Effect of the Natural Clay Mineral Illite on the Enhanced Growth of Red Pepper (*Capsicum Annuum L.*) in the Glass House

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Abstract
This study was performed to explore the effect of the natural clay mineral illite on the improvement of soil quality and plant growth. Red pepper (***Capsicum Annuum L.***) was used as a model vegetable crop. The experiment was performed during ten weeks in the glass house of the Chungbuk National University. Its seedlings were pre-cultivated in soil normally used for horticultural purpose. Of the seedlings cultured, the healthy and regular size plant were selected and cultivated in pots 7 cm in diameter and 7 cm in height. They were treated with two forms of illite, particulate (PA) and powder (PW), at the following application rates: standard application [P1(PA1, PW1), 1:30(w/w)], two times[P2(PA2, PW2), 1:15(w/w)], and four times[P4(PA4, PW4), 1:7.5(w/w)] of standard application. Untreatment (P0) was used as a control pot. After the four weeks of cultivation, their length was greater in pots treated with P1, P2, and P4 of illite than the P0. At ten weeks of cultivation, their lengths were correspondingly increased as the application rate was increased ranging from P0, P1, P2, and to P4. Their growth length was a little greater for the application of powder illite (PW) than the particulate illite (PA). Based on plant analysis for the leaf, stem, and fruit parts of red pepper, the uptake of K, Ca, and Mg correspondingly increased, as the application rate was increased ranging from P0, P1, P2 to P4. At the same application rate, their amounts taken up in the respective parts were higher for the application of PW illite than for PA. K was relatively evenly distributed in the three plant parts: leaf, stem, and fruit, whereas, the amounts of Ca and Mg were higher in the leaf than in the stem and fruit. Consequently, it appears that illite treatment, especially, PW form of illite, enhance the growth of red pepper in the glass house during the whole ten weeks of experiment.

Key Words
Natural clay mineral, illite, soil conditioner, red pepper, growth, cations, K, Ca, Mg uptake

Introduction
Light, temperature, air, water, and nutrients are essential for the growth of vegetable crops in agriculture. Among these things, water and nutrient are taken up through the plant root. It is well known that the soil function as providing the plant with the water, nutrient, and space to which the root can be extended. For a long time, a great attention has paid to the conservation of soil quality. Traditionally, until recently, the soil quality has been in large evaluated using parameters, such as, crop productivity, soil color, organic matter, soil texture, soil hardness, and irrigation. However, soil quality in modern agriculture to a large extent depends on the use of external agricultural resources, such as, fertilizer, pesticide, and manure for the increased crop productivity. As a result, the crop productivity has been greatly increased, whereas, the agricultural ecology in terms of sustainable agriculture have been adversely affected. The proper soil conditioning and management for the improvement of soil quality is essential to maintain the proper function of plant root and increase the crop productivity of soil. Inorganic mineral materials are frequently used for soil conditioning and improvement, such as bentonite, zeolite, illite, perlite, vermiculite, limestone, and dolomite. Of those materials, it is reported that illite enhance the growth of vegetable crops (Choo 2001). However, scanty information is available to scientifically support such research. Therefore, this study was performed to explore the stimulatory effect of illite on the growth of red pepper (Imperial) through the measurement of plant size and the plant analysis for major cations (K, Ca, and Mg).

Materials and Methods
- *Materials*
Two forms of illite, such as particulate and powder, which are produced in the area of Yeongdong of Chungbuk province, Korea, were used as soil conditioner in this study. The red pepper (*Capsicum Annuum*

L, was cultivated as the target plant for ten weeks.

- *Cultivation and treatment*

The seedlings of red pepper were pre-cultivated in the box with dimension of 60cm X 30cm for two weeks packed with bed soil used for horticultural purpose. Then, the healthy seedlings were selected and transplanted to cup pot with dimension of 7cm in diameter and 7 cm in height. Before they are transplanted, the particulate and powder forms of illite were mixed well in the cup pot as standard concentration, two times and four times of standard concentrations (Table 2).

- *Plant extraction*

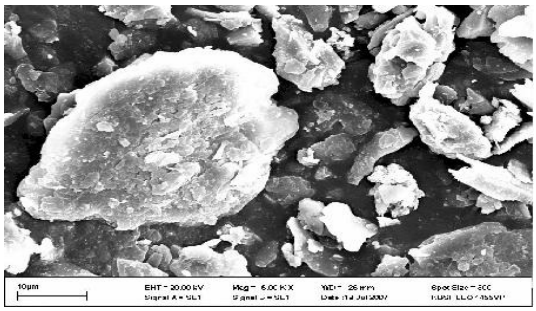
Plant extraction for the K, Ca, and Mg measurement were performed according to the plant analytical method (NAAS 2000).

- *Instrumental analysis*

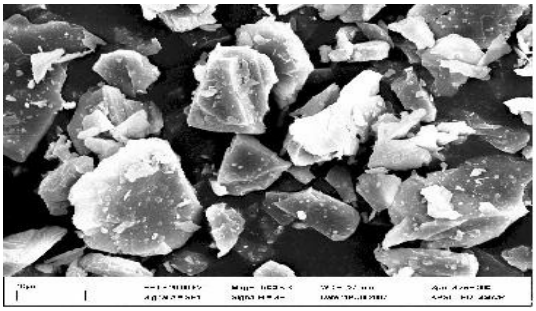
ICP (Perkin Elmer, USA) was used for the analyses of K, Ca, and Mg.

- *Experimental Design & Data analysis*

Seventy pots with 2 forms and 3 levels of illite including the control and 10 replications were arranged by randomized block design. Data analysis was performed by Duncan's multiple test of SAS at the significance level 0.05.



SEM of particulate illite



SEM of powder illite

Figure 1. Scanning electron microscope(SEM) images of particulate and powder forms of illite.

Table 1. Chemical properties of particulate and powder forms of illite.

Class	pH	O.M (%)	Exch. Cations($cmol^+/kg$)			EC (dS/m)
			K	Ca	Mg	
Particulate illite(PA)	7.13	0.34	0.12	1.13	0.49	0.10
Powder illite(PW)	7.14	0.52	0.45	1.55	0.69	0.13

Table 2. Application rate of particulate (PA) and powder (PW) forms of illite used in the study.

	Standard application P1(PA1, PW1) (w/w)	Two times application P2(PA2, PW2) (w/w)	Four times application P4(PA4, PW4) (w/w)
Illite treatment	1:30	1:15	1:7.5

Results

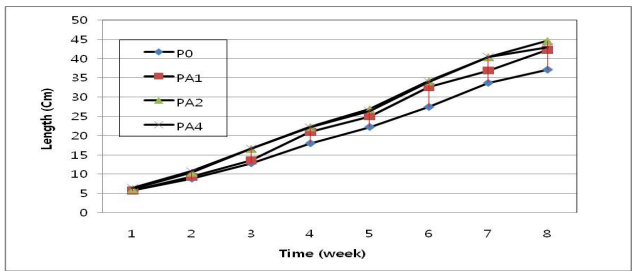


Figure 2. Growth of red pepper treated by particulate (PW) illite as a function of time.

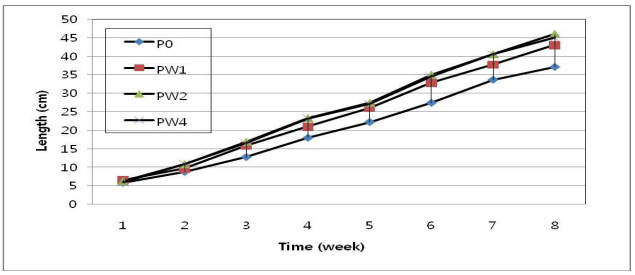


Figure 3. Growth of red pepper treated by powder (PA) illite as a function of time.

Figures 2 and 3 showed the growth of red pepper in the pots treated with the particulate and powder forms, respectively. The length of red peppers were greater in the pots treated with both particulate and powder

forms of illite than plants in untreated pots. The growth length of red pepper treated with the PA illite were 12.2%, 16.7%, and 13.6% greater than that of untreated one(control), respectively. Also, the growth length of red pepper treated with PW illite were 12.4%, 19.0%, and 15.8% greater than that of untreated one (control), respectively. Their growth length was a little better for the PW application than on the PA one.

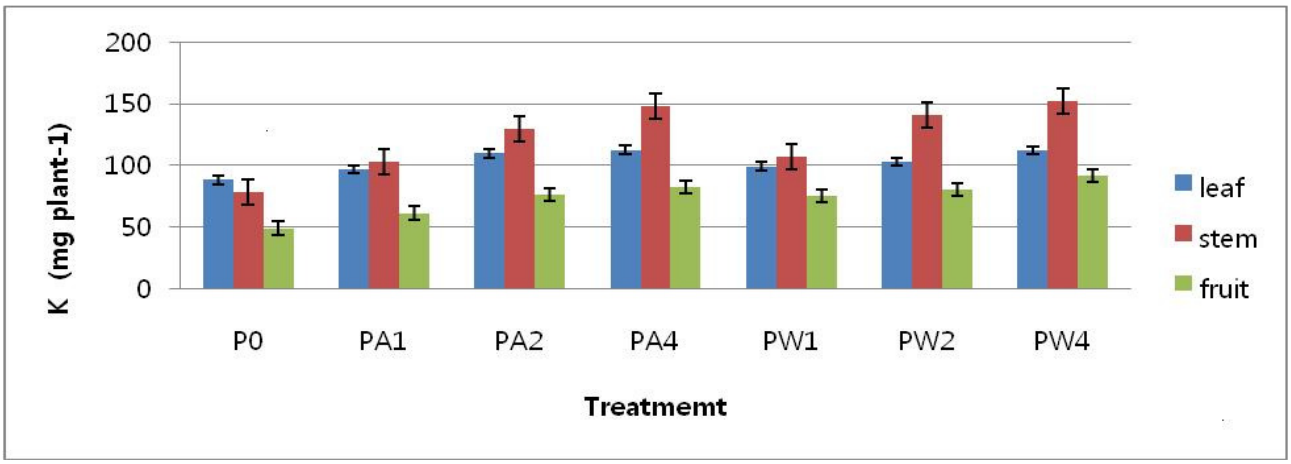


Figure 4. Amount of K in the leaf, stem, and fruit as affected by the application rate of particulate(PA) and powder(PW) forms of illite.

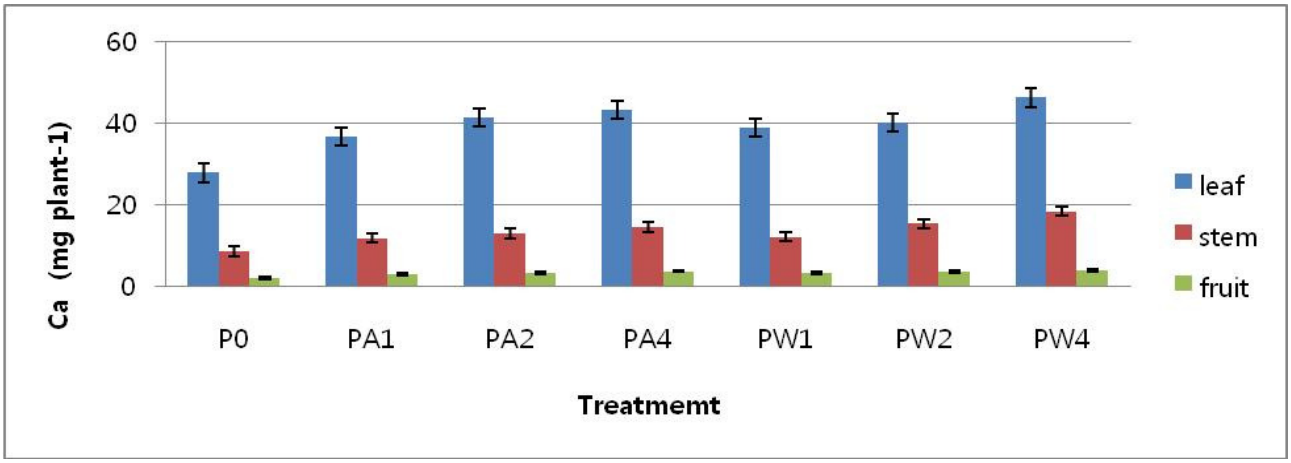


Figure 5. Amount of Ca in the leaf, stem, and fruit as affected by the application rate of particulate (PA) and powder (PW) forms of illite.

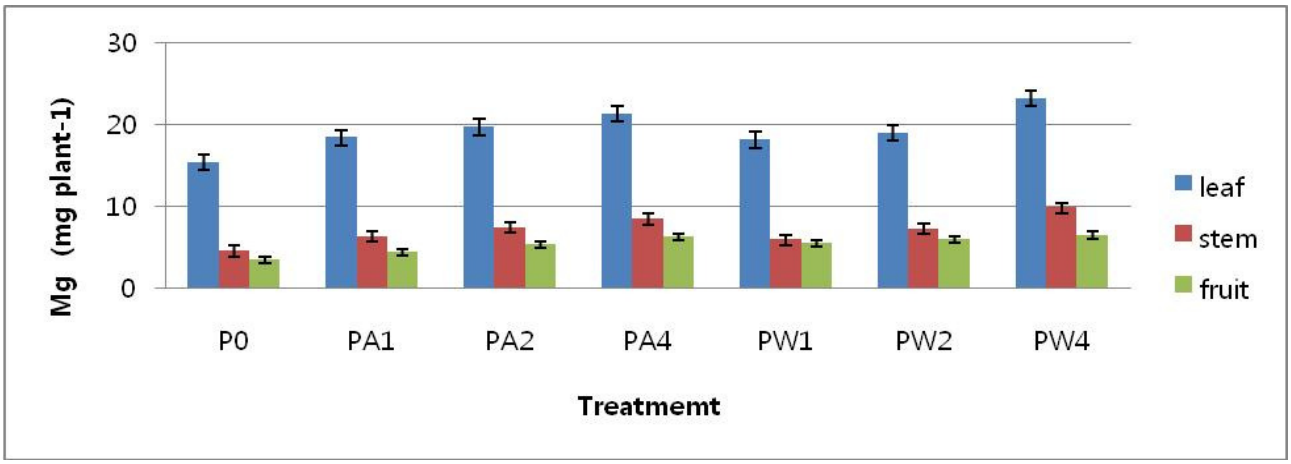


Figure 6. Amount of Mg in the leaf, stem, and fruit as affected by the application rate of particulate (PA) and powder (PW) forms of illite.

Figures 4, 5, and 6 demonstrate the amount of K, Ca, and Mg in the leaf, stem, and fruit of red pepper as affected by the applications of particulate(PA) and powder(PW) forms of illite. The amount of K, Ca, and Mg in the three parts of red pepper were higher on the applications of both forms of illite than on the non

application, respectively. They showed that as the application rate was increased, the uptake amounts of K, Ca, and Mg were correspondingly increased. In addition, on the all the applications of illite including control, the amount of K were relatively evenly distributed in three parts, but, those of Ca and Mg were more abundant in the leaf than in stem and fruit.

Conclusion

This study showed that the growth length of red pepper was increased by the application of PA and PW forms of illite relative to nil application (P0). It demonstrated that the growth length of red pepper was 12-17% greater for the application of PA illite and 12-19% greater for the application of PW illite than on the nontreatment under the range of three different application rates (P1, P2, and P4) of illite during the whole ten weeks of cultivation. Their growth length was a little greater for the application of PW illite than for the PA. Under the three different application rates (P1, P2, and P4) of illite, the plant analysis for the red pepper showed that the amount of K was 19-46% for the application of the PA illite and 21-48% for the application of PW illite greater than for the non application. The content of Ca was 24-45% for the application of PA illite, 28-53% for the application of PW illite greater than for the nil treatment. The content of Mg was 16-46% for the application of PA illite and 15-54% for the application of PW illite than for the nil treatment. The amounts of cations were a little greater for the application of PW illite than on the PA one. Consequently, it appears that the illite stimulated the growth of red pepper through the uptake of K, Ca, and Mg included in illite.

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