Abstract

The 2017's year research was conducted in order to develop the prototype of bio-product and select the arsenic immobilizing substance for reduction of soil acidity and toxicity of arsenic from arsenic contaminated highland soil. The study was divided into 3 parts, (1) development of the prototype of bio-product and selection of arsenic immobilizing substance (2) efficiency test of the bio-product prototype and arsenic immobilizing substance for arsenic remediation under field conditions and (3) analysis of arsenic in agricultural production inputs.

For development of the bio-product prototype, 5 carriers, zeolite, pumice, diatomite, mixture of diatomite and leonardite and mixture of biochar and leonardite were selected to test as a carrier for Ars.19 bacteria. The results show that zeolite, pumice and diatomite were suitable for Ars.29 bacterial carrier due to viability cell of Ars.29 were maintained at the high level (>10^5 cfu/g) after 180 days of storage. Therefore, 3 carriers were selected for arsenic immobilization test. The pumice-Ars.29 bacteria showed the highest in reduction of water soluble arsenic (WSAs). The pumice-Ars.29 reduced 87% of WSAs while diatomite-Ars.29 reduced 43% of WSAs. However diatomite was selected for Ars.29 carrier due to (1) maintaining of high level of viability cell (2) low production cost and (3) available in market. Four arsenic immobilizing substances, calcium carbonate, ferrous sulfate, ferric chloride and Fe-EDTA were selected for efficiency test. In the test, the soil sample were contaminated by arsenic to 1,000 mg/kg. Each immobilizing substance was introduced into soil sample in doses of 0.1 0.5 and 1.0 % (w/w). Determination of the arsenic in the soil sample was done at 0 and 15 days after arsenic addition. The result showed that the average efficiency of WSAs immobilization was 92% and 90% for efficiency of loosely adsorbed arsenic (LAAs). In addition, ferrous sulfate at the rate of 0.1, 0.5 and 1.0% was also tested with 27.65 mg/kg of arsenic contaminated soil collected from farmer's field. The results indicated that application ferrous sulfate at the rate of 0.1% (w/w) was sufficient to immobilize WSAs which this form was easy uptake by plant. Therefore, ferrous sulfate was selected for the arsenic immobilization test in the farmer's fled.

To evaluate the efficiency of bio-product prototype and arsenic immobilizing substance two experiments were carried out in vegetable growing greenhouse at Mae

Tho village, Hot district, and in the planting area of the Royal Agricultural Station, Pang Da, Samoeng district, Chiang Mai province where the high concentration of arsenic (31.31 and 35.08 mg/kg) in soil has been reported. The experiment design was a RCB with 6 treatments and 4 replications. Five methods for arsenic remediation including application of 1) diatomite-Ars.29 2) diatomite-Ars.29 in combination with dolomite 3) diatomite-Ars.29 in combination with dolomite and ferrous sulfate 4) diatomite-Ars.29 in combination with ferrous sulfate and 5) immobilization by ferrous sulfate were tested. No arsenic remediation treatment was used as control treatment. When each treatment was applied to arsenic-contaminates soil, followed by growing Chinese cabbage and eggplant to test the efficiency of the treatment. The application of 0.1% w/w of ferrous sulfate showed highest in reduction of water soluble arsenic. The average efficiency of water soluble arsenic immobilization was >21%. In addition, the application of diatomite-Ars.29 in combination of lime and ferrous sulfate to soil reduced arsenic uptake by Chinese cabbage and eggplant significantly. Arsenic content in the edible above ground part and root of Chinese cabbage decreased 28-49% and 21-29% respectively. Similarly, in eggplant, arsenic content in the root and shoot decreased 39% and 28% respectively. However, no arsenic contamination in fruits of eggplant were observed.

In the third part of this research, agricultural production inputs including irrigation water, chemical fertilizer, organic fertilizer, pesticide, culture media and dolomite were collected from 10 Development Centers of the Royal Project Foundation, Pang Kha, Huay Nam Rin, Mae La Noi, Pang Ung, Tong Rao, Tung Roeng, Mae Hae, Mae Tho Pang Da and Mont-ngo for total arsenic analysis. 117 samples of agricultural production inputs were subjected to arsenic analysis and 42 arsenic contaminated samples (35.6%) were observed. It should be noted that high level of arsenic content were found in organic fertilizer. About 71% of organic fertilizer were arsenic contaminated.

It is possible to draw conclusions based on the tests carried out. In order to prevent the arsenic contamination in highland agricultural soil, the farmers should avoid or reduce the use of contaminated agricultural inputs in farmer's field. In addition, arsenic contamination in agricultural production inputs should be analyzed before using in the farmer's field. Through arsenic immobilization by application of diatomite-Ars.29 in combination of dolomite and 0.1% of ferrous sulfate, it is possible to reduce the toxic impact of arsenic on plants.