purpureum* inoculated with inoculum A and inoculum B (Table 3). The protein production of *P. purpureum* inoculated with inoculum A was higher than inoculum B. This difference is due to the higher shoot dry weight production and crude protein content of *P. purpureum* inoculated with inoculum A. Protein production in *P. purpureum* inoculated with inoculum A increased by 40.15%. Deficiency of nitrogen would reduce leaf photosynthesis and plant biomass accumulation in a large number of plants. The photosynthetic activity decreased in the leaf of plant with low Nitrogen level because most of the nitrogen in the leaf was located in the enzymes of the Calvin cycle and the thylakoids containing the chlorophylls (Evans, 1989). Protein productivity in plant could be raised as a part of an increase in crop yield and increased protein productivity of plants was regulated by the increased carbon flow during photosynthesis (Platt & Bassham, 1978).

Phosphorus is macro-essential nutrient for plants and fungi, but there are some difficulties in obtaining this nutrient from soil (Smith & Smith, 2012). One unique characteristic of P is its low availability due to a slow diffusion and a high fixation in soils causing this nutrient becomes a limiting factor for plant growth (Shen *et al*., 2011). Phosphor content of *P. purpureum* were not affected by type of AMF inoculum. However, Phosphorus uptake in *P. purpuerum* inoculated with AMF inoculum A was higher by about 40% ($P<0.05$) compared to those inoculated with inoculum B. The high phosphorus uptake is related to a higher dry matter production and the ability of AMF hyphae to absorb phosphorus (Smith & Read, 2008; Karti & Setiadi, 2011; Shukla *et al.* 2012). The increased exploitation of the soil by the hyphae and the competitive ability of the hyphae to absorb local sources of orthophosphate (Bucher, 2007) result in improving plant phosphorus acquisition in the leaves of inoculated plants compared to non-inoculated plants (Liu *et al*., 2007). A primary benefit of arbuscular mycorrhizal fungi is the improved P uptake on the symbiotic plants that eventually usually grow better than plant without mycorrhizal inoculation. The improved P uptake is a consequence of enhanced direct P uptake by the roots of the plant via the arbuscular mycorrhizal fungi pathway (Shen, 2011). Phosphorus is a major component of nucleic acids, membrane lipids, and phsophorylated intermediates of energy metabolism and this nutrient is essential for physiological and biochemical processes (Taiz & Zeiger, 2010). The application of selected arbuscular mycorrhizal fungi as a biofertilizer could improve the crop profitability and reduce the need for P fertilization (Conversa, 2013). Increasing doses of AMF on *P. purpureum* showed no difference in nutrients value, but the shoot dry production was the highest at a a dose of 1 kg/planting hole with AMF inoculum A.

CONCLUSION

The highest shoot dry weight production was found in *P. purpureum* inoculated with AMF inoculum A at a dose of 1 kg/planting hole (AD2). Inoculum A increased shoot dry weight production (34.04%), crude protein content (10.21%), phosphorus uptake (40%), N content (10.53%), N uptake (38.10%), and protein production (40.15%) of *P. purpureum* compared to inoculum B.

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