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GROWTH DEVELOPMENT AND NATURAL INFECTION INCIDENCE OF TOBACCO MOSAIC VIRUS (TMV) ON SILICON-TREATED CHILLI (*Capsicum annuum* L.) CULTIVATED IN COMMERCIAL SOIL

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ABSTRACT

Chilli (*Capsicum annuum* L.) is one of the most important cultivated crops in Malaysia. It is largely cultivated for its fruits. The application of the chemical fertilizer solely is able to supply the desire nutrient for chilli plant but did not helping in resistant of pathogen attack. Therefore, this study attempts to determine the potential of silicon application on plant growth and disease resistant on treated plants. Chilli seedling were transplanted into individual polybag containing commercial soil and supplied with silicon at 0.5ml/L and 1.5ml/L concentrations for the period of 11 weeks. Control plants were supplied with water instead of silicon nutrient. Assessment was conducted from week 3 to 11 after transplanting. Result showed that the plant growth of chilli treated with both Si nutrient concentrations measured by plant height, leaf number, leaf diameter and stem diameter were significantly better than control plants. Besides, the natural occurrence of Tobacco Mosaic Virus (TMV) disease incidence observed on treated chilli were 26.7–44.4% reduced compared to control plants. This study provides the knowledge on the benefit of Silicon application on the cultivated chilli and could possibly help the farmers to produce higher and better quality of yield in the future.

Key words: Chili, plant growth, disease incidence, Silicon nutrient, commercial soil

INTRODUCTION

In Malaysia, Chilli (*Capsicum annuum* L.) is known as the second most popular vegetable fruit after long bean. The genus consists of 25 species that have been cultivated worldwide. From these, *C. annuum, C. chinense, C. frutescence, C. pubescence* and *C. baccatum* are known as domesticated plants (Sudré *et al.,* 2010; Ibiza *et al.,* 2012). Among the species, *C. annuum* variety "Kulai" is commonly planted by Malaysian farmers due to its high marketable value. In most of countries, chilli has become an important spice in many cuisine (Manoharan *et al.,* 1998; Materska & Perucka, 2005; Altomare *et al.,* 2006). It can be consumed as fresh, dried or in powder (El-Ghoraba *et al*., 2013). Besides its economic importance, the fruit has high nutritional and medicinal values due to high content of ascorbic acid (vitamin C), carotenoids (provitamin A), tocopherols (vitamin E), flavonoids, and capsaicinoids (Iqbal, 2009; El-Ghoraba *et al*., 2013).

Although chilli has been widely cultivated by farmers, the plant is very susceptible to many diseases which can be occurred during pre-harvest or post-harvest stage (Nurulhuda *et al.,* 2009). A wide range of pathogens such as virus, fungi and bacteria have been reported to infect the chilli plant. Among these, virus disease is the most difficult to control as it is transmitted by the vector. Emerging of virus population in the plantation area is an important signal for huge economic losses that can threatening crop production (Varma & Malathi, 2003). For example, mosaic disease associated with

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tobacco mosaic virus (TMV) has been reported as destructive disease that infect chilli plantation worldwide (Nyana *et al.,* 2008). Most of viral pathogen is able to attack the chilli plant at early stage of the plant growth (Kumar *et al.,* 2006). As consequence, the disease will disseminate and cause high profit loss to many farmers. Occurrence of diseases has forced the farmers to use extensive pesticide in order to maintain high yield production. Besides that, application of chemical fertilizer was also preferred to guarantee continuous production of chilli. Frequent application of chemical fertilizers can increase potential of ground and surface water pollution due to nitrate leaching and surface runoff (Zhu *et al.,* 2005). However, continuous application of these chemicals has led to public concerns due to its negative effects on human, animals and agriculture soil health (Whipps & Lumsden, 2001). Therefore, this scenario has resulted to a more demanding sustainable approach which used a safe nutrient fertilizer and pesticides that can sustain soil health for agriculture production.

Silicon is an agronomical fertilizer that can enhances plant tolerance to abiotic stresses (Liang *et al.,* 2005). The beneficial effects of this element on plant growth, development, yield, and disease resistance have been observed in a wide variety of plant species (Fauteux *et al.,* 2005). In plant, silicon does not only supply the nutrient but also create a physiological defence in the plant tissue. It can reinforces plant-protective properties against diseases, insect attack, and unfavourable climatic conditions. When apply as soil treatment, the silicon can improve soil fertility by improving water, physical and chemical properties of the soil while maintaining the nutrients in plant-available forms. Although silicon has many benefit, its application on many crops are not well documented. Therefore, this study was aimed to evaluate the silicon nutrient performance at different concentrations on plant growth and the natural pre-harvest diseases development on chilli cultivated in commercial soil.

MATERIALS AND METHODS

Silicon nutrient preparation

Concentrated Silicon nutrient solution was diluted with sterile distilled water into two different concentrations, 0.5ml/L and 1.5ml/L. The diluted concentrations were prepared freshly on the day of application to avoid any crystallization effect.

Plant seedling preparation

Chilli (*Capsicum annuum* L. var Kulai) seeds were obtained from the local supplier in Kuala Terengganu. Chilli seeds were soaked in diluted Silicon nutrient solution overnight according to different concentration (0.5ml/L and 1.5ml/L) prepared above. For control, chilli seeds were soaked in sterile water instead of Si nutrient solution. After soaking, treated seeds from each Si nutrient solution concentration including control were placed in between two layer of tissue paper wetted with different Si nutrient solution concentration accordingly for germination in approximately 7-10 days. Once germinated, the seed were transferred into germination tray filled with moist peat moss. The germination tray were placed under the shade house at Universiti Malaysia Terengganu to avoid direct sunlight to the new emerging seedling. Once a week, seedlings were supplied with 1 mL of Si nutrient solution according to the concentration used during wet tissue germination and no Silicon nutrient were applied for control plants. All seedlings were allowed to grow until 3-4 true leaves before transplanting into individual polybag filled with commercial soil (Growmate Eazy Mix) in greenhouse (Flores *et al.,* 2010). Seedling were watered daily and fertilizer was applied following Jabatan Pertanian (2009). After transplanting into individual polybag containing commercial soil, 40 mL of Silicon nutrient in different concentration were applied on the treated chilli once a week.

Plant growth assessment

Plant growth assessment were conducted started from 3 weeks after transplanting (WAT) until 11 WAT. Assessments were done on weekly basis. Plant height were measured started from the ground until the top of the plant by using measuring tape while stem diameter were measured using digital callipers. Number of leaf were count manually. Leave diameter were measured on the same marked representative leaves by using measuring tape. Disease incidence was also recorded on each plants during the assessment time. The present or absence of the disease were observed by the visual expression of any symptom on treated and control plants. The disease incidence was calculated as below:

Percentage of disease incidence (%) = Number of symptomatic plant / total number of plant at risk

Data analysis

All the experimental data were analysed by analysis of variance (ANOVA) in Genstat 17 with means value were separated using Tukey's HSD test at $P \leq 0.05$.

RESULTS AND DISCUSSION

In general, application of Si nutrient on chilli plant showed a better performance in every parameters measured in this study. The height of treated chilli plant over 11 WAT is presented in Fig. 1 with the plant height ranged from 10.27 cm to 44.57 cm. All treatments including control plant showed height increment throughout the assessment time. The height of chilli plants treated with Si in both concentration were significantly higher than control plants (Fig. 2). Nevertheless, comparison between two Silicon nutrient concentrations showed that chilli plants treated with Si 0.5ml/L had the higher height (44.57 cm) at 11 WAT compared to plants treated with Si 1.5ml/L (42.50 cm). However, the difference was not statistically significant. The effects of Si in improving growth of plant such as maize was reported by Kaya *et al*. (2006) under water stress condition. In their study, they found that Si application was able to improve above plant physiological parameter which also demonstrated in this study.

Silicon nutrient application showed a significant effects on the vegetative growth of chilli plant throughout 3-11 WAT. Leaves number, leaves diameter and stem diameter of control plants were significantly lower than plants treated with Silicon nutrient (Table 1). Nonetheless, application of Silicon nutrient at 1.5ml/L concentration had significantly larger leaves and stem diameter compared to 0.5ml/L. A study on chilli plant conducted by Jufri *et al*. (2016) also demonstrated that leaf length on Si-treated plant was greater than those without Si. This has resulted to more effective of photosynthesis because of the increase in leaf

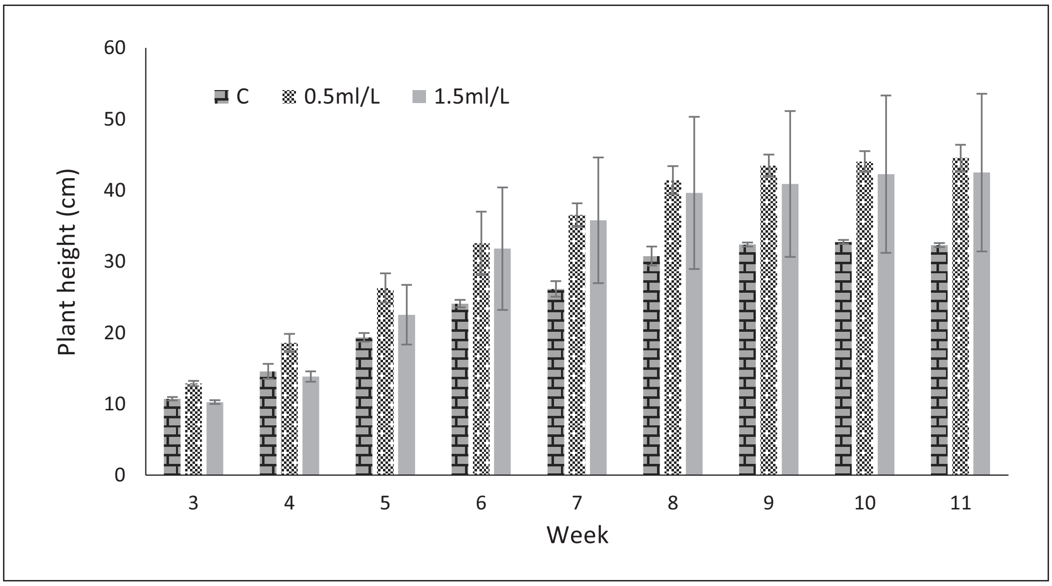

Fig. 1. Effects of different Silicon nutrient concentration application on chili plant height assessed from 3 to 11 weeks after transplanting.

Fig. 2. Plant height of chili assessed at 11 week after transplanting; A) control plants, B) plants treated with 0.5ml/L Silicon nutrient, and C) plants treated with 1.5ml/L Silicon nutrient.

Table 1. Effects of different Silicon nutrient concentration application on vegetative growth of chili assessed from week 3 to week 11 after transplanting

Treatment	Leaves number	Leaves diameter	Stem diameter
Control	22.59[a]	3.73[a]	4.86[a]
Si (0.5 ml/L)	25.56[b]	4.81[b]	5.58[b]
Si (1.5 ml/L)	26.56[b]	5.03[c]	5.94[c]

*Means in the same column followed by the same later are not significantly different at $P \leq 0.05$ according to Tukey's test.

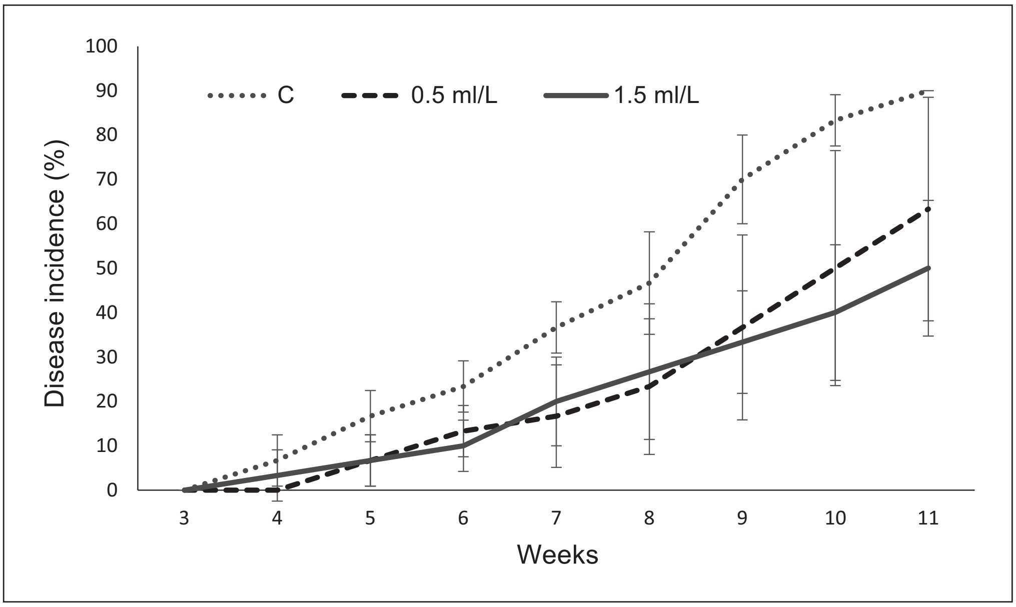

Fig. 3. Effects of different Silicon nutrient concentration application on the disease incidence of chili plant assessed from 3 to 11 weeks after transplanting.

area. Thus, it could expected that plants treated with Si would have a better and faster growth performance compared to none-treated plants. Result from the current study was also in agreement with Gong *et al*. (2003) who found that wheat plant grown in pot with the application of Si had a greater plant height, leaf area and dry matter compared to control plant in well watering condition. Furthermore, they also reported that even in the drought condition, wheat plants treated with Si could maintain higher relative water content (RWC), water potential and leaf area compared to those without Si applied. Even though different host plant were used in previous study and this study, the result from both studies showed the similar potential of the Si application in improving the plant growth.

The disease symptoms were developed on all plants including plants treated with Silicon nutrient (Fig. 3) at four WAT. The symptoms observed on infected plants were characteristic to TMV disease which visible as stunting, mosaic pattern of light and dark green (or yellow and green) on the leaves, malformation of leaves or growing points, yellow streaking of leaves, yellow spotting on leaves and distinct veins yellowing (The Pennsylvania State University, 2017). The TMV had naturally infected the plants as no inoculation was conducted in this study. The causal agent of TMV has been reported to have a wide host range which also infected a members of useful Solanaceae family including tomato and pepper. Nevertheless, the disease incidence on plants treated with both Silicon nutrient concentration were significantly reduced compared to control plants which showed 90% of disease incidence at 11 WAT. The highest disease incidence observed at 11 WAT on plants treated with 1.5ml/L and 0.5ml/L of Silicon nutrient were 50% and 63.33%, respectively. In this case, application of Si nutrient had reduced the disease incidence on treated plant up to 44.4% and 26.7% for Si 1.5ml/L and 0.5ml/L, respectively. Result showed that the higher application of Si nutrient could resulted in lesser disease incidence on crop. As an abundant element in natural ecosystem, Si play an important role in maintaining the healthy growth, development, and yield as well as increase the disease resistance in a wide variety of plant species such as rice and sugarcane (Ma, 2004). The beneficial effect of Si is more evident under stress conditions (Ma & Takahashi, 2002). This is because Si is able to protect plants from multiple abiotic and biotic stresses (Ma & Yamaji, 2006). Numerous studies have shown that Si is effective in controlling diseases caused by fungi on strawberry (XiaoLei *et al.,* 2013) and chilli (Jufri *et al.,* 2016). Silicon accumulation in plants has been explained in different ways, i.e. Si acts as a physical barrier and induces biochemical defence responses similar to systemic acquired resistance in plants (Ma, 2004). Silicon acting as a physical barrier, which increase the resistance that has been associated with the density of silicified cell present in epidermis layer, prevent from the pathogen penetration through plant epidermis. Accumulation of Si on the plants tissue could possibly provide resistance to disease but did not directly inhibit the pathogen development as shown in study by Rodrigues *et al*. (2004).

CONCLUSION

Silicon nutrient application has significantly improved the plant growth of chilli. The significant result on the benefit of Si on the plant height, leave number, leave and stem diameter as well as disease incidence provide the evident that this additional nutrient could possibly help farmers to produce better quality of yield and reduce the cost of disease management in their cultivation area.

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