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ABSTRACT

The production of vegetables has been a key sector for the economy of the households in Thai Nguyen City. The farmers do not fully follow the safe vegetable production model. Therefore, there is no assurance of quality and safe vegetables to consumers. The analysis results of NO_{3-} content in Mustard(*Brassica juncea L*) experiment during winter 2014 at Thai Nguyen city shown that the nitrate content from 4 treatment vegetable samples is under safety levels when applied fertilizers (Urea 46%, Superphosphate 16% P_2O_5, potassium sulphate 58% K_2O_5, $(NH_4)_2SO_4$ 21%, NH_4Cl 26%) follow treatment 70N + 60 P_2O_5+ 35 K_2O_5 . NO_{3-} content in mustard wasn't excess of the permitted standards (VNS April 2007/QĐ-BNN). The accumulation of nitrate is lowest in control treatment (52.60 mg/kg fresh), that highest is in the treatment 2 (Urea 46% N/ha with 301.28 mg/kg fresh). Nitrate tends to decrease when the last time dressing as far as the day of harvest. The content of NO_{3-} in the soil before planting is 0.36 mg NO_{3-}/g soil. After harvest, NO_{3-} content accumulated lowest in the soil at control treatment 0.55 mg/100g soil, highest in treatment 2 and 3 (Urea and $(NH_4)_2SO_4$ are 0.71 mg/100g soil, the treatment 4 NH_4Cl is 0.60 mg/100g soil. The study was conducted in order to find out some solutions to improve sustainable quality and quantity of vegetables consumed in Thai Nguyen.

Keywords:	**NO_{3-} , mustard (*Brassica juncea L*), Safety vegetable**
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Supervisor **Student**

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PART I. INTRODUCTION

1.1. Research rationale

Vegetables are essential to human health since they are good source of vitamins, minerals and biologically active substances. However, vegetables also contain nitrate and nitrite. Nitrate itself is relatively non-toxic but its metabolites, nitrite, is associated with methaemoglobinaemia (commonly known as Blue Baby Syndrome). Nitrite might also react with amines to form carcinogenic nitrosamines in the stomach. According to the Agency for Toxic Substances and Disease Registry, the chemicals used in the making of commercial fertilizers create high concentrations of nitrate compounds within the soil. Nitrates are naturally occurring ions that form when organic nitrogen materials decompose in the soil. Nitrate ions act as chemically charged molecules that offset the natural balance within a soil environment. Nitrates can have the same effects on the human body as well as in plant and animal bodies, according to Pest Management at the Crossroads. Over time, nitrates can accumulate inside the body and eventually disrupt normal functions within the body's endocrine, neurological and immune systems. Nitrates pose a particularly dangerous threat to fetal development and infant health in terms of brain and immune system development.

Thai Nguyen City is an economic, political and cultural center in the North of Vietnam. For many years, the city has established food processing belt in which vegetables are considered the most important products. With the growth of agriculture, vegetable production in Thai Nguyen has met the demand in quantity, slowly overcoming the shortage of food before rice harvest, many

kinds of high quality vegetables in the meals have been added to people's daily diet. However, the intensive vegetable production technology now reveals the downside is that the massive application, lack of selection of technical advances such as fertilizers, growth stimulant, plant protection drugs not only cause cultivation environmental pollution but also make vegetables contaminated there by affecting the health of users.

In cruciferous plants, mustard has a short growing time from 20 to 40 days, high yields of 20-40 tons/ha. Currently there are many safe vegetable production areas to create safe products meet human needs. In order to mustard growth and development - the highest yield with nitrate residue levels permitted requiring provide a sufficiently logical. Therefore we need to be more research on nutrition for vegetables in general and mustard in particular. Stemming from the above problems to meet the requirements of actual production, to contribute to the understanding improve the efficiency of fertilizer nitrogen in general and in particular I proceed to study more about ***"Effects of Nitrogen types on yield performance and NO_3^- content in Mustard in Thai Nguyen ".***

Thai Nguyen City is the area of administrative agencies, factories of Thai Nguyen province, especially the school enterprise agencies of the central government, with five universities and some educational and vocational training colleges. This is the largest market for consumption of agricultural products, especially vegetables. In recent years, the city has established food production belt in which vegetables are considered the number one produce.

Areas that supply mainly vegetables for the city are Dong Bam, Tuc Duyen, Cam Gia, Quang Vinh, Thinh Dan, and Quyet Thang.

Thai Nguyen has a suitable climate and soil conditions for vegetable production. On the other hand, the farmers have traditional and experienced vegetable production for a long time. Currently, the production of vegetables has been a key sector for the economy of the households in Thai Nguyen City. The vegetables are mainly short-term ones such as kangkong, mustard, beans, etc,… very few long - term ones like cabbage, kohlrabi, tomatoes, cauliflower which are supplied by other areas because the average cultivated area per person is very low. Therefore, growers have focused on the production of short-term vegetables, usually 4 - 5 crops per year or even 6-7 crops per year for vegetables.

In recent years, safety vegetable production has been the Plant Protection Department attention which opened the IPM training for farmers. In 2001, development of safe vegetable production was conducted. From 2003 to 2004 safety vegetable program was implemented for 60 households at Tuc Duyen which a total area of 3 ha covering cabbage, mustard, kangkong, etc. Yearly output of vegetables is about 400 tons. (Thai Nguyen Plant Protection Department (2005). However, until now effect of the program is not high because growers are not consciousness with food safety but profit. The farmers do not fully follow the safe vegetable production model. Therefore, there is no assurance of quality and safe vegetables to consumers that is the reason why consumption is very low.

Table 1.1. Area, yield, and production of vegetables in Thai Nguyen city through the years

Year	Area (ha)	Yield (ton/ha)	Production (ton)
2011	119.256	173.21	12.285
2012	119.342	177.13	13.745
2013	120.361	188.74	15.382
2014	121.339	179.84	18.164
Average	**120.074**	**179.73**	**14.894**

(source: Thai Nguyen Department of Agriculture and Rural Development)

Table 1.1 shows that from 2011 - 2014, Thai Nguyen city's vegetable production has increased generally in area, yield and production. Specifically, vegetable production has increased 1.42 times from 2011 to 2014. Yield has like were increased 1.03 times during the period but the highest yield was in 2013 of 188.74 kg / ha or an increase of 15.53 kg / ha. Consequently, vegetables output or production has increase 1.47 times during the same period with an average of about 14.894 tons.

In the process of promoting industrialization - modernization, in many localities in the country, soil pollution in Thai Nguyen is a serious problem affecting production and quality of people's life, etc,... So, confronting the problem posed is to have the right solution to fit the production development, investment attraction, but must ensure the ecological balance of the environment, stability and improved living environment of communities, especially in urban areas, and industrial sites in the area.

Besides soil, surface water in the city of Thai Nguyen has been heavily contaminated by toxic chemicals from industrial waste of factories such as Iron

and Steel Thai Nguyen Company, Paper- mill Hoang Van Thu, Cao Ngan factory; waste from agriculture and urban centers, etc,.. They are the causes for reducing fresh vegetable growing areas of the city.

To increase crop yields, farmers use pesticides and chemical fertilizers more and more. Currently, farmers in Thai Nguyen used chemical fertilizers estimated at around 500,000 tons per year, the excess flowing into the basin is about 33%. In the vegetable areas, the percentage of pesticides and fertilizers is higher than 3-5 times with the rice growing areas (Thai Nguyen Department of Agriculture and Rural Development, 2010).

The problem of soil pollution caused by industrial activities, agriculture, urban waste in the city of Thai Nguyen has been articulated by many researches but only focusing on the assessment of soil pollution, and they have not yet researched on the impact of pollution on the quality of agricultural products and food safety.

This study was conducted to investigate the effects of Nitrogen types on yield performance and NO3- content in Mustard, the results of which is expected in provide a contribution to solving the problems food safety.

1.2. Research Objectives

Determine the amount of nitrogen fertilization suitable for mustard cultivation to achieve productivity and high economic efficiency with residual NO_3^- less than permitted level.

The content of NO_{3-} in soil make vegetable absorb higher NO_{3-} and risk soil pollution. The content of NO_{3-} in high vegetable will affect health user.

1.3. Research questions and hypotheses

Nowadays, food safety issues are the concern of everyone in every aspects of lives. Vegetable is one of the foods that is used daily in all families. In recent years, state and the agricultural sector have developed many local policy measures for producing safe vegetable to ensure users' health.

Although the authorities had a lot of efforts in the development of safe vegetable models, these models of safe vegetable production have not been used extensively. Vegetable production areas according to technical processes are polluted by many causes. Currently safe vegetable production areas is still sparse and it is too difficult for the organization, production, and testing consumers' products.

In Vietnam, the producers have abused nitrogen fertilizer use to increase productivity and profitability of their farms. Using nitrogen fertilizer has increased but the use of phosphate, and potassium are very low. Rate of unreasonable combination makes nitrate level in commercial products high.

Studying the soil, water, and fertilizer contamination and their effects on agricultural products is a pressing issue at present to contribute to decrease domestic waste and industrial materials as well as to provide useful measures to create safe products.

INDEPENDENT VARIABLES DEPENDENT VARIABLES

Experiment

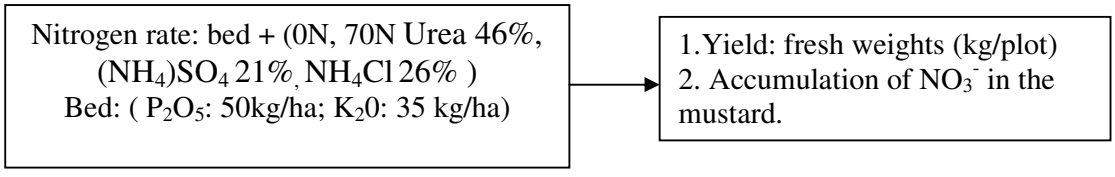

Fig 1. Paradigm of the conceptual framework of the study.

Figure 1 shows an overview of stydy where the relationship between and among the inputs and the outputs of the study is being shown in two boxes:

The left box contain the inputs which are actually the independent variables: Nitrogen rate: bed + (0N, 70N Urea 46%, $(NH_4)SO_4$ 21%, NH_4Cl 26%) Bed: (P_2O_5: 50kg/ha; K_20: 35kg/ha).

The right box contain the outputs which are the dependent variables: Yield: fresh weights (kg/plot).Accumulation of NO_3^- in the mustard.

This study was conducted to find out the effects of fertilizer doses on yield, residual NO_3^- in mustard.

Specifically, this study sought to answer the following questions:

1. Do the mustard have residual NO_3^- in the soil?

2. Does different nitrogen affect yield, and residual NO_3^- in mustard?

1.4. Limitation

This study has limited its scope on effect of nitrogen types on yield, residual NO_3^- in mustard in Thai Nguyen city, Vietnam.

The study was conducted in Thai Nguyen city: Pot experiment: This was done at Thai Nguyen University.

This experiment was conducted at the vegetable production area, Thai Nguyen City, in Vietnam from August, 2014 to January, 2015.

1.5. Definition

For better understanding of the study, different terminologies have been defined operationally as follows:

Fertilizer. Is any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients essential to the growth of plants.

Compost. Is organic matter that has been decomposed and recycled as a fertilizer and soil amendment.

Micro-organic fertilizer. Is in granular form. The product containing nutrients and organic matter which help improving soil, increasing fertility and the nutritional supplement needed for plant nutrition.

Mustard. **(***Brassica juncea)* also known as mustard greens, spinach, leaf mustard and white mustard, is a quick to mature, easy to grow, cool season vegetable for greens or salads.

Nitrate (NO_3^-). Is a compound that contains nitrogen and water. Nitrogen comes from decomposing organic materials like manure, plants, and human wastes. Often the nitrogen (N) comes from ammonia (NH_3) or ammonium (NH_4).

Nitrogen. Is a chemical element essential for the growth of plants and animals.

Safe vegetables. Are produced under the technical process to ensure standards as follows: Limit to the minimum the use of chemical fertilizers, pesticides, recreational drugs, etc. To reduce the backlog of toxins in vegetables such as nitrates, pesticides, heavy metals and pathogenic microorganisms.

Soil pollution. Is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

Urea. Is an organic. Urea serves an important role in the metabolism of nitrogen-containing compounds by animals and is the main nitrogen-containing substance

in the urine of mammals. It is a colorless, odorless solid, although the ammonia that it gives off in the presence of water, including water vapor in the air, has a strong odor. It is highly soluble in water and practically non-toxic.

Etc. It mean written abbreviation for et cetera and other similar things. It is used to avoid giving a complete list.

PART II. LITERATURE REVIEW

This chapter presents the literature review as well as that this portion provided the researcher essential ideas and concepts that serve as a guide in the conduct of the study.

2.1. Related Literature

Fruit and vegetables are important components of healthy diet, and their sufficient daily consumption could help prevent major diseases, such as cardiovascular diseases and certain cancers. Approximately 16.0 million (1.0%) disability adjusted life years (DALYs, a measure of the potential life lost due to premature mortality and the years of productive life lost due to disability) and 1.7 million (2.8%) of deaths worldwide are attributable to low fruit and vegetable consumption Moreover, insufficient intake of fruit and vegetables is estimated to cause around 14% of gastrointestinal cancer deaths, about 11% of ischaemic heart disease deaths and about 9% of stroke deaths globally (FAO, 2012).

A recently published WHO/FAO report recommends a minimum 400g of fruit and vegetables per day (excluding potatoes and other starchy tubers) for the prevention of chronic diseases such as heart disease, cancer, diabetes and obesity, as well as for the prevention and alleviation of several micronutrient deficiencies, especially in less developed countries (FAO, 2012).

Fruit and vegetables can be contaminated with a range of microbial and chemical contaminants. Fruit and vegetables eaten raw, as well as food of animal origin, have long been known to serve as vehicles for transmission of infectious microorganisms. In contrast, the number of confirmed cases of illness associated with consumption of raw fruit and vegetables in industrialized countries has been

relatively low compared to the number due to foods of animal origin. However, the number of cases associated with fruit and vegetables is not insignificant and includes infections caused by some of the more serious pathogens associated for foods of animal origin. Outbreaks of human disease associated with the consumption of raw fruit and vegetables often occur in developing countries and have become more frequent in developed countries over the past decade. The rapid growth of international trade in fresh produce has also resulted in outbreaks due to imported food (Moy, 2004).

Prevention of contamination is the most efficient way to ensure food safety and prevent food borne illness. Thus, every effort should be made to protect food from primary sources of contamination. However, this is not always possible and raw foodstuffs, particularly fruit and vegetables grown close to the soil, may be contaminated with various pathogens. In such cases, efforts should be made to establish critical control points to reduce contamination to safe levels, for example, by applying the Hazard Analysis and Critical Control Point (HACCP) system (WHO, 1998).

Vietnam has a long history growing vegetables, with climate conditions that are suitable for growth, development and seed production of vegetables, including vegetable origin of subtropical and tropical. At present, Vietnam has 60 vegetables processing workshops with annual capacity of 290,000 metric tons. Of that capacity, the State-owned make up 50%, the State-not-owned make up 16%, the foreign invested make up 34%, and households make up the rest (agricultures network, 2013).

On the whole, the processed amount is quite small and most of the output of vegetables is domestically consumed. 2005 vegetables export value totaled at 235 million Dollars, mostly contributed by the processed vegetables. There were few kinds of export oriented vegetables like tomato, cucumber, maize, red pepper, watermelon, either processed (dried, bottled, canned, salted, condensed, frozen) or not. The foodstuff safety is always considered very important, especially for vegetables production. Although guidance on safety vegetables production has been given, it is hard to know whether the guidance may be followed or not. Thus, safety vegetables are sometimes "not safe enough" and cannot compete effectively on the market (agricultures network, 2013).

Safety of vegetables and price are foremost in the minds of Vietnamese consumers. The government is encouraging safe vegetable production systems, and has acknowledged the need for Good Agricultural Practice (GAP) and EurepGAP compliance, as well as intensive/reduced chemical management and protected cultivation. Priority is also being given to water quality and safe waste disposal to reduce the risks of pre- and postharvest contamination of produce. However, more attention by government and traders is needed to improve supply flowsand reduce product losses and logistical costs (agricultures network, 2013).

Using of fertilizers to increase yield of crop, improve soil fertility. However, if the irrational use of fertilizers will pollute the soil. In agricultural production due to the irrational use of inorganic fertilizer to make contaminated soil: acidic soil, accumulated heavy metals, NO_3^- contamination in the soil, etc.

The most important goal of agriculture is the production of high quantity and quality, safe and non-expensive food for an ever increasing worldwide population.

With the increasing problems associated with the use of synthetic chemicals in agriculture (impacts on health and the environment, resistance development in plant pathogens and pests, etc.) There has been an ever -increasing interest in the use of beneficial microorganisms to improve plant health and productivity while ensuring safety for human consumption, and protection of the environment, particularly for the developing countries (Avis et.al., 2008).

Nitrogen is essential for growth and reproduction of all plant and animal life. It is a basic constituent of proteins. The form of nitrogen within plants when consumed by animals has important effects on growth and reproduction. Several different groups of nitrogen-containing compounds may be found in plants. The amount of each form depends on plant species, maturity and environmental conditions during growth. These nitrogen compounds may be broadly classed as either protein or non-protein compounds. Under normal growing conditions plants use nitrogen to form plant proteins. When normal growth is altered, protein formation may be slowed and the nitrogen remains in the plant as non-protein nitrogen. Nitrate, nitrite, amides, free amino acids and small peptides make up most of the non-protein nitrogen fraction. Nitrate is of special concern in animal production and in human foods because of its potential toxicity when excessive amounts are ingested.

According to FAO (2012) nitrate content vegetables can be divided into three groups: Plants with nitrate content higher than 1000 mg/kg - rocket, lettuce, spinach, herbs, beetroot, etc. Plants with average content of nitrate (50-1000 mg/kg) - carrot, green beans, cauliflower, onion, pumpkin, eggplant, potato, etc. Plants with nitrate content lower than 50 mg/kg such as berries, fruits, cereals, pod vegetables.

Studies have confirmed a dose increase nitrogen fertilizer unreasonable is the cause reduce productivity and increase nitrate in vegetables. Nitrate on vegetables in pollution levels due to an overdose of nitrogen fertilizer, applied incorrectly. Reduction of nitrogen fertilizer will reduce the accumulation of NO_3^- in vegetables (Eustix et.al., 1991).

Vegetables are important components of a healthy diet since they are a good source of vitamins, minerals, fibres and other nutrients. Sufficient daily consumption of vegetables can help prevent major diseases, including cardiovascular diseases, cancers, obesity and diabetes (WHO, 2003). Vegetables also contain nitrate and nitrite. The potential hazard of vegetable borne nitrate is from its conversion to methaemoglob in-producing nitrite before and/or after ingestion (Greer et.al., 2005).

The concentrations of nitrate in vegetables depend on species, season, light, temperature, method of growth and fertilizers used (EFSA, 2008). Leaf crops (e.g. cabbage, lettuce and spinach) have fairly high nitrate concentrations, whereas storage organs (e.g. potato, carrot, pea and beans) have relatively low concentrations. Very high concentrations (>2500 mg/kg) of nitrate (Santamaria, 2006). In vegetables (especially leafy vegetables) have been reported in diffgerent countries (Du et.al., 2010; EFSA, 2008). With the increased use of synthetic nitrogen fertilizers and livestock manure in intensive agriculture, vegetables may contain higher nitrate concentrations than in the past (Santamaria, 2006). In fresh, undamaged vegetables, the nitrite concentrations are usually very low and there are no correlations between the nitrate and nitrite concentrations (Mor et.al., 2010). However, under adverse post-harvest storage

conditions, nitrite concentrations can increase in vegetables as a greater proportion of the nitrate is converted to nitrite as a result of bacterial contamination and endogenousnitrate reductase action (EFSA, 2008). Nitrite accumulation in vegetables is inhibited under frozen storage because the endogenous nitrate reductase is inactivated (EFSA, 2008). During storage at ambient temperatures, the nitrite contents of vegetables increase in relation to their nitrate concentrations and over time (Chung et.al., 2004).

Nitrate accumulated evidently in 0-30 cm soil of vegetable fields and orchards compared with croplands because of heavier nitrogen application. Nitrate concentration in 0-30 cm soil of vegetable fields and orchards were 3.8 and 1.2 folds of that in croplands. Too much nitrogen fertilization can increase the risk of nitrate pollution of groundwater. Nitrate concentration of groundwater under croplands was 5.0 mg kg-1 and the over-standard ratio was the lowest (only 13.6%) (DU Lian-feng et.al., 2011).

According to Hanafy Ahmed, A.H. et.al., 2000 no significant effects could be detected on most of the studied growth characters (shoot height, number of leaves, fresh and dry weights of shoots) as well as yield of the plants treated with rhizobactrien or biogien when compared with the control-untreated plants. However, significant increases were recorded by the plants treated with nitrobien, while the plants treated with microbien recorded significant decreases. Significant decrease in nitrate accumulation was recorded by the plants treated with all studied biofertilizers, specially those plants treated with nitrobien, biogien and rizobactrein, while the least decrease was recorded by the plants treated with microbien.

In order to maximise the health benefits from eating vegetables (WHO, 2003), measures should be taken to reduce the nitrate and nitrite exposures while maintaining the recommended intake of vegetables (Centre for Food Safety, 2010). Excessive use of nitrogen fertilizers should be avoided so as to reduce nitrate build up in soil and vegetables. Vegetables must be stored and processed properly to prevent bacteria contamination and hence reduction of nitrate to nitrite. Removal of stem and midrib results in a decrease of nitrate content by 30%-40% in lettuce and spinach. Peeling of potatoes and beetroot decreases the nitrate content by 20%-62%. When peas, cabbage, beans, carrots, potatoes spinach and endives are cooked in water, nitrate levels decrease by 16%-79%. Nitrate in Chinese flowering cabbage, Chinese spinach and celery can be reduced significantly by 12%-31% after blanching for 1-3 minutes.

Within the agricultural industry, fertilizers provide an effective means for increasing crop yields. Fertilizer usage is a widespread practice that poses potential dangers to the health of humans as well as to the environment. Excess chemicals from fertilizer applications, known as runoff, can contaminate surface and groundwater supplies, which ultimately affects the quality of drinking water and the quality of crops produced.

According to the Agency for Toxic Substances and Disease Registry, the chemicals used in the making of commercial fertilizers create high concentrations of nitrate compounds within the soil. Nitrates are naturally occurring ions that form when organic nitrogen materials decompose in the soil. Nitrate ions act as chemically charged molecules that offset the natural balance within a soil environment. Nitrates can have the same effects on the human body as well as in

plant and animal bodies, according to Pest Management at the Crossroads. Over time, nitrates can accumulate inside the body and eventually disrupt normal functions within the body's endocrine, neurological and immune systems. Nitrates pose a particularly dangerous threat to fetal development and infant health in terms of brain and immune system development (Jacquelyn, 2005).

Vegetables are rich in many important nutrients that protect against chronic diseases (WHO, 2003). It is safe to eat vegetables with higher nitrate content, if they have been properly stored and prepared (Centre for Food Safety, 2010). However, home prepared infant food containing vegetables should be avoided until the infant is 3 months or older (Greer et.al., 2005).

More and more nitrogen fertilizers are applied in fields, since N fertilizer plays a significant role both in crop yield and quality (Wang et.al., 2003). Nitrate is often the major source of N available to higher plants, especially to vegetables. Nitrate uptake and distribution in crops is of major importance with respect to both environmental concerns and the quality of crop products. Nitrate, not taken up by a crop, may potentially contribute to ground and surface water pollution through nitrate leaching and soil erosion. (Zong et.al., 2002).

On the other hand, nitrate taken up by plant causes high nitrate accumulation in plants, especially in the most vegetables. Because of edible parts contain very high concentrations of nitrate that has been implicated in the occurrence of methaemoglobinemia and possibly in gastric cancer as well as other diseases (Ishiwata et.al., 2002).

The reduction of nitrate in fruits and vegetables are big problems and important in agricultural production in the world. Agricultural products with high residual nitrate, the more risk of poisoning to consumers.

According to scientists there are 20 factors that cause nitrate residues in agricultural products such as: temperature, light, land, water, farming practices, etc, but the main reason was the agronomist said that fertilizer especially nitrogen, by improper use: high doses of fertilizers, fertilizer monitoring the harvest period, unbalanced fertilizer with phosphorus, Potassium and micronutrients.

Many research results have demonstrated that residual nitrate in the vegetable closely related to the supply of nitrogen and photosynthesis process before harvest. If there is enough time and conditions for strong plant photosynthesis and respiration create glucid create acetoacid the nitrate concentration in the plant not to toxic levels. Thus period nitrogen applies before harvest deciding to residual nitrate in vegetables. However, absorption of nitrate and accumulate rapidly or slowly depending on the vegetables. Most vegetables have nitrate concentrations peaked after the last apply additional fertilizes from 3-10 days (Venter F. and P. D. Fritz, 2007; Dang et.al., 2003).

Generally, increasing nitrogen fertilization increased both fresh and dry yield of rocket plants, however this increase was accompanied with increasing nitrate concentration. Double phosphorus and potassium fertilization reduced nitrate concentration even under high nitrogen fertilization. This may suggest that an important factor for a good yield and low nitrate accumulation is the nutrient balance, specially among NPK (Hanafy Ahmed, A. H. et.al., 2000).

The nitrate pollution of vegetables caused by excessive nitrogen fertilizer application was serious. According to the nitrate concentrations, vegetables were sorted as the sequence of below: green leafy vegetables, rhizome vegetables, cabbages, and fruit vegetables (DU Lian-feng et.al., 2011).

Significant decrease in nitrate accumulation was recorded by the plants treated with all studied biofertilizers, specially those plants treated with nitrobien, biogien and rizobactrein, while the least decrease was recorded by the plants treated with microbien. A negative relationship between nitrate accumulation and concentration of phosphorus, total sugars, total free amino acids and soluble phenols were detected by the plants treated with the different biofertilizers. Nitrogen concentration tended to decrease by various biofertilizers. However, no constant trend could be detected by potassium concentration. Thus, it can be suggested that the increase in total sugars, free amino acids and soluble phenols may be implicated indirectly in decreasing nitrate accumulation due to the use of these biofertilizers. Also, the increase of the previous mentioned organic components may enhance the use of nitrate transformation with the available carbon into plant structural growth (Hanafy Ahmed, A. H et.al., 2000).

In the past decade there has been a lot of publicity about the large number of food-poisoning cases and attitudes towards Vietnam's food supply have shifted. The emerging middle classes in Hanoi, Ho Chi Minh City and other urban centers have become concerned about the food they eat and are starting to demand vegetables with fewer pesticide residues. Some are even willing to pay a slightly higher price for these products, up to 10 percent more than vegetables that are not certified as safe. Concerned urban consumers are increasingly demanding "safe" vegetables. Rural people are more likely to be able to grow a small patch of vegetables for their own consumption, an option that is not available for many urban people. In Ho Chi Minh City, it is estimated that the

current supply of “safe” vegetables can meet only 30 percent of the demand from urban consumers (agricultures network, 2013).

Safe vegetables are sometimes confused as organic vegetables in the local newspapers, but the regulations for safe vegetables are not as stringent as organic regulations. The regulations on safe vegetable production allow for the application of chemical fertilizers and certain classes of pesticides, although the most toxic classes of chemicals are banned. To be sold as safe vegetables, farmer’s products must meet certain standards as set out by the Ministry of Agriculture and Rural Development. Basically, the regulations on safe vegetables state that pesticide residues, nitrate content, heavy metal content and bacterial pathogens all must be below the specified tolerance levels. The Plant Protection Department of the Ministry of Agriculture is in charge of regulating safe vegetable production and they collect random samples of vegetables from farmers and from the markets for testing to ensure that the pesticide residues are below the allowable limits (agricultures network, 2013).

This system of testing is helping to boost consumer confidence in the quality of safe vegetables, although greater effort is required on this front, as many consumers remain sceptical. More rigorous testing of vegetables, labelling of vegetables with recognisable brands and consumer education campaigns are all needed to further improve consumer confidence in the safe vegetable system. As people around the world are becoming more concerned with the quality and safety of their food, opportunities like safe vegetable production are emerging. These opportunities can allow farmers to move towards a more sustainable form of

agriculture that is better for the health of their farms, their families and the communities that depend on them for food (agricultures network, 2013).

2.2. Related Studies

The different levels of nitrate were found in each kind of vegetables because of the different factors in cultivation such as types of vegetables, types and amount of fertilizers, types of soil and light intensity. It was found in this study that the application of large amounts of fertilizers, especially nitrogen fertilizers was the major factor that caused high levels of nitrate residues in vegetables. For lead and cadmium contents, the study found that most of the leafy vegetables contained lead and cadmium levels higher than that of beans, fruit and root vegetables. It was also found that lead and cadmium levels in most of the leafy vegetables from conventional and good agricultural practice cultivations were higher than in the organic cultivation.

PART III. METHODS

This chapter presents the research design, subjects of the study, determination of sample, research procedures, research instrument, and statistical treatments of data.

3.1. Materials

The following materials were used in this study:

Mustard: The scientific name: *Brassica juncea L.*, family name *Cruciferae.* The variety used in the experiments is Chinese Mustard of Southern Seed Company (Ho Chi Minh City, Vietnam) with growing time of 40 - 45 days.

- Fertilizers: Urea 46% N, Superphosphate P_2O_5 16% N, potassium sulphate K_2O 58% N, $(NH_4)_2SO_4$ 21% N, NH_4Cl 26% N.
- Well water: It was used for pot experiments.
- Pot: This was used in growing vegetables.
- Soil: Alluvial soil was used for pot experiments. Soil samples were tested (some possible physical, chemical and nitrate, heavy metals) before conducting the experiment.

3.2. Methods

Experiment : Effect of nitrogen types on yield performance and residual of NO_3^- in mustard.

This experiment was used Randomized Complete Block Design, single factor with four treatments and three replications.

Treatment	Nitrogen type
1	0N + 60 P_2O_5 + 35 K_2O (control)
2	Control + 70 N (urea)
3	Control + 70 N $(NH_4)_2SO_4$
4	Control + 70 N (NH_4Cl)

Experimental Lay-out

The experimental units were laid out as follows:

Block 1	T1	T3	T2	T4
Block 2	T2	T4	T1	T3
Block 3	T4	T2	T3	T1

Legend:

T1 - Control

T2 - Treatment 2

T3 - Treatment 3

T4 - Treatment 4

Fertilizing process is application as follows::

planting-dressing : 40%N + (100% P_2O_5 + K_2O).

First Top-dressing : 30%N + (100% P_2O_5 + K_2O).

Second Top-dressing : 30%N + (100% P_2O_5 + K_2O).

Lab analysis:

Sample of soil: After getting, the roots were removed, impurities, drying, then crushing and sieving were done then brought to soil laboratory for analysis (after first top dressing, after second top-dressing and after harvest).

Sample of mustard: analysis content of NO_3- in mustard (5 days after first top-dressing, 5 days after second top-dressing, 7 days after second top-dressing, 9 days after second top-dressing).

Determine NO_3^- : Measured on by ion selective electrode method.

SenSion 2 of HACH firm, with a catalyst ISA.

NO_3^- content in vegetables is determined by the formula

$$NO_3^- \text{ content (mg / kg fresh)} = \frac{100 \cdot X}{a}$$

Where: X: the measured concentration of NO_3^- (mg / l or ppm)

a: sample weight (g)

Methods of analysis NO_3^- concentrations in mustard:

NO_3^- content in vegetables is determined by the center scientific research and technology transfer of Thai Nguyen University of Agricultural and Forestry.

Statistical Treatment of Data

The data gathered were organized and subjected to statistical analysis, particularly the Analysis of Variance for single factor experiment in Randomized complete block design (RCBD) using SAS 9.1.

PART IV. RESULTS

This chapter includes the result of analysis, presentation and interpretation of collected data which may answer the specific questions set in this study.

4.1. The fact of soil and fertilizer in vegetables production area of Thai Nguyen City

4.1.1. Soil in Thai Nguyen

Land used for vegetable production in the three sites in Thai Nguyen City is alluvial soil or sandy rich soil with pH 5.2 - 5.7 (acid soil) and humus, N, P_2O_5, K_2O contents are low. The result of analysis of heavy metal content (Pb and As) are show in Table 4.1.

Table 4.1. pH and content of Pb, As in the soil at three areas in Thai Nguyen City

Site	**No. of samples**	**pH** (Range)	**Content in the soil** *(mg/kg dry soil simple)*	
			Pb (Range)	As (Range)
Tuc Duyen	8	5.3-5.7	23.54-52.78	4.87-10.92
Quang Vinh	8	5.3-5.6	40.54-65.78	6.36-11.55
Dong Bam	8	5.2-5.5	30.70-61.15	5.25-7.29

(source:Thai Nguyen Department of Agriculture and Rural Development)

Standard March, 2008: Pb $\leq$ 70 mg/kg dry soi; As $\leq$ 12 mg/kg dry soi.

According to Vietnam standard March 2008 by Ministry of Natural resources and Environment, the soil where vegetable are grown conducive for production. In 24 soil samples, no sample contamination were observed contents of Pb and As in the soil are low compared to Vietnam standard March 2008.

Vegetable growing areas in study sites here industrial production and mining, current Pb and As are content still in general with the standard of tolerable limits.

4.2.2. The current situation of application fertilizers

Supply of fertilizer for vegetables is important technical measures to promote the development and increase productivity. How to supply fertilizer and ensure productivity, quality, and also ensure hygiene and food safety? Is an issue that must be taking care of growers. Basically, some vegetables production processes are applied in the summer-autumn season of 2012, the scope of the investigation was the 60 households at three study areas of the Thai Nguyen city, the following results were obtained.

The results show that in general, the amount of fertilizer that farmers used for vegetables in Thai Nguyen City varies, depending on the production conditions of each area and each household. Almost all farmers apply fertilizers for vegetable production. In three important chemical fertilizers, growers only generally used very little of nitrogen, phosphorus and potassium. The amount of muck applied for vegetables was low, while inorganic fertilizer use was very high, especially the nitrogen.

Compare with safe vegetable production process of the Ministry of Agriculture and Rural Development, the amount of fertilizer used for vegetables in Thai Nguyen City in the production of bitter melon, mustard, kangkong, cucumber is around 1.5 - 3 times higher than the safe production process. Phosphate used for kangkong, and cucumber are regulated but bitter melon and mustard green had higher than safe production process. For potassium, most vegetables lower than the standards and in fact 35% of the total households surveyed do not use potassium.

The application of last supply of nitrogen before harvest is also worrisome. The survey results shows that only about 15% of the surveyed households ensured sufficient time for nitrogen isolation, almost households have an isolated time of nitrogen very short as compared with prescribed, which is about 3 -10 days. This is the main cause of high NO_3^- residual in vegetables.

Table 4.2. The current of application fertilizers to vegetables at Thai Nguyen City

Kind of vegetables	**Content**	**Muck,** *in kg/ha (Range)*	**Nitrogen** *in kg/ha (Range)*	**Phosphate** *in kg/ha (Range)*	**Potassium** *in kg/ha (Range)*	**Last day of application of Nitrogen before harvest** *(days)*
Bitter melon	Farmer practice	13500	289-354	33-87	21-40	8 - 10
	MARD recommendation	**20000**	**150**	**70**	**45**	**18 - 20**
Mustard	Farmer practice	13500	50-140	48-78	25-35	3 - 5
	MARD recommendation	**18000**	**70**	**60**	**35**	**10 - 14**
Kangkong	Farmer practice	900	67-328	18-27	21-12	5 - 7
	MARD recommendation	**15000**	**150**	**70**	**45**	**10 - 14**
French bean	Farmer practice	4800	43-96	36-97	48-67	2 - 6
	MARD recommendation	**20000**	**100**	**100**	**200**	**8 -10**
Cucumber	Farmer practice	13000	178-250	43-75	56-100	5 - 7
	MARD recommendation	**20000**	**100**	**100**	**200**	**8 - 10**

According to survey results of Nguyen Thi Thuy, PhD

4.3. Effect of different nitrogen types on yield performance and residual of NO_3^- in mustard

4.3.1. Effect of nitrogen on yield performance of mustard

Understanding the process of plant growth with the ultimate goal is to achieve high productivity, is the primary basis of evaluating the adaptation of plants to land and the impact of technical measures on plant cultivation planting can bring the best economic efficiency or not.

Results in the table shows that the yield of mustard are difference between the nitrogen types with control lowest is 4.1 tons/ha. Reach highest when apply Urea 46% N/ha the yield is 10.26 ton/ha (corresponding respectively). When apply $(NH_4)_2SO_4$ 21% N the yield was 7.10 ton / ha.

When using difference nitrogen types have differ affecting on the yield of mustard.

Table 4.3. Effect of nitrogen types on the yield of mustard

Treatment	**Yield** *(ton/ha)*			
	Replication 1	*Replication2*	*Replication3*	***Average***
T1	4.05	4.15	4.10	4.10
T2	10.30	10.00	10.50	10.26
T3	7.10	7.05	7.15	7.10
T4	8.65	8.06	8.80	8.50

The results were affirmed using large amounts of urea. It is the main cause of high nitrate content in the vegetable but the economic benefits and high yields. Farmers use NPK less because having low yield and low economic value.

The factors toxic to vegetable is an important issue that agriculture must have been very interested. Nitrate levels are excessive accumulation of vegetables and agricultural products is one of the causes of many diseases harmful to humans. Therefore NO_{3-} in vegetables is one of the important indicators between vegetables and "clean" vegetables "unclean." So to have NO_{3-} concentrations in vegetables in extent permitted, and also to achieved high productivity needs technical measures.

4.3.2. The effect of nitrogen types to NO_3^- variation in mustard

NO_3^- accumulation in plants is due to the growth and development of plants absorbs nitrogen from the soil and from the air. NO_3^- accumulation in plants more or less depends on the ability to provide protein of soil more or less, the absorption capacity of the plant is strong or weak. Also depends on the type of vegetable (edible leaves, edible tubers, and fruit).

The results of analysis of mustard grown in winter in 2014 average of four treatments and three replications are shown in Table 4.4 .

Table 4.4 . The effect of nitrogen types to the variation in NO3 - in mustard

Treatments	**Mean levels of nitrate** (*mg/kg fresh)*			
	5 days after first top-dressing	5 days after second top-dressing	7 days after second top-dressing	9 days after second top-dressing
T1	45.53[d]	73.77[d]	65.8[d]	52.56[d]
T2	76.72[a]	402.28[a]	371[a]	301.28[a]
T3	59.56[b]	327.14[b]	295.4[b]	272.62[b]
T4	54.75[c]	325.18[c]	288.5[c]	256.46[c]

* a,b,c,d significant at the 0.01 probability levels.

* According to Vietnam standard April,2007/QĐ-BNN of Ministry of Agriculture NO_3^- content in Mustard ≤ 500mg/kg fresh

In table 4.4 shows that the accumulation of nitrate in vegetables after harvest ascending doses nitrogen, lowest in control treatment is 52.56 mg/kg and the highest in the treatment 2 Urea 46% N/ha was 301.28 mg/kg. when using different types of nitrogen the concentration of NO_{3-} in the mustard is difference. Results showed that the concentration of NO_{3-} in vegetables remained at levels allowing because of nitrogen to be applied according to the formula.

Nitrate accumulation in mustard is highest in 5th day after the second top-dressing when the most powerful plant growth stage, due to nitrate nutrition also increase content of NO_{3-} this phase mustard also absorb the most nutrients (including N). In the treatment 2 Urea 46%N/ha reached the highest was 402.28 mg NO_3^-/kg fresh control and the lowest was 73.77 mg NO_3^- / kg of fresh vegetables but up to 7 days after second top-dressing and 9 days after second top-dressing, the concentration of NO_3- in the treatment are reduced, because the nitrogen dressing last time influenced the variation of nitrate in vegetable. Nitrate tends to decrease when the last time dressing as far as the day of harvest. From Table 4.4 shows that the meaning of nitrate level in each period has significant among all treatments.

4.3.3. The effect of nitrogen types to changes of NO_3^- in the soil

Nitrate in the soil is easily digested protein supply for crops, it is formed in the ground and go through the process of mineralization due to the operation of a variety of microorganisms. Cumulative NO_3-N in soil more or less depending on the activity of microorganisms and the ability to supply nitrogen to the soil.

Most of soil in Vietnam is poor in nitrogen and the fact shows that if only planted without proper nutrition plants would poorly developed. Appling chemical nitrogen or other fertilizers containing nitrogen such as: manure and muck plant growth thrive (Bui and et.al., 1996).

Land used for vegetable production in Thai Nguyen City is alluvial soil or sandy rich soil with pH 5.2 - 5.7 (acid soil) and humus, N, P_2O_5, K_2O contents are low. The content of NO_{3-} in the soil before planting is 0.36 mg NO_3^- /kg soil

Table 4.5. The effect of types nitrogen to changes of NO_3- in the soil

Treatments	**Mean levels of nitrate** (*mg/g soil)*		
	after first top - dressing	after second top - dressing	after harvest
T1	0.36^d	0.64^d	0.55^c
T2	0.91^a	1.42^b	0.71^a
T3	0.72^b	1.76^a	0.71^a
T4	0.67^c	1.20^c	0.60^c

* a,b,c,d significant at the 0.01 probability levels.

At harvest, NO_3^- content accumulated lowest in the soil at 0.55 mg/100g soil, highest is 0.71 mg/100g soil. Nowaday Vietnam don't have standard about content of NO_{3-} in soil. If the concentration NO_{3-} in soil with high levels , the vegetables will absorb more NO_{3-} in soil . when eating vegetables have high content of NO_{3-}, Nitrite might also react with amines to form carcinogenic nitrosamines in the stomach.

In most of the treatments of applied nitrogen, NO_3^- content in the soil after harvesting higher than NO_3^- content and total nitrogen in the soil before planting and this show that the fertilizer increased the amount of digestible in the soil.

Thus, applying nitrogen levels not only result to effect on yield of vegetables but also improve the fertility of the soil.

The correlation between nitrogen types and nitrate accumulation in the soil after harvest: There is a strong correlation between the nitrogen content and nitrate accumulation in the soil after harvest and before planting. Results indicated that in the experimental conditions, when applied nitrogen types will increase the amount of nitrate accumulation in the soil after harvest and will lead to increased risk of water pollution from cropland.

PART V. DISCUSSION AND CONCLUSION

This chapter summarizes the findings draws conclusions and gives discussion about the findings as gathered from the study.

5.1. Discussion

1. The farmers use the right dose chemical fertilizer, increase the use of compost, organic fertilizer, limit of use nitrogen fertilizer to minimize the amount of NO_{3-} in vegetables.

2. Soil and water for agricultural production to residues nitrate should be studied and treated by appropriate measures.

3. Need to conduct training courses for safe vegetable production techniques in the communes to the households in the region for other place to learn, and follow. Education for farmers to safe vegetables production process, bring high-yield and reduce risk of soil pollution.

4. Need to attention to time of the harvest as far as final top-dressing ensure low levels of NO3- in vegetables does not affect the health of users and high yield.

5.2. Conclusion

Based on the results of this study the following conclusions were drawn:

1. Different types of nitrogen various influences to the accumulation of nitrate in plants. Urea to do accumulation of nitrate higher $(NH_4)SO_4$ and (NH_4Cl). The content of NO_{3-} in mustard in 4 treatments are lower than standard of Vietnam April,2007 /QĐ-BNN.

2. Nitrate accumulation in plant, soil and total nitrogen have large fluctuations over the growth period of the plant. However, this variation tends to decrease at

harvest. According to the experimental results showed that 7 days after second top-dressing can be harvested

3. Content of NO_{3-} in soil isn't high but if using nitrogen fertilizer with bulk will lead to in soil pollution risk. because people are indirect contact so less affected.

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APPENDICES

* *Experiment: Content of NO_3- in mustard*

The GLM Procedure

Class Level Information

Class	Levels	Values
a	4	T1 T2 T3 T4
b	3	1 2 3

Number of Observations Read 12
Number of Observations Used 12

The SAS System 21:28 Thursday, January 15, 2015 2

The GLM Procedure

Dependent Variable: c

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	1542.037417	308.407483	91833.5	<.0001
Error	6	0.020150	0.003358		
Corrected Total	11	1542.057567			

R-Square	Coeff Var	Root MSE	c Mean
0.999987	0.097827	0.057951	59.23833

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	1542.030700	514.010233	153055	<.0001
b	2	0.006717	0.003358	1.00	0.4219

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	1542.030700	514.010233	153055	<.0001
b	2	0.006717	0.003358	1.00	0.4219

The GLM Procedure

Dependent Variable: d

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	185189.1313	37037.8263	4.63E7	<.0001
Error	6	0.0048	0.0008		
Corrected Total	11	185189.1361			

R-Square	Coeff Var	Root MSE	d Mean
1.000000	0.010027	0.028284	282.0908

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	185189.1292	61729.7097	7.716E7	<.0001
b	2	0.0021	0.0010	1.29	0.3416

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	185189.1292	61729.7097	7.716E7	<.0001
b	2	0.0021	0.0010	1.29	0.3416

The GLM Procedure

Dependent Variable: e

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	156009.3543	31201.8709	Infty	<.0001
Error	6	0.0000	0.0000		
Corrected Total	11	156009.3543			

R-Square	Coeff Var	Root MSE	e Mean
1.000000	0	0	255.1750

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	156009.3540	52003.1180	Infty	<.0001
b	2	0.0000	0.0000	Infty	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	156009.3540	52003.1180	Infty	<.0001
b	2	0.0000	0.0000	Infty	<.0001

The GLM Procedure

Dependent Variable: f

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	116207.9569	23241.5914	2.905E7	<.0001
Error	6	0.0048	0.0008		
Corrected Total	11	116207.9617			

R-Square	Coeff Var	Root MSE	f Mean
1.000000	0.012814	0.028284	220.7308

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	116207.9548	38735.9849	4.842E7	<.0001
b	2	0.0021	0.0010	1.29	0.3416

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	116207.9548	38735.9849	4.842E7	<.0001
b	2	0.0021	0.0010	1.29	0.3416

The GLM Procedure

t Tests (LSD) for c

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0.003358
Critical Value of t	2.44691
Least Significant Difference	0.1158

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	76.71667	3	T2
B	59.95667	3	T3
C	54.74667	3	T4
D	45.53333	3	T1

The GLM Procedure

t Tests (LSD) for d

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0.0008
Critical Value of t	2.44691
Least Significant Difference	0.0565

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	402.27667	3	T2
B	327.14333	3	T3
C	325.17667	3	T4
D	73.76667	3	T1

The GLM Procedure

t Tests (LSD) for e

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0
Critical Value of t	2.44691
Least Significant Difference	0

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	371.0	3	T2
B	295.4	3	T3
C	288.5	3	T4
D	65.8	3	T1

The GLM Procedure

t Tests (LSD) for f

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0.0008
Critical Value of t	2.44691
Least Significant Difference	0.0565

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	301.27667	3	T2
B	272.62333	3	T3
C	256.45667	3	T4
D	52.56667	3	T1

**** Experiment: Content of NO_3- in soil***

The GLM Procedure

Class Level Information

Class	Levels	Values
a	4	T1 T2 T3 T4
b	3	1 2 3

Number of Observations Read	12
Number of Observations Used	12

The GLM Procedure

Dependent Variable: c

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	0.46385000	0.09277000	2569.02	<.0001
Error	6	0.00021667	0.00003611		
Corrected Total	11	0.46406667			

R-Square	Coeff Var	Root MSE	c Mean
0.999533	0.901388	0.006009	0.666667

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	0.46333333	0.15444444	4276.92	<.0001
b	2	0.00051667	0.00025833	7.15	0.0258

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	0.46333333	0.15444444	4276.92	<.0001
b	2	0.00051667	0.00025833	7.15	0.0258

The GLM Procedure

Dependent Variable: d

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	2.01200833	0.40240167	8521.45	<.0001
Error	6	0.00028333	0.00004722		
Corrected Total	11	2.01229167			

R-Square	Coeff Var	Root MSE	d Mean
0.999859	0.545745	0.006872	1.259167

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	2.01189167	0.67063056	14201.6	<.0001
b	2	0.00011667	0.00005833	1.24	0.3554

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	2.01189167	0.67063056	14201.6	<.0001
b	2	0.00011667	0.00005833	1.24	0.3554

The GLM Procedure

Dependent Variable: e

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	0.05902500	0.01180500	265.61	<.0001
Error	6	0.00026667	0.00004444		
Corrected Total	11	0.05929167			

R-Square	Coeff Var	Root MSE	e Mean
0.995502	1.034929	0.006667	0.644167

Source	DF	Type I SS	Mean Square	F Value	Pr > F
a	3	0.05895833	0.01965278	442.19	<.0001
b	2	0.00006667	0.00003333	0.75	0.5120

Source	DF	Type III SS	Mean Square	F Value	Pr > F
a	3	0.05895833	0.01965278	442.19	<.0001
b	2	0.00006667	0.00003333	0.75	0.5120

The GLM Procedure

t Tests (LSD) for c

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0.000036
Critical Value of t	2.44691
Least Significant Difference	0.012

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	0.910000	3	T2
B	0.723333	3	T3
C	0.670000	3	T4
D	0.363333	3	T1

The GLM Procedure

t Tests (LSD) for d

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0.000047
Critical Value of t	2.44691
Least Significant Difference	0.0137

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	1.766667	3	T3
B	1.423333	3	T2

C	1.206667	3	T4
D	0.640000	3	T1

The GLM Procedure

t Tests (LSD) for e

NOTE: This test controls the Type I comparisonwise error rate, not the experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	6
Error Mean Square	0.000044
Critical Value of t	2.44691
Least Significant Difference	0.0133

Means with the same letter are not significantly different.

t Grouping	Mean	N	a
A	0.713333	3	T3
A			
A	0.710000	3	T2
B	0.603333	3	T4
C	0.550000	3	T1

SOME PICTURES IN THE STUDY

Map of Thai Nguyen City

Seeding

Fertilisation percentage:

First top-dressing

Second top-dressing

Experiments