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Effects of Arbuscular Mycorrhizal Fungi on Yield and Nutritive Values of Napier Pak Chong 1 (*Pennisetum purpureum* cv. pakchong1)

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Study on arbuscular mycorrhizal fungi (AMF) to promote yield and nutritive values of Napier Chong Pak 1 (*Pennisetum purpureum* cv. pakchong 1*)*. The experiment was conducted at Agricultural Research and Training Center 100 rai, Nakorn Rachasima Rajabhat University, Amper Muang, Nakorn Rachasima Province during November 2014 to March 2015. The pot experiment design was RCBD with four treatments and four replications namely 1) control (no AMF inoculated and no urea fertilizer applied) 2) commercial AMF inoculated 3) 20kg/rai urea applied and 4) combination between commercial AM fungi and 20kg/rai urea fertilizer application. The commercial AMF could promote number of tillers per plant ($p<0.05$) and dry matter ($p<0.01$), while plant height ($P>0.05$), the number of leaf per stem ($P>0.05$), fresh weight ($P>0.05$) and dry weight ($P>0.05$) were opposite comparing with control. For chemical composition, AMF decreased of NDF ($P<0.05$) and ADF ($P<0.05$). Using of AMF was not increase in crude protein of Napier Pak Chong 1 compared with control. Application of urea fertilizer was higher promote growth and yield of Napier Pak Chong 1 more than other treatment. However, commercial AMF used decreased in dry matter ($p<0.01$). In addition the combination of commercial AMF and urea fertilizer increased in crude protein of Napier Pak Chong 1. The result indicated that arbuscular mycorrhizal fungi possibly used as biofertilizer for Napier Pak Chong 1. And the more future work will needed

Keywords: Napier Pak Chong 1, AMF, yield, nutritive values

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Introduction

Napier Pak Chong 1 grass (*Pennisetum purpureum* cv. pakchong 1) is a cross of ordinary Napier (*Pennisetum purpureum*) and pearl millet (*Pennisetum americanum*) developed by Dr. Krailas Kiyothong, an animal nutritionist and plant breeder from the Department of Livestock Development in Pakchong, Nakhon Ratchasima province in northeastern Thailand. It grows well under many locations. But it performs best in soils that are rich in organic matter. Napier Pak Chong 1 grass is a renewable energy sources and provides a very nutritious forage crop which could be fed to cattle, carabaos and other livestock in Thailand (Sarian, 2013). It provides nutritive and palatable green fodder all the year round, which contains 10-12% of crude protein, 14.9%DM, 15.9%protien, 35.8%NDF, 14.5% ash and 36.5%soluble carbohydrate at the harvest time of 45 day (Pitaksinsuk *et al*., 2010). Arbuscular mycorrhizal fungi (AMF) associate with a broad range of species and are more widely distributed than other types of mycorrhizal association (Power and Mills, 1995). They stimulate plant growth especially in soil substrates with low fertility mainly due to improved phosphorus absorption (Smith *et al.* 1986). AMF are known to play an important role in the growth and development of fodder crop plant, as the help increase the plant nutrition uptake especially P. They increased shoot and root P contents by 16.7 and 72.9%, respectively (Hao *et al*, 2014), also increased N uptake by wheat (Sharif *et al*., 2009) and inoculation of AMF enhanced N and P uptake (Jan *et al*., 2014). To date, research in Thailand has concentrated on the ultilization of AMF to promote the yield of many crops**.** However, Norfadzrin et al (2016) found no effect of AM fungi application on wet basis yield, DM CP, CF of Napier grass in Malaysia. Wanjiru *et al* (2009) found using of AMF showed no enhanced growth in napier grass cuttings. But Chahar (2014) found application of *Glomus intraradices* significantly increased the fresh weight, dry weight, chlorophyll content, nitrogen andphosphorus uptake of the Giant Napier and Hybrid Napier compared to the uninoculated plants. AMF roles effect on the yield and nutritive values of Napier Pak Chong 1 needed.

The aim of the research was to study effects of arbuscular mycorrhizal fungi on growth, yield and nutritive of Napier Pak Chong 1 (*Pennisetum purpureum* cv pakchong 1).

Materials and methods

The pot was conducted from November 2014 to March 2015 at Agricultural Research and Training Center 100 rai, Nakorn Rachasima Rajabhat University, Amper Muang, Nakorn Rachasima Province. The

experimental design was a randomized complete block design (RCB) with four replications. Four treatments was including; 1) control (no AMF inoculated and no urea fertilizer applied) 2) commercial AMF inoculated 3) 20kg/rai urea applied and 4) combination between commercial AM fungi and 20kg/rai urea fertilizer application. Seven kilogram of sterilized soil mixed with manure (2:1) was put into each pot. Napier Pak Chong 1 cutting was planted in the pot as each treatment. The commercial AM inoculum treatment was produced by Department of Agriculture, Bangkok Thailand using. In each pot of AM treatment, 5 g of AM inoculum containing 25 spores per gram of *Glomus* sp. and *Acalospora* sp. was placed below the grass cutting. Urea fertilizer was used after planting. The plants were watering to keep optimum moisture and allowed to grow for 120 days. After 1st cutting stage (60 DAP) plant heights, number of tillers per plant and number of leaf plant were measured and harvested to analyze for fresh weight, dry weight, dry matter (DM), ash, crude protein (CP) AOAC, 1985), neutral detergent fiber (NDF) (Goering and Van Soest, 1970), acid detergent fiber (ADF; Goering and Van Soest, 1970).

Data obtained were analyzed by Analysis of variance (ANOVA) using a statistical package (Statistical Package for Social Science) (Levesque and SPSS Inc., 2006). Treatment mean (plant height, tillers per plant, number of leaf per stem, fresh weight, dry weight, dry matter, CP, OM, ASH, NDF, ADF) were analysed by Duncan's New Multiple Range Test (DMRT) at 5% level of significance.

Results

Chemical composition Napier Pak Chong 1

We analysed the chemical composition of Napier Pak Chong 1 at 45 DAP planted under field condition. There were 23.72%DM, 91.63%OM, 8.37%ash, 6.65%CP, 72.21%NDF, 45.72%ADF and 28.34% lignin. And after fermentation for 21 day, we found 15.45-17.22%DM, 87.71-91.37%OM, 11.96-14.68 %ash, 5.42-5.75 %CP, 2.57-2.85 of ammonia, pH 4.19-4.49 and 24.7-25.0 ℃.

Effect of AMF on growth and yield of Napier Pak Chong 1

Inoculation of commercial AM fungi had no effect on plant heights ($P>0.05$) and number of leaf per plant ($P>0.05$) of Napier Pak Chong 1 whereas AM fungi inoculated showed highly significant in number of tillers per plant ($P<0.01$). Urea fertilizer showed significant in number of tillers per plant ($P<0.05$) at 1st cutting stage (60 DAP) and 2nd cutting interval (60 days regrowth) (Table 1). And application of urea fertilizer had no effect on in plant heights ($P>0.05$) and number of leaf per plant ($P>0.05$) of Napier Pak Chong 1.

But urea fertilizer showed highest plant high, number of tillers per plant and number of leaf per plant following by using no commercial AMF, using commercial AMF inoculated and combination between commercial AM fungi and urea fertilizer (Table 1).

Application of urea fertilizer increased highly significant in FW ($P<0.01$) DW ($P<0.01$) and DM ($P<0.01$) of Napier Pak Chong 1. The yield of Napier Pak Chong, fresh weight (FW), dry weight (DW), dry matter (DM) showed highest when applied with urea fertilizer at 1st cutting stage (60 days after planting) and 2nd cutting interval (60 days regrowth) as shown in Table 2. While inoculation of commercial AMF showed no significant in FW, DW and DM of Napier Pak Chong 1 when comparing with control (Table 2).

The chemical compositions of 1st cutting stage (60 DAP) and 2nd cutting interval (60 days regrowth) of Napier Pak Chong 1 were shown in Table 3 and 4. DM content was highest ($P<0.05$) in combination between commercial AMF and urea fertilizer applied than those other treatment. Crude protein content were found significantly different among treatment ($P<0.05$); data were show high level in term of application of urea fertilizer and combination between commercial AMF and urea fertilizer (Table 3 and 4).

Table 1 Height of plant, number of tillers per plant, number of leaf per stem of Napier Pak Chong1 at 1st cutting stage (60 DAP) and 2nd cutting interval (60 days regrowth) using different treatment

Treatment	At 1st cutting stage			At 2nd cutting interval		
	Height of plant	number of tillers per plant	number of leaf per plant	Height of plant	number of tillers per plant	number of leaf per plant
1) Control	93.20	1.08 b	13.4	93.97	2.99 b	15.59
2) AMF	84.64	1.89 a	11.4	91.08	2.89 b	17.28
3) Urea	97.48	1.06 b	19.3	92.44	5.14 a	28.76
4) AMF+Urea	78.37	1.10 b	10.9	87.81	4.24 a	26.23
F-test	ns	**	ns	ns	*	ns
C.V. (%)	12.74	22.99	26.22	12.62	11.61	34.73

Means with different letter(s) in columns are significantly different at $P \leq 0.05$.
Urea = 20 kg·rai^{-1}, AMF = 125 spores pot^{-1}.

Table 2 FW, DW and DM of Napier Pak Chong1 at 1st cutting stage and 2nd cutting interval (60 days regrowth) using different treatment

Treatment	At 1st cutting stage (60 DAP)			At 2nd cutting interval		
	FW (g)	DW (g)	%DM	FW (g)	DW (g)	%DM
1) Control	185 ab	61 ab	33 bc	88 b	24.0 c	26.8 a
2) AMF	119 bc	50 b	43 ab	96 b	24.8 bc	25.9 a
3) Urea	221 a	65 a	29 c	281 a	47.9 a	17.1 b
4) AMF+Urea	110 c	50 b	47 a	158 b	36.2 b	24.2 ab
F-test	**	**	**	**	**	**
C.V. (%)	19.66	9.67	12.80	25.40	16.23	15.18

Means with different letter(s) in columns are significantly different at $P \leq 0.05$., Urea = 20 kg·rai^{-1}, AMF = 125 spores pot^{-1}., FW=Fresh weight, DW= dry weight, DM=dry matter

Table 3 CP, OM, Ash, NDF and ADF of Napier Pak Chong1 at 1st cutting stage (60 DAP) using different treatment

Treatment	Chemical compostion of Napier Pak Chong1 (%)				
	CP	OM	ASH	NDF	ADF
1) Control	3.45 c	92.51 a	15.48 ab	68.05	38.69
2) AMF	3.47 c	91.02 ab	16.41 a	62.54	39.12
3) Urea	11.4 b	92.66 a	14.43 b	61.95	40.34
4) AMF+Urea	13.6 a	89.75 b	16.63 a	66.44	37.07
F-test	**	*	*	ns	ns
CV (%)	4.02	0.97	4.03	4.81	4.97

Means with different letter(s) in columns are significantly different at $P \leq 0.05$. Urea = 20 kg·rai^{-1}, AMF = 125 spores pot^{-1}., CP =Crude protein, OM = organic matter, NDF = neutral detergent fiber, ADF = acid detergent fiber

Table 4 CP, OM, Ash, NDF and ADF of Napier Pak Chong1 at2nd cutting interval (60 days regrowth) using different treatment

Treatment	Chemical compostion of Napier Pak Chong1 (%)				
	CP	OM	ASH	NDF	ADF
1) Control	3.96 c	94.37 a	11.76 c	78.50 a	48.47 a
2) AMF	3.96 c	94.38 a	12.47 b	75.90 b	44.66 b
3) Urea	12.22 b	94.32 a	13.47 a	67.27 d	39.84 d
4) AMF+Urea	14.65 a	93.00 b	11.89 c	71.04 c	42.75 c
F-test	**	*	**	**	**
CV (%)	1.80	0.46	0.86	1.15	0.98

Means with different letter(s) in columns are significantly different at $P \leq 0.05$. Urea = 20 kg·rai^{-1}, AMF = 125 spores pot^{-1}., CP =Crude protein, OM = organic matter, NDF = neutral detergent fiber, ADF = acid detergent fiber

Discussions

Chemical composition of Napier Pak Chong 1 at 45 DAP from field was 23.72%DM, 91.63%OM, 8.37%ash, 6.65%CP, 72.21%NDF, 45.72%ADF and 28.34% lignin. And after fermentation for 21 day, we found 15.45-17.22%DM, 87.71-91.37%OM, 11.96-14.68 %ash, 5.42-5.75 %CP, 2.57-2.85 of ammonia, pH 4.19-4.49 and 24.7-25.0 ℃. The Napier Pak Chong 1 provides nutritive and palatable green fodder all the year round, which contains 12-18% CP, 35.8% CF, 14.5% ash and 36.5-33.3 %soluble carbohydrate at the harvest time of 45 day (Pitaksinsuk *et al.*, 2010).

At 1st cutting stage (60 days after planting) and 2nd cutting interval (60 days regrowth), application of urea fertilizer showed highest plant highest, number of tillers per plant and number of leaf per plant following by using no commercial AMF, using commercial AMF inoculated and applied with urea fertilizer together with commercial AMF inoculated. Norfadzrin et al (2016) was also found no effect of AM fungi application on wet basis yield, DM CP, CF of Napier grass in Malaysia. Chahar (2014) found application of *Glomus intraradices* significantly increased the fresh weight, dry weight, chlorophyll content, nitrogen andphosphorus uptake of the Giant Napier and Hybrid Napier compared to the uninoculated plants. Wanjiru *et al* (2009) investigated the ability of arbuscular mycorrhizal fungi (AMF) in enhancing growth in tomato

seedlings, tea and Napier grass cuttings. They found that DAP fertilizer individually enhanced growth in tomatoes, tea and Napier while AMF only enhanced growth in tomatoes.

The chemical compositions of 1st (60 days after planting) and 2nd cutting interval (60 days regrowth) of Napier Pak Chong 1 were shown in table 3 and 4. DM content was highest ($P<0.05$) in combination between commercial AM fungi and urea fertilizer applied than those other treatment. Crude protein content were found significantly different among treatment ($P<0.05$); data were show high level in term of application of urea fertilizer and combination between commercial AM fungi and urea fertilizer application ; therefore supplementation sources became more beneficial to improve nutritional composition particular protein content of the matured napier grass. There were no effected by supplementation all treatments ($P>0.05$) of NDF and ADF content (1st cutting). According to Yakota and Ohshima (1991) had been reported that NDF and ADF contains large amount when contain high levels of lignin may affected on dry matter digestibility of feed. It might be affected by temperatures during growth reduce dry matter digestibility because of increased amount of cell wall and lignification as well as promoting stem development. As 2nd cutting interval were affected on NDF and ADF content ($P<0.05$) the NDF and ADF highest values were found in control and follows by commercial AMF, combination of commercial AMF with urea fertilizer and urea fertilizer application, respectively. Research in Thailand of cutting interval on quality of Napier Pak Chong 1 was reported by Wijitphan and Lowilai (2011) when cutting at 55 days after planting were found NDF and AFF content at 71.8 and 45.8 % of DM; respectively. It is suggested that Napier Pak Chong 1 should be harvested at optimum cutting interval at 60 days in order of high nutritive values (CP, DM, OM, NDF and ADF) with relative of biomass production to fed as basal roughage to ruminant production in Thailand. All result was found in this study as similar data as reported by Agaga et al (2005).

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