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USE OF BIO-AGENTS FOR TITHONIA CULTIVATION AS HEDGEROWIN ULTISOLS

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Abstract

The field experiment was conducted with the objective to determine the type of suitable bacteria to be used for cultivating tithonia as hedgerow to increase dry matter and nutrients yield of tithonia in Ultisols. There were 5 treatments; K= without bio-agents; L= bacteria diluting phosphate (BDP); M= *Azospirillium*; N= BDP+*Azospirillium*; and O= BDP+ *Azospirillium* + *Azotobacter*, using a randomized block designed (RBD) and 3 replications. Those bacteria treatments were re-inoculated to the rhizosphere of tithonia in the nursery. Then, the young tithonia was planted as hedgerow in Ultisol for 8 months, and pruned every 2 months. The results showed that the bacteria diluting phosphate, and/or its combination with *Azospirillum* were the suitable bio-agents for tithonia cultivation in Ultisols.

Keywords: bio-agents, tithonia, alternative fertilizer, Ultisol

Introduction

Ultisols require much higher fertilizer than other soils. Recently, the price of synthetic fertilizers increased with time and very often disappears from the market. Therefore, an alternative fertilizer, which is easier and cheaper to produce, is needed to reduce synthetic fertilizers application without reducing yield. According to Jama *et al*. (2000) tithonia contained high nutrients (3.5- 4% N; 0.35-0.38% P; 3.5- 4.1% K, 0.59% Ca; and 0.27% Mg). So, tithonia (*Tithonia diversifolia*) could be used as an alternative fertilizer and/or a soil amendment.

The application of fresh tithonia (equivalent to100 kg N and 100 kg K) can reduced the application of NK synthetic fertilizers up to 50% for cultivation of chilly, ginger, and corn in Ultisol (Hakim *et al*., 2004; Hakim and Agustian, 2005). Therefore, tithonia had better cultivated and used as an alternative fertilizer *in situ*. Tithonia can be cultivated as hedgerow with a distance of 5 m between rows at a 50cm x 50cm spacing within the rows with 100 cm wide, and pruning every 2 months. With this cultivation technique, tithonia produced 6.6 - 6.8 tones of dry matter (DM) with nutrient contents of 150-240 kg N and 156-245 kg K on the 2,000 m^2 rows area $ha^{-1}y^{-1}$ (Hakim and Agustian, 2005).

Hakim *et al*. (2007) reported that the high DM yield and nutrient uptake of tithonia was due to the activities of bio-agents at the rhizosphere of tithonia. They found 3 isolates of arbuscula mycorhizae fungi, 3 isolates of fungi diluting phosphate, 3 isolates of *Azotobacter*, 4 isolates of bacteria diluting phosphate, and 3 isolates of bacteria phyto-hormone producer. Asman *et al*. (2008) found 4 treatments selected from 10 treatments of pot experiment to produce high amounts of DM and nutrients yields, namely: (1) bacteria diluting phosphate (BDP), (2) *Azospirillium,* (3) BDP + *Azosprillium*, and (4) BDP + *Azotobacter* +*Azospirillium*. Based on the results of pot experiment, the four bio-agents should be tested in the field using an Ultisol.

The aim of this study was to determine the type of suitable bacteria to be used for cultivating tithonia as hedgerow, in order toi ncrease dry matter and nutrients yield of tithonia as an alternative fertilizer in Ultisols.

Materials and Methods

A field experiment was conducted in 2009 in Ultisol, at the Experimental Farm of Andalas University, Limau Manis, Padang, West Sumatra Province, Indonesia, located at 250 m above sea level. The mean annual temperature is approximately 26°C, and annual precipitation is 5,546 mm.

The treatment was based on data of Asman *et al*. (2008) and the experimental units were arranged in a randomized block designed (RBD) with 5 treatments and 3 replications. The treatments were: K= without bio-agents; L= bacteria diluting phosphate (BDP); M= *Azospirillium;* N= BDP + *Azospirillium*; and O= BDP + *Azospirillium* + *Azotobacter*. Those bacteria were re-inoculated to the rhizosphere of tithonia in the nursery. Then, the young tithonia was planted as hedgerow in Ultisol for 8 months, and pruned every 2 months. Biomass of each pruning was weighed, and sampled for measurement of dry matter (DM). Parameters included the dry matter weight also N, P, and K content.

Results and Discussion

The effect of re-inoculation of bio-agents on DM and nutrient (N, P, and K) yield of tithonia planted in Ultisols as hedgerow for 8 months (4 times pruning) and estimated for 6 times pruning (a year) are presented in Table 1 and Table 2. Results showed that re-inoculation of bio-agents to rhizosphere of tithonia increased DM and nutrient yield of tithonia significantly compared to the control. The yield of 7.8 to 11.27 tones DM ha^{-1} y^{-1} was high enough compared to the yield without re-inoculation (6.8 t ha^{-1} y^{-1}) as reported by Hakim and Agustian (2005). It showed that re-inoculation with BDP played an important role in the growth of Tithonia to produce a high DM yield. Table 2 described that if tithonia was re-inoculated with BDP then pruned 6 times a year, it would produce approximately 173 kg N, 24 Kg P and 203 kg K. $ha^{-1}.y^{-1}$. Re-inoculation with BDP + *Azospirillium* produced higher nutrients such as 180 kg N and 24 Kg P, but K was lower as 114 kg K $ha^{-1}y^{-1}$. The results obtained with re-inoculation BDP or BDP + *Azospirillium* was higher than that reported by Hakim and Agustian (2005) without re-inoculation with bio agent.

Table 1. The dry matter weight of tithonia shoots as influenced by re-inoculation with bio-agents to the rhizosphere on Ultisols, Padang Indonesia.

Treatments	pruning I	pruning II	pruning III	pruning IV	Total 4 times pruning	*if 6 times pruning a year
	............................(kg. 1.6 m^{-2})				....	t. $ha^{-1}y^{-1}$
K = without bio-agent	0.64 c	0.99 b	1.13 a	1.33 b	4.09	7.64
L = bacteria dilutig phosphate(BDP)	1.19 a	2.14 a	0.75 c	1.93 a	6.01	11.27
M = *Azospirillum*(Azos)	0.88 b	1.02 b	0.86 bc	1.05 c	3.81	7.15
N = BDP + Azos	0.78 b	1.02 b	0.95 b	1.29 b	4.17	7.79
O = BDP + Azos+*Azotobacter* (Azot)	0.80 b	1.10 b	1.19 a	1.42 b	4.51	8.46

Table 2. The total of N, P, and K of tithonia shoots as influenced by bio-agents re-inoculation to rhizosphere on Ultisols, Padang Indonesia.

Treatments	Total yield of N, P, dan K for 4 times pruning (g 1,6 m^{-2}), and estimation for 6 times pruning a year (kg.2000 m^2.ha^{-1}.y^{-1})*								
	N(g.1,6 m^{-2})		(kg.ha^{-1})	P(g.1.6 m^{-2})		kg.ha^{-1}	K(g.1.6 m^{-2})		(kg.ha^{-1})
K = without bio-agent	88	b	132	10	b	15	48	c	72
L = bacteria dilutig phosphate (BDP)	115	a	173	16	a	24	135	a	203
M = *Azospirillum*(Azos)	101	b	152	14	a	21	65	b	98
N = BDP + Azos	120	a	180	16	a	24	76	b	114
O = BDP + Azos+*Azotobacter* (Azot)	116	a	174	14	a	21	65	b	98

Note: Figures in the same column followed by different letters are significantly different according to HSD 5%, ha^{-1}

* If pruned 6 times a year on a 2000 m^2 hedgerow ha^{-1}

Conclusions

The suitable bio-agents re-inoculation to rhizosphere of tithonia planted as hedgerow on an Ultisol were bacteria diluting phosphate and/or bacteria diluting phosphate combined with *Azospirillium* in order to increase dry matter, N, P, and K yield. Re-inoculation of bacteria diluting phosphate to the rhizosphere of tithonia produced 11 t dry matter, 173 kg N; 24 Kg P, and 203 kg K / 2000m^2 ha^{-1}y^{-1}, whereas the bacteria diluting phosphate + *Azospirillum* re-inoculation was about 8 tones dry matter, 180 kg N; 24 Kg P , and 114 kg K on the 2,000 m^2 rows area ha^{-1} y^{-1}.

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