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Research Article

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Studying environment characteristics of cultivation land in Dai Thinh Area, Me Linh District, Ha Noi city to serve sustainable development of health safe vegetables

Vinh Thi Dang[1,*], Giang Khac Nguyen[2]

ABSTRACT

Cultivation land (Planting Soil) is a natural resource that plays an important role for organisms and humans. Soil pollution will badly affect human and animal health through food, vegetables, fruits, medicinal herbs, etc. To clarify the characteristics of the geochemical environment and estimate the quality of the soil environment in the Dai Thinh area, Me Linh district, Hanoi city, the authors combined the using of traditional and modern methods in the research process, such as: field research methods, grain-size analytical method plus X-ray fluorescence spectroscopy (XRF) method to determine the major components (oxides) of soil. The high-frequency inductive plasma source spectroscopy combined mass spectrometry (ICP-MS) method and optical AAS atomic adsorption spectroscopy have been used to determine the concentration of critical heavy metals in soil samples. Besides, the direct measurement method used to determine environmental indicators (pH, Eh, Ec). Research results show that agricultural soil in the studied area belongs to the group of heavy sandy loam, sandy loam, and sandy clay soils, with average content of sand (size of 0.05-2mm): 60.8 (%), silt (limon) (size of 0.005-0.05mm): 17.96 (%), clay (size of <0.005mm): 21.46 (%). The soil has not been yet polluted by critical heavy metals such as: As, Cd, Cu, Zn, Cr, Ba, Sb, Co, Mo, Se and Sn. The soil in the studied area shows neutral acid-base values (average pH is 6.61), has a strong oxidizing environment (Eh > 150mV) (with values of Eh ranging from 183 to 310 mV), and is not saline (values of Ec ranging from 58.7 - 317.0 (μS/cm). Therefore, in terms of the results of determining environmental physical-chemical criteria and heavy metal concentration, the soil in the studied area can be used for health safe vegetable production. The research results not only serve as a basis for assessing the quality of the soil environment for safe healthy vegetable planting, but also serve as a scientific basis for the authors to propose a number of appropriate solutions to protect and improve the quality of vegetables, land environment protection, contributing to the planning and sustainable use of agricultural lands for the studied area.

Key words: Cultivation land, heavy metals, health safe vegetables

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INTRODUCTION

As we know, in the world, the problem of pollution in agriculture in general and in fruit and vegetable products in particular has been a big concern for a long time. In Vietnam, the planning of areas for safe health vegetable production is being gained attention by Government and implemented across the country, especially in areas surrounding large cities. For Hanoi city, many areas specializing in safe health vegetable cultivation have been formed such as in Van Noi, Tien Duong (Dong Anh), Van Duc, Dang Xa, Yen Thuong, Le Chi, (Gia Lam), Linh Nam (Hoang Mai), Van Con (Hoai Duc) etc... On the other hand, the demand for safe agricultural products in general and health safe vegetables in particular in Hanoi City is very large[1]. For example, green vegetables consumption only, the habitants off inner Hanoi city requires thousands of tons every day.

There are many factors to ensure the safe vegetable production, including good cultivation soils. In fact, soil plays an extremely important role in ensuring the quality of health safe agricultural products in general, as well as green vegetables in particular, because the cultivation soil is the place that provides water and nutrients for plants grown[2]. Currently, the development of the industrialization process has made the agricultural land fund decreasing dramatically. Besides, the industrialization and mechanization processes have impacted heavily to environment by many ways including pollution of soil and water, then to crops, leading to badly affecting human health[3,4]. In addition, the need for large volume of agricultural products to supply to the market is one of the reasons that increases the risk of soil pollution due to human

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overuse of growth stimulant chemicals for quick increasing in agricultural production. Therefore, possible risks of soil environmental pollution such as heavy metal pollution, pesticide pollution, and soil growth simulants are quite high.

Meanwhile, soil characteristics such as grain size and mineralogical composition (especially to clay minerals) play a crucial role in forming physical and mechanical properties as well as the name of the soil, especially affecting the ability to retain water and micronutrients useful to plants and the same time, to the ability to retain substances toxic to the environment. In order to understand the soil characteristics to serve health safe vegetable production, in recent years, in the Dai Thinh area, Me Linh district, Ha Noi city, there have been research projects on structural characteristics and mineral composition to evaluate the quality of soil [1], and some related research works on agricultural land [3,5–8]. Recent research on the existence forms of microelements for the ability of plants to use depends on the geochemical environmental factors of the soil such as pH, Eh, and organic matter [9]. Among these, pH is a factor that strongly affects the ability to dissolve and absorb trace elements by plants. Research works on the role of providing nutrients and microelements during plant growth that affect the quality of agricultural products [10–17]. Moreover, for cultivation soil, studying the soil geochemical environmental characteristics for sustainable agricultural production in general and safe vegetable production in particular is very necessary. Therefore, the authors conducted research on the geochemical environment of cultivation land (studying soil profiles, grain-size composition, geochemical environmental indicators (pH, Eh, Ec) and heavy metal content) in the soil as well as the distribution characteristics of soil nutrients) in Dai Thinh area, Me Linh district to solve the above problems.

RESEARCH METHODS

Inheritance method

The research team collected, analyzed, and interpreted relation documents on human economic issues, natural conditions, geological and environmental characteristics related to the Dai Thinh area, Me Linh district, Hanoi city to serve a better understanding of the soil in the studied area.

Field works

Field works in cultivation land in Dai Thinh commune, Me Linh district were conducted to explore real topography, geomorphology, and vegetation planted on the land, describe soil profiles, and measure soil and water environmental indicators and collect soil and water samples.

The research team selected typical cross-sections (transects) intersecting through areas with different elevation (high and low land) and is currently planting vegetables, flowers and other crops in the research area. Along each profile, some holes ara dug to observe the soil profiles (the dug holes), the size of holes dug ranges from 0.5m - 1.0m depending the local soil layer structure. The research was conducted on structural characteristics of soil profiles, color, preliminary assessment of physical and mechanical properties such as cohesion (plasticity, friability), grain size, and color... at each site (Survey Point). In this area, the soil developed on sediments of the Vinh Phuc formation (Figure 1), with a relatively long time of surface exposure. The survey of a total of 22 soil profiles (holes) on 5 transects in an area of about 100 hectares (Figure 2) have been conducted.

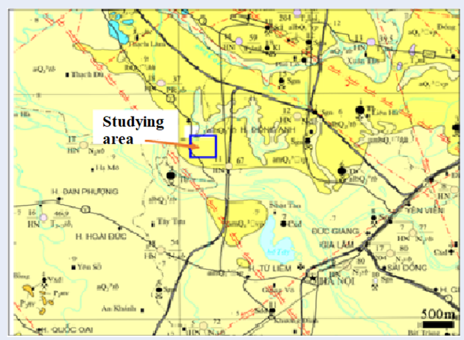

Figure 1: Sketch of the location of the studied area.

Lab methods

- Soil sample processing: soil samples are dissolved with distilled water, using a 0.1mm sieve to filter the smaller batch of the sample, and dried before sending for analysis.
- Determining the grain-size composition of cultivation soil in the study area using the wet sieving method (with main sieve size 2mm, 0.05mm and 0.005mm), and using particle measurement in suspension with a laser meter. The soil sample is dissolved with distilled water, then a set of sieves with different screen sizes (2 mm, 0.05mm, 0.005mm) are used to separate the soil sample into particle sizes. Particle analysis was conducted at the Laboratory of the Department of Mineralogy and Geochemistry, Hanoi University of Mining and Geology (HUMG) and the Laboratory of Hanoi University of Natural Resources and Environment (HUNRE).

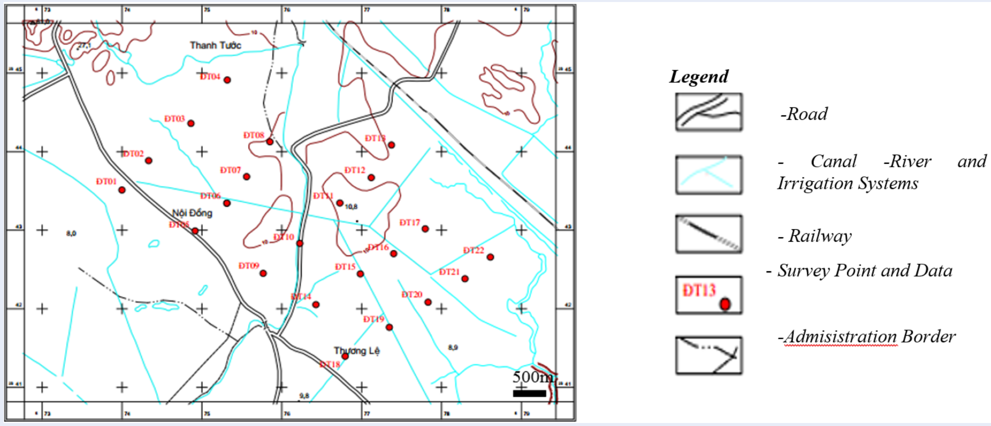

Figure 2: Sketch of Surveying and sampling Stations

- Determining the geochemical environment indicators (pH, Eh, Ec): using the HANNA Hi 98120 meter to measure the pH and using the SDL 100 meter to determine the Eh, Ec index of the soil environment.

- Analyzing the chemical composition of soil samples using fluorescence spectroscopy X-ray (XRF) to determine the main components (oxides) at the Geological Experiment and Analytical Center - Vietnam General Department of Geology and Minerals; Institute of Geology, Vietnam Academy of Science and Technology.

- Analyzing macronutrients of soil: To determine the content of heavy metals in cultivation soil in the research area, the authors conducted field surveys, selected representative study locations, dug soil profiles and collected soil samples (Sampling works conducted according to TCVN 7538-2:2005 (ISO 10381-2:2002) standards), then processed (sample preparation according to TCVN 6647:2007 (11464:2006) standards) and sent for analysis at the labs of analytical Center of the General Department of Geology and Minerals. Inductive plasma source spectroscopy combined with Mass Spectrometry (ICP-MS) and Atomic Adsorption Spectroscopy (AAS) methods were used to determine the content of heavy metals in vegetable cultivation soil samples in Dai Thinh area.

- Data Interpreting: synthesizing heavy metal analysis results, comparing with Vietnamese environmental standards (QCVN 03-MT:2015/BTNMT)[18] and Comparative Canadian standards (CCME)[19] to evaluate the pollution level of cultivation soil in the study area.

RESULTS AND DISCUSSION

Grain-size composition of vegetable cultivation soil in Dai Thinh area

Studying the characteristics of soil grain size components is very important for assessing the possibility of soil degradation and erosion.

Accordingly, the grain-size composition of vegetable soil in the study area was determined by the wet sieving method and using particle measurement in suspension with a laser meter for samples with predominately fine particles. The results of granular component analysis of 15 representative samples on 5 surveying transect are listed in Table 1.

Based on the results of analyzing the grain composition of soil samples comparing with the soil classification table (Soil Taxonomy) depending on granular composition in the US (USDA, 1999)[20] which is widely used in Vietnam, the authors have identified the names of the group soils in the study area including heavy sandy loam, sandy loam, and sandy clay soil. In general, these types of soil have relatively good aeration and drainage while still ensuring the necessary moisture retention in the soil, suitable for dry-land crops in general and vegetables in particular.

According to the results of soil profile observations in the field, the cultivation land in the study area was developed on the sediments of the Vinh Phuc system. Soil often has a three-zone structure distinguished by color and grain composition, which are quite clearly different (Figure 3). On top (layer O) is a layer of grey, brown- grey, dark grey soil, with mainly silty sand mixed with organic matter (tree roots and plant humus). The middle zone below (layer A) is yellow- grey, white- grey -brown grey, patchy yellow- grey, with

Table 1: Statistics of grain size components in cultivation land in Dai Thinh - Me Linh area

Grain size percentage (%)	Grain size (%)		
	Clay < 0.005mm	Silt (Limon): 0.005 - 0.05mm	Sand: 0.05 - 2mm
Max	36,3	24,0	82,0
Min	3,8	8,1	43,2
Average	21,46	17,96	60,82

finer granularity (mainly clay - silt and fine-grained sand). Below layer A (layer B) is a patchy layer of white- grey, yellow-brown, red-brown clay, with soft reddish-brown laterite conglomerates or grey -black laterite conglomerates, quite solid.

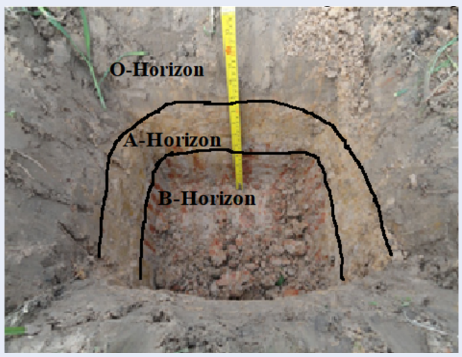

Figure 3: Soil profile at survey point No. 06, Noi Dong Village, Dai Thinh commune.

Basic environmental physicochemical characteristics of cultivation soil in Dai Thinh area

pH value

Soil pH value is a major factor affecting the nutrient absorption of plants. The soil pH plays an important role in the solubility of some chemical compounds and the movement as well as deposition of chemical components in the soil. Previous research also showed that the pH of the soil is often the most important chemical property governing trace element sorption, precipitation, solubility, and availability.

Soil pH affects phosphorus solubility and nitrogen fertilizer effectiveness. In a simple chemical environment, inorganic phosphorus dissolves when pH decreases and organic phosphorus dissolves when pH increases. However, in acidic soils, there is also a chemical adsorption process due to the effect of iron and aluminium on phosphate fertilizers. So in acidic environments, the solubility of phosphate fertilizers decreases. In addition, pH also affects the solubility of heavy metals in the soil. When pH decreases, most heavy elements such as Mn, Cu, Pb, Zn... become mobile and easily absorbed by plants, possibly causing excess levels in the plant.

People rely on the value of pH (pH = - $\log[H^+]$) to evaluate the acidity or alkalinity of the soil. The best pH value for plants is from 5.5 - 7.5, however, many plant species can still adapt well outside this range. In the case pH= 7: Neutral soil. This condition is favorable for most plants; If pH < 5: Soil is acidic (acidic soil). In acidic soil environments, aluminium, iron, and manganese are easily soluble and can be toxic to plants. Soil lacks Ca and Mo; If pH > 7.5: Excess Al, Fe, and Zn in the soil cause poisoning for plants. If pH > 8: There is the formation of Calcium Phosphate that plants cannot absorb. If pH > 8.5: Sodium amount exceeds the allowable level. Plants will suffer from salt poisoning and Fe and Zn deficiency. If the pH is too high, iron is in bound form and cannot be absorbed by plants, causing them to lose chlorophyll.

The pH index of the soil environment in the study area was determined using a HANNA Hi 98120 meter. The results of measuring twice times on 24 soil samples at the Laboratory of the Department of Mineralogy and Geochemistry, University of Mining and Geology were compared with the "pH value to evaluate soil acidity according to the United States Department of Agriculture" to evaluate the acidity of cultivation soil in the study area (Table 2).

According to the average pH value of twice measuring (Table 2), the soil environment in the study area has a pH ranging from 4.89 to 7.32 (average is 6.61) indicating that the soil in the study area has an acidic to neutral environment. Results compared with the standard for assessing soil acidity based on pH (according to the US Department of Agriculture) (Table 2), the cultivation soil in the study area is mainly neutral soil (16/24 measured samples) to slightly acidic soil (5/24 measured samples). This soil

Table 2: The result of pH measurement and pH value to assess soil acidity according to the US Department of Agriculture.

No	Sample Number	pH value (twice Measured)	Evaluation of soil acidity according to pH value (After United States Department of Agriculture)									
			<3.5 (1)	3.5 - 4.4 (2)	4.5 - 5.5 (3)	5.6 - 6.0 (4)	6.1 - 6.5 (5)	6.6 - 7.3 (6)	7.4 - 7.8 (7)	7.9 - 8.4 (8)	8.5 - 9.0 (9)	>9.0 (10)
1	ĐT1/1	6.69						x				
2	ĐT1/2	6.39					x					
3	ĐT2/1	4.89			x							
4	ĐT2/2	6.35					x					
5	ĐT3/2	6.75						x				
6	ĐT7/2	7.03						x				
7	ĐT8/1	6.28					x					
8	ĐT8/2	6.65						x				
9	ĐT9/1	7.05						x				
10	ĐT9/2	7.12						x				
11	ĐT10/2	7.08						x				
12	ĐT11/2	6.75						x				
13	ĐT12/1	6.11					x					
14	ĐT12/2	6.22					x					
15	ĐT14/1	6.65						x				
16	ĐT14/2	6.93						x				
17	ĐT15/2	7.30						x				
18	ĐT16/1	6.90						x				
19	ĐT16/2	7.32						x				
20	ĐT18/1	5.61				x						
21	ĐT18/2	6.82						x				
22	ĐT19/2	7.02						x				
23	ĐT20/1	5.97				x						
24	ĐT20/2	6.72						x				

Note: (1): Ultra acidic Soil; (2): Super Acidic Soil; (3): Very Acidic Soil; (4): Medium Acidic Soil; (5): Litle Acidic Soil; (6): Neutral Soil; (7): Litle alkaline Soil; (8): Medium Alkaline Soil; (9): Very Alkaline Soil; (10): Extremely Alkaline Soil.

is suitable for planting vegetables (onions, tomatoes, potatoes, beans, cabbage...). Some samples are moderately acidic soil (2/24 measured samples). Only 1 of 24 samples belongs to highly acidic soil. For neutral soil, the amount of nutrients in the soil is always maintained in an appropriate state to help plants easily absorb. The process of exchanging nutrients between the root system and the soil is easily carried out, helping plants grow very strongly. In addition, in a neutral soil environment, beneficial microorganisms develop very well. They work to synthesize more nitrogen, decompose phosphorus and organic matter, making the soil more fertile and limiting harmful species. Neutral soil requires almost no additional action. Only by maintaining adequate organic matter in the soil can help plants grow stably and yield high productivity.

In addition, cultivation soil in the study area showed signs of acidity (8/24 measured samples having pH = 4.5-6.5). In acidic soils, the mobility of aluminum increases. Except for a few plants such as tea whose growth is stimulated by Al^{3+}, most plants cannot tolerate high levels of mobile Aluminum (Al) Ions. Because acidic soil has high Al ions, it can easily lead to poisoning of plant roots, causing the roots to become bound and stunted, unable to develop. Plants have difficulty absorbing micronutrients (K, Ca, Mg...) leading to deficiencies of these nutrients. When the soil environment is acidic, to some extent. it will create conditions for some divalent heavy metal ions (Ni^{+2}, Zn^{+2}, Co^{+2}, Cd^{+2}, Mn^{+2}) to maintain significant mobility and the mobility of Se^{4+}, Se^{6+} and Mo^{6+} increased significantly. That creates the risk of dispersing some of these heavy metal ions, causing pollution to the soil environment.

For acidic soil, most microorganisms cannot perform the function to decompose organic matter, leading soil to be compacted, and poor in nutrients... So acidic soil will limit the growth of plants, affecting the productivity and quality of agricultural products.

Conductivity (Ec) and redox potential (Eh) of vegetable cultivation soil in Dai Thinh area

The Ec and Eh indicators of vegetable cultivation soil in the study area were determined using an SDL100 meter. The measurement results are shown in Table 3. Comparing the measured values of Ec ranging from 58.7 - 317.0 (μS/cm) (Table 3) to the standard Soil salinity classification (Soil is not saline when Ec < 400 μS/cm), it shows that the vegetable cultivation soil in DaiThinh area is not be salted. The solubility (electrical conductivity) of the components in soil solution is not high.

Determining the Eh index in soil is conducted to serve as a scientific basis for assessing soil aeration. Oxidizing threshold: Eh > 150mV - strong oxidizing environment; 40mV < Eh $\leq$ 150mV - weak oxidizing environment; Eh $\leq$ 40mV - reducing environment. The higher the Eh value, the higher the aeration and porosity of the soil. When Eh changes, it will lead to a change in the existence of nutritional elements in the soil. According to the results of measuring Eh values in Table 3, the vegetable cultivation soil in the study area has Eh ranging from 183 to 310 (mV) (Eh > 150mV) proving that the cultivation soil environment of Dai Thinh area is a strong oxidizing environment. When the soil has an oxidizing environment, the soil is richer in free oxygen and the circulation of air in the soil is better or the soil is aerated, which is beneficial for plant growth, especially plants growing in dry cultivation field, including vegetables.

In general, with the basic environmental parameters (pH, Ec and Eh) as above, the cultivation soil in the study area will be quite favourable for the growth of plants as well as beneficial (aerobic) microorganisms in soil.

Characteristics of chemical composition

Chemical composition characteristics of macroelements

The chemical composition of the major components (macroelements) such as SiO_2, TiO_2, Al_2O_3, Fe_2O_3, MnO, MgO, CaO, Na_2O, K_2O, P_2O_5 in the vegetable cultivation soil of the study area was determined by X-ray fluorescence spectroscopy (XRF).

Analysis results show that the soil in the study area has oxides of the elements Si, Al and Fe in large concentrations (playing a main role), especially the average SiO_2 content of 71.66% - accounting for major amount in soil. Silicon is present mainly in quartz minerals and clay minerals. In particular, Si in clay minerals is more easily hydrolyzed and dissolved than in Quartz, so it can provide the nutritional needs of Si (microelement) for plants (for example, Si is the main component in husk cover of rice grains).

The average content of Al_2O_3 is 12.4%, representing its role as the second oxide in the chemical composition of soil, after silica oxide. Aluminum in soil in the study area exists mainly in silicate minerals such as clay minerals, feldspar, amphibole... and is also present in gibbsite. Aluminum does not play a prominent role in crops. Because the soil in the study area is located in well-drained terrain and a neutral environment, there is no process of sulphation of aluminum, which is harmful to plants.

Table 3: Results of Ec and Eh measurements of 24 soil samples in the study area

No	Sample Number	Measuring Value		No	Sample Number	Measuring Value		No	Sample Number	Measuring Value	
		Eh (mV)	Ec (μS)			Eh (mV)	Ec (μS)			Eh (mV)	Ec (μS)
1	ĐT1/1	245	142.1	9	ĐT9/1	234	78,5	17	ĐT15/2	191	88.1
2	ĐT1/2	253	78.1	10	ĐT9/2	213	80.7	18	ĐT16/1	261	129.8
3	ĐT2/1	310	197.0	11	ĐT10/2	191	118.5	19	ĐT16/2	202	95.9
4	ĐT2/2	205	58.7	12	ĐT11/2	197	116.9	20	ĐT18/1	211	139.3
5	ĐT3/2	221	105.7	13	ĐT12/1	273	115.3	21	ĐT18/2	196	114.1
6	ĐT7/2	225	81.7	14	ĐT12/2	250	125.1	22	ĐT19/2	183	67.1
7	ĐT8/1	224	90.7	15	ĐT14/1	253	156.3	23	ĐT20/1	301	317.0
8	ĐT8/2	266	92.7	16	ĐT14/2	216	105.3	24	ĐT20/2	220	105.3

The Fe_2O_3 oxide content in the soil here is relatively low, on average only about 4.95%; This oxide has a small variation in content compared to SiO_2 and Al_2O_2 and is less dependent on soil groups. Iron is present in the soil here mainly in the form of oxide and hydroxide minerals (goethite and hematite).

In addition to the main oxides mentioned above, there are also less common oxides with an average concentration several times smaller than the main oxides such as: K_2O (2.81%), MgO (0.68%), TiO_2 (0.98%), CaO (0.25%), Na_2O (0.24%).

Characteristics of nutrient distribution in the cultivation soil of the study area

Soil nutrients are essential for the survival and growth of vegetation. Therefore, soil should have enough nutrients to support the growth and development of plants.

In this paper, the authors evaluate some main macronutrient elements such as CaO, Na_2O, P_2O_5, K_2O and MnO. These components are mainly involved in the growth and development of organisms, they play a crucial role in creating cells, tissues and other parts of living organisms. Results of analysis of the content of main nutrients in cultivation soil samples in the study area show that the average content of K_2O, CaO, Na_2O, P_2O_5 and MnO are: 2.81%; 0.25%; 0.24%; 0.091% and 0.057% respectively. The K_2O content in soil varies depending on location and possibly, due to formation conditions or human cultivation and potassium fertilization activities. Research results also show that the easily digestible K content in the soil is relatively low, or in other words the soil here is poor in Potassium[6].

Characteristics of distribution of heavy metals in cultivation soil of the study area

The results of heavy metal analysis were compared with national standards on soil environment (QCVN 03-MT: 2015/BTNMT) to evaluate the pollution level of heavy metals (As, Cd, Cu, Pb, Cr and Zn) in the soil of the study area. In addition, some indicators not included in QCVN 03-MT:2015/BTNMT (such as: Ba, Sb, Co, Mo, Se and Sn) are evaluated using Canadian Standards (Canadian Environmental Guideline, CCME, 2003) that regulates the content of heavy metals in soil.

The data in Table 4 show that the average content values of mostly heavy metals such as As, Cd, Cu, Zn, Pb, Cr, Ba, Sb, Co, Se and Sn are below the Vietnamese standard (QCVN03-2015)[18] values. The maximum values of these heavy metals are also below the comparative (CCME) standard values, only one of 24 analyzed samples (sample DT09/1) has a lead concentration of 74.9 mg/kg, slightly higher than the comparative values (exceeds QCVN 03-2015 and CCME standards at a very low level of 0.07 times). The Pb content in this sample is higher than the other 23 analyzed samples, possibly partly due to the sampling location near the intersection of two main traffic roads of the study area. On the other hand, according to the results of interpreting using Sufer software to draw charts representing the distribution of main heavy metals (As, Cd, Cu, Pb and Zn) in the study area, indicating that Pb is mainly concentrated in the south (Figure 4a). Where the Gold Star rubber factory is located. It may be due to the impact of waste at this factory (because lead can be mixed in rubber filler (zinc oxide) for rubber products).

Table 4: Statistics of heavy metal analysis results in soil (24 samples).

Values	Content of Analysed element (mg/kg)										
	As	Ba	Cd	Co	Cr	Cu			Se		Zn
Minimur	5.69	73.94	0.01	9.91	17.37	13.20	8.55	3.70	3.60	3.50	16.31
Maxcimu	15.0	296.53	0.20	34.96	71.06	53.32	74.90	18.93	4.90	4.70	69.22
Average	9.56	138.25	0.10	16.32	39.53	22.75	21.30	5.06	4.27	4.25	37.45
Skew	2.76	56.86	0.06	6.72	14.10	8.85	17.05	3.11	0.36	0.33	18.33
QCVN 03-2015	15.0		1.5		150.0	100.0	70.0				200.0
TC Canada	12.0	700	1.4	40.0	64.0	63.0	70.0	20.0	5.0	5.0	200.0

Figure 4b shows that As is mainly concentrated in the west of the Dai Thinh area. Figure 4c, Figure 4d, and Figure 4e indicate that the distribution of Cd, Cu and Zn content in the study area is not much different. The Southwest region, however, has a locally slightly higher Cu and Zn content. This may be due to the influence of human agricultural and industrial production activities (near the Gold Star rubber factory and to the East, near Quang Minh industrial park).

Thus, the vegetable cultivation land in the study area has not been polluted by As, Cd, Cu, Zn, Cr, Ba, Sb, Co, Se and Sn. Therefore, in terms of research on heavy metal content in soil, the cultivation land in this area can still be used for safe healthy vegetable production.

Some measures to protect and improve the soil environment in the study area

The soil in the study area is locally acidic, so appropriate improvement measures such as deacidification are needed. For locations showing signs of acidity, it is necessary to add dolomite-lime powder. Using organic fertilizers (manure, green manure, animal and plant residues) that have been composted into the soil to increase the amount of microorganisms in the soil, increasing soil fertility and making the soil rich in nutrients again. Previous research also showed the benefits of applying straw to soil[21]. Specially, analysis shows that soil samples in the upper layer often have a lower pH than soil samples in the lower layer (patchy clay), which will not be favorable for growing vegetables and fruit trees with cluster roots. On the other hand, when the soil has a low pH, it will create favourable conditions leading more soluble heavy metals to be more mobile and have a higher dispersion, easily entering the food chain through the plant roots. Therefore, it is very necessary to do deacidification works (eliminate acidity) and choose the appropriate fertilizer for acidic soil.

It is also necessary to use appropriate methods such as using suitable plants to treat heavy metal pollution in soil. Cultivation soil in the study area shows signs of local Pb pollution at low levels only. It is necessary to plant trees with good Pb adsorption ability such as vetiver grass, water spinach, and guava pineapple trees to reduce Pb pollution in soils.

Applying crop diversification models in the form of intercropping, overlapping cultivation, and crop rotation. Combining cultivation and animal husbandry, enhance the development and expansion of animal husbandry - garden - pond economic models, create sustainable and stable productivity, reduce the use of mineral fertilizers and toxic chemicals to plant protection.

Industrial parks should be soil monitoring every year to control pollutants, especially heavy metals. It is necessary to build a system to collect and treat common wastewater sources before discharging into natural streams to avoid spreading pollution.

It is necessary to have reasonable measures to manage and monitor the operations of factories to limit discharge of waste into the environment.

In addition, increasing propaganda and education to raise awareness of environmental protection for local habitants in environmental aspects such as not abusing chemicals for plants if not necessary; collecting waste and stored in designated places for treatment; brick and concretize animal logging, toilets in households, and building common sewage system in residential areas to limit BOD_5 and coliform pollution...

Based on the above mentioned, this study proposes that local habitants expanding the area specializing in

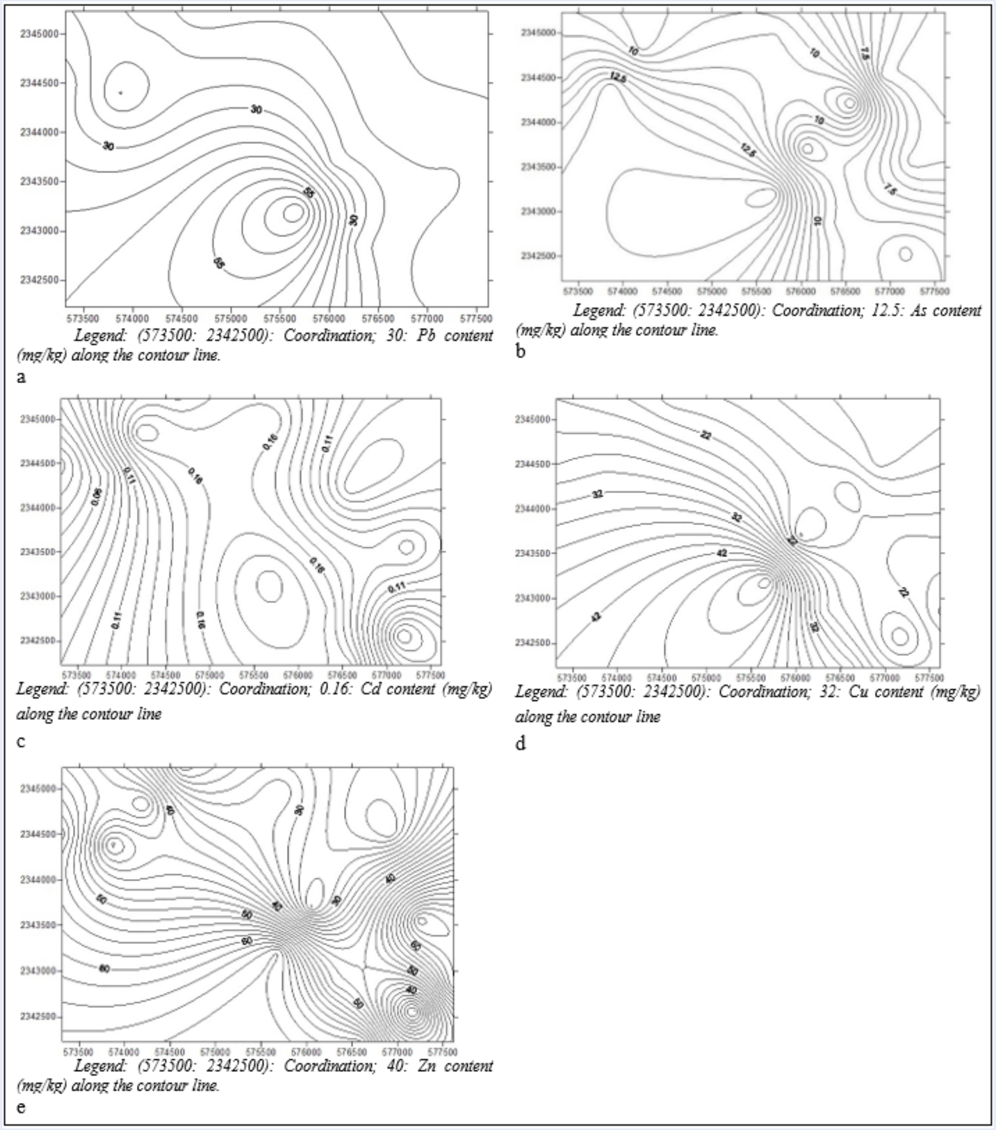

Figure 4: Distribution Sketch of Lead (Pb) content (a), distribution Sketch of Arsenic (As) content (b), distribution Sketch of Cadmium (Cd) content (c), distribution Sketch of Copper (Cu) content (d), and distribution Sketch of Zinc (As) content (e) in Dai Thinh area.

safe health vegetable cultivation, and should apply scientific and technical measures in planting and caring for vegetables, to meet the needs of safe vegetable demand for domestic and export markets.

CONCLUSION

Based on the results of geochemical environmental research on cultivation land in Dai Thinh area (Me Linh-Ha Noi), the following conclusions have been drawn:

Cultivation soil in the study area was developed on sediments of the Vinh Phuc system. Soil often has a three-zone structure, distinguished by color and quite clearly different grain size composition.

Soil groups in the study area include heavy sandy loam, sandy loam, and sandy clay soil. These types of soil, in general, have relatively good aeration and drainage while still ensuring the necessary moisture retention in the soil, suitable for crops with shallow root in general and vegetables and short-term fruit trees in particular.

Cultivation soils in the Dai Thinh area mainly have a neutral to weak acidic environment (pH ranging from 4.89 to 7.32), a non-saline (Ec ranging from 58.7 -

317.0 (μS/cm)), and a strong oxidizing environment (Eh ranging from 183 to 310 (mV) (Eh > 150mV). So it will be favorable for plant growth, suitable for growing short-term fruits and vegetables and the proliferation of beneficial (aerobic) microorganisms in the soil. The main macrochemical components of the vegetable cultivation soils in Dai Thinh area are oxides of the elements Si, Al and Fe, especially the large amount of SiO_2 in the soil. In addition, the vegetable cultivation soil of the study area also contains macro nutrients such as: CaO, Na_2O, P_2O_5, K_2O and MnO.

Cultivation soil in the study area has not been polluted by As, Cd, Cu, Zn, Cr, Ba, Sb, Co, Se and Sn. Therefore, in terms of research on heavy metal content in soil, the cultivation land in this area can still be used for health safe vegetable production.

It is necessary to reduce acidity by applying dolomite-lime powder in areas where the soil shows signs of acidity and applying mainly organic fertilizers (manure, green manure, animal and plant residues) that have been composted into the soil to increase the amount of nutrients. organisms and increase soil fertility.

Applying the model of crop diversification, combining farming and animal husbandry, enhance the development and expansion of garden - pond - animal husbandry economic models. In addition, propagandize and educate to raise awareness of land environmental protection among local people.

Industrial parks should be soil monitoring every year to control pollutants, especially heavy metals. It is necessary to build a system to collect and treat common wastewater sources before discharging into natural streams, and have reasonable measures to manage, monitor the operations of factories to limit discharge of waste into the environment.

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ABBREVIATIONS

CCME: Comparative Canadian standards

QCVN: Vietnam National standard

USDA: United States Department of Agriculture

BTNMT: Ministry of natural resources and environment

US: United States

CONFLICTS OF INTEREST

The authors would like to confirm that there is no conflicts of interest in publishing the article.

AUTHORS' CONTRIBUTIONS

The manuscript was prepared by Vinh Thi Dang; Comments and edits of the manuscript made by Giang Khac Nguyen.

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Bài nghiên cứu

Nghiên cứu đặc điểm môi trường địa hoá đất trồng màu khu vực Đại Thịnh - Mê Linh - Hà Nội phục vụ phát triển bền vững rau an toàn

Đặng Thị Vinh[1,*], Nguyễn Khắc Giảng[2]

TÓM TẮT

Đất canh tác (Trồng đất) là tài nguyên thiên nhiên có vai trò quan trọng đối với sinh vật và con người. Ô nhiễm đất sẽ ảnh hưởng xấu đến sức khỏe con người và động vật thông qua thực phẩm, rau, quả, dược liệu... Để làm rõ đặc điểm môi trường địa hóa và đánh giá chất lượng môi trường đất khu vực Đại Thịnh, huyện Mê Linh, thành phố Hà Nội, các tác giả đã kết hợp sử dụng các phương pháp truyền thống và hiện đại trong quá trình nghiên cứu như: phương pháp nghiên cứu thực địa, phương pháp phân tích độ hạt, phương pháp quang phổ huỳnh quang tia X (XRF) để xác định các thành phần chính (oxit) của đất. Phương pháp quang phổ nguồn plasma cảm ứng cao tần kết nối khối phổ ICP-MS và quang phổ hấp phụ nguyên tử AAS đã được sử dụng để xác định hàm lượng các kim loại nặng trong các mẫu đất. Bên cạnh đó, phương pháp đo trực tiếp để xác định các chỉ số môi trường (pH, Eh, Ec). Kết quả nghiên cứu cho thấy đất trồng màu tại khu vực nghiên cứu thuộc nhóm đất nhóm đất thịt nặng pha cát, đất cát pha, đất sét pha cát, với hàm lượng cát trung bình (kích thước 0,05-2mm): 60,8(%), bụi (limon) (kích thước 0,005-0,05mm): 17,96 (%), sét (kích thước <0,005mm): 21,46 (%). Đất chưa bị ô nhiễm các kim loại nặng quan trọng như: As, Cd, Cu, Zn, Cr, Ba, Sb, Co, Mo, Se và Sn. Đất khu vực nghiên cứu thuộc loại đất trung tính (pH trung bình là 6,61), có môi trường oxy hóa mạnh (Eh > 150mV) (có giá trị Eh dao động từ 183 đến 310 mV), đất không nhiễm mặn (giá trị Ec nằm trong khoảng từ 58,7 - 317,0 (μS/cm).

Do đó, xét trên phương diện về kết quả xác định các chỉ tiêu lý hóa môi trường và hàm lượng các kim loại nặng, đất tại khu vực nghiên cứu có thể sử dụng để sản xuất rau an toàn. Các kết quả nghiên cứu không những làm cơ sở cho việc đánh giá chất lượng môi trường đất phục vụ trồng rau an toàn mà còn làm căn cứ khoa học để nhóm tác giả đưa ra một số giải pháp phù hợp nhằm bảo vệ, cải thiện môi trường đất, góp phần vào việc quy hoạch, sử dụng quỹ đất nông nghiệp bền vững cho vùng nghiên cứu.

Từ khoá: đất trồng, các kim loại nặng, rau an toàn

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