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Using of Chemical Fertilizer and Arbuscular Mycorrhizal Fungi to Promote Growth and Yield of INSEE 2 Sweet Corn

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The effects of chemical fertilizer and arbuscular mycorrhizal fungi (AMF) on growth and yield of INSEE 2 sweet corn under field condition were studied. The experimental design was completely randomized design (CRD) which consisted of four treatments and three replications namely (1) no fertilizer applied (2) inoculated with AMF (3) chemical fertilizer with recommended rate (50 kg/rai of 15-15-15 and 25 kg/rai of urea) (4) combination ttreatment (50 kg/rai of 15-15-15 and 25 kg/rai of urea and AMF inoculated). The plot experiment was conducted during June, 24th to September, 13th 2015 at 78, Tambon Naimuang, Amper Muang Buriram, Buriram Province. ANOVA and mean comparison were analyzed for corn height, number of leaf, fresh weight of plant and sweet corn yield. The result showed that combination treatment (50 kg/rai of 15-15-15 and 25 kg/rai of urea and AMF inoculated) significantly increased growth and yield of sweet corn ($p<0.01$) compared to chemical fertilizer. However, using of AMF inoculation showed non-significant ($p>0.05$) which compared to non fertilizer application.The result concluded that chemical fertilizer was still increasing growth and yield of INSEE 2 sweet corn and inoculation of AMF before applied chemical fertilizer which significantly promoted the growth and yield of INSEE 2 sweet corn under field conditions.

Keywords: Arbuscular mycorrhizal fungi, Sweet corn, Insee 2

Introduction

Sweet corn, a variety of maize with a high sugar content, reduce the risk of heart disease and cancer. They can release ferulic acid, antioxidant, that efficient for body's immune system, anti-aging of cells, prevent cancer cells, heart disease, influenza, the effects of ultraviolet radiation. (Kerdsri and Suwanaginda, 2008). INSEE 2, the famous hybrid sweet corn, was developed rom SSWI 114 x KSei 14004 or)] sh2 Syn 29 x KS 1) x Suwan 3(S)C4]-F4-S8-24-2-4-2-2 by National Corn and Sorghum Research Center, Nakorn

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Rachasima, Thailand. They gave high unhusked ear weight (2,430 kg/rai), husked ear weight (1,371 kg/rai) and sweetness 15 percent brix. Arbuscular Mycorrhizal Fungi (AMF) a group of root obligate symbiont mutual benefits with about 80% of plants. They are considered as biofertilizers, since they provide the host with water, nutrients, and pathogen protection, in exchange for photosynthetic products (Berruti *et al*., 2015). AMF are known to play an important role in the growth and yield of corn and maize, as the help increase the plant nutrition uptake. Inoculation with *Glomus mosseae* enhanced growth of sweet corn by increasing concentration of N, P and K (24.2, 8.4 and 18.2%) respectively (Ali *et al*., 2010). The growth of sweet corn was significant in plant height, stem girth, leaf height, leaf number, leaf length, leaf width and leaf area when using of chicken manure inoculated with AMF on Rasau series soil (Arshad and Rawayau, 2017). Tas (2014) founded that the mycorrhiza application will be beneficial from the perspective of enhancing plant development both in natural and agricultural ecosystems. Corn has a high demand for N and P nutrients (Jokela and Randall, 1989; Olson and Sander, 1988). In order to get a high yield, large amounts of N and P fertilizers are applied (Barry and Miller, 1989). However, increase in fertilizer application decreases olonization potential of AMF. Root colonization level of Un-inoculated plants ranges from 11.2% in control plants to 2.4% in plants treated with 120-60-50 kg ha-1 NPK (Abdullahi and Sheriff, 2013). Poomipan and Tonglueng, (2011) studied effects of AMF on growth and phosphorus (P) uptake of corn (*Zea mays* L.) in pots under sterilized Pak Chong soil series. They founded AMF significantly increased shoot dry weights of fieldcorn (Suwan 4452) and sweet corn (INSEE 2) by 35% and 120% compared to non AM inoculation, respectively. And AM inoculation also increased P uptakes in shoot of fieldcorn and sweetcorn by 67% and 134%, respectively. Although AMF showed a significant positive effect on sweet corn development, in Thailand there is insufficient information on using combination between chemical fertilizer and AMF effects on sweet corn var INSEE 2 under natural codition. Therefore, the following research was carried out to study how combination between chemical fertilizer and AMF effects on growth and yield of INSEE 2 sweet corn under field condition.

Materials and methods

This research was studied effects of chemical fertilizer and arbuscular mycorrhizal fungi (AMF) on growth and yield of INSEE 2 sweet corn under field condition. Twelve plots, 1x4 m per plot, were conducted at 78 Tambon Naimuang, Amphoe Muang, Buriram province during June 24th to September

13th, 2015. Plot experimental was designed into CRD with three replications. Four treatments were including; (1) no fertilizer applied (2) inoculated with AMF (3) chemical fertilizer with recommended rate (50 kg/rai of 15-15-15 and 25 kg/rai of urea) (4) combination ttreatment (50 kg/rai of 15-15-15 and 25 kg/rai of urea and AMF inoculated). The soils were sampled and tested to determine the N, P, K content in the plots. Soil pH was also tested using pH test kit by Soil and fertilizer development project, Department of Soil Science, Kasetsart University, Thailand. The soils was low N, high P and low K and also acidic soil (pH =5). INSEE 2 sweet corn was done seedling with and without commercial AM inoculum that produced by Department of Agriculture, Bangkok Thailand. After 10 days, thirty-three seedling were transplanted into each plot as described treatment with 25x35 cm on spacing. For chemical fertilizer treatment, we applied 50 kg/rai of 15-15-15 by banding before transplantation. The side dressing of urea was used after planting for 25 days. The plants were watering to keep optimum moisture and allowed to grow for 75 days. Data obtained were analyzed by Analysis of variance (ANOVA) using a statistical package. Treatments mean (plant height, number of leaf, plant fresh weight, ear with husk fresh weight) were analysed by Least Significant Difference (LSD) at 5% level of significance.

Results

Soil in this experiment was poor soil because of low N-K content and also strongly acid soil (pH = 5.0). Using of combination between 50 kg/rai of 15-15-15and 25 kg/rai of 0-0-46and inoculated with AMF showed highly significant increase growth and yield of INSEE 2 sweet corn. There increased plant heights ($P<0.01$), number of leaf per plant ($P<0.01$), plant fresh weight ($P<0.01$), and fresh weight of ear with husk ($P<0.01$) comparing with no fertilization. And application of 50 kg/rai of 15-15-15and 25 kg/rai of 0-0-46 and inoculated with AMF increased growth and yield of corn INSEE-2 more than others treatment follweing by 50 kg/rai of 15-15-15and 25 kg/rai applied, inoculated AMF and no fertilization. The result showed the application of 50 kg/rai of 15-15-15and 25 kg/rai of 0-0-46and inoculated with AMF significant increased in plant heights ($P<0.01$), number of leaf per plant ($P<0.01$), plant fresh weight ($P<0.01$), and fresh weight of ear with husk ($P<0.01$) more than application of 15-15-15and 25 kg/rai of 0-0-46 alone. INSEE 2 sweet corn inoculated with AMF alone showed non significant in growth and yield when compared with no fertilization (Table 1, Table 2).

Table 1 Height of plant, leaf number of of INSEE2 sweet corn at 35, 45, 60 DAP using AMF and chemical fertilizer

Treatment	Plant height (cm)			Number of leaf (leaf)		
	35 DAP	45 DAP	60 DAP	35 DAP	45 DAP	60 DAP
1) Control	10.8 c	16.4 c	71.9 c	5.25 c	6.44 c	8.00 c
2) AMF	11.2 c	17.3 c	74.7 c	5.32 c	6.87 c	8.18 c
3) ChemFer	18.3 b	41.5 b	130 b	7.23 b	9.95 b	10.9 b
4) ChemFer+AMF	21.3 a	52.5 a	137 a	8.32 a	10.7 a	11.3 a
F-test	**	**	**	**	**	**
C.V. (%)	6.93	10.31	6.74	7.49	6.34	4.30

Means with different letter(s) in columns are significantly different at $P \leq 0.05$.
AMF = inoculated with arbuscularmycorrhizal fungi,
ChemFer = applied with 50 kg/rai of 15-15-15and 25 kg/rai of urea.

Table 2 Fresh weight of plant, yield of INSEE2 sweet corn using AMF and chemical fertilizer

Treatment	Fresh weight of plant (g/plant)	Ear with husk (g/ear)	Fresh weight of plant (kg/rai)	Ear with husk (kg/rai)
1) Control	60.3 c	60.0 c	1,068 c	790 c
2) AMF	62.7 c	66.3 c	1,101 c	876 c
3) ChemFer	251 b	197 b	4,415 b	2,595 b
4) ChemFer+AMF	292 a	229 a	5,138 a	3,029 a
F-test	**	**	**	**
CV (%)	19.03	18.03	18.91	18.08

Means with different letter(s) in columns are significantly different at $P \leq 0.05$.
AMF = inoculated with arbuscularmycorrhizal fungi,
ChemFer = applied with 50 kg/rai of 15-15-15 and 25 kg/rai of urea.

Discussion

In this field study, inoculated with AMF increased growth and yield of INSEE 2 sweet corn, although this change was not significant in Low soil N-K content. This indicates that the N, K availability in the soil was limiting plant growth and yield, under N-limited, P-rich field conditions, Saia *et al*., (2015) found no effects of AMF on wheat above ground biomass, grain yield and yield components were observed at maturity due to inoculation with AMF negatively affected amination activity in the root and concentrations of most of amino acids as the hypothesis that N availability is crucial for the AM benefit to the plant growth and yield. Cheeke *et al*. (2013) suggested that the cultivation of Bt maize may not have an impact on AMF in the soil ecosystem under field conditions. Blanke *et al*., (2005) investigated AMF in industrially polluted grassland characterized by high phosphorus levels, they found negative relationship between percentage root colonization of A. vulgaris by AMF and

both tissue N concentration and N : P ratio. For fertilization experiment, N-poor plants had higher mycorrhization rates than N-fertilized plants. However, the responsiveness of sweet corn (*Zea mays* L.) to AMF (*G. mosseae*) inoculation study under sterile soil was found positive relationship between host response to AMF and growth stage of the host (Ali *et al*., 2010). Poomipan and Tonglueng, (2011) founded AMF significantly increased shoot dry weights of sweet corn (INSEE 2) by 120% compared to non AM inoculation under sterilized Pak Chong soil series (low soil P). The result also indicated that INSEE 2 sweet corn still needs chemical fertilizer for enhancing growth and yield in low soil fertility. In addition, inoculation of AMF before applied with recommemded rate of chemical fertilizer (50 kg/rai of 15-15-15 and 25 kg/rai of urea) significantly promoted growth and yield of INSEE 2 sweet corn under field conditions. Althought colonization potential of AMF decreases with increase in fertilizer application but Abdullahi and Sheriff (2013) recorded applying fertilizer at 60-30-50 kg ha^{-1} NPK showed the highest colonization level (39.7%) followed by (31.9%) in plants treated with (40-20-50 kg ha^{-1} NPK). The inoculated plants with 60-30-50 kg ha-1 NPK produced plants with highest growth parameters (38.63 cm, 13.66, 27.80g and 3.74 g) for plant height, number of leaves, fresh shoot and dry biomass respectively. Ziane *et al*. (2017) showed that tomato needed both fertilization and AMF inoculation to achieve optimal growth and yield under field condition. And that the application of AMF can compensate for the reduction in chemical fertilizers that in mycorrhizal inoculant, an application of 50% of recommended fertilizer provided the same yield as the full fertilizer dose without inoculation. In addition using organic manure amendment promote growth and yield of sweet corn as observed by Arshad and Rawayau (2017) found a significant impact of organic manure amendment and AMF inoculation on sweet corn growth, with chicken manure having superiority over other sources of organic manure (cattle, horse and biochar).

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