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礦物質元素對馬鈴薯種植成效影響研究

The Impact of Mineral Elements on the Growth of Potato Cultivation

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C.M, Lasquite

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摘要

土壤管理不善導致富含礦物質的表層土壤劣化，而表層土壤存在於礦物質含量低的食物中。海能離子礦元素，使命是在高產需求下，為地球提供更多天然多樣的生長元素，培育更健康的農作物，為人類帶來健康。本研究旨在了解海能離子礦物元素對馬鈴薯發芽率和發芽速度的影響，對土壤淨化和生長的影響，抑制馬鈴薯栽培病蟲害。結果表明，GC+GA 等海能離子礦物質有助於提高馬鈴薯的發芽率和速度，同時施用 GC 還能降低開花率和蟲害。

關鍵詞：海能離子礦物質元素、馬鈴薯栽培、土壤淨化

ABSTRACT

Poor soil management worldwide is causing decline in mineral-rich topsoil levels, which present in foods with low-minerals content. Sea energy ionic minerals elements which mission is to provide the earth with more natural and diverse growth elements under the demand of high production, cultivate healthier crops and bring health to people. The purpose of this study is to see the influence of Sea energy ionic minerals elements on the germination rate and speed of potato, it’s influence to soil purification and growth and inhibiting pest and diseases on potato cultivation. The results show that Sea energy ionic minerals such as GC+GA could help increase the germination rate and speed of potato, while the application GC could lower the flowering rate and insect infestation as well.

Keywords: Sea energy ionic minerals elements, Potato cultivation, Soil purification

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CHAPTER ONE
INTRODUCTION

1.1 Background and Motivation

The world is facing an unprecedented global hunger crisis. In just two years, the number of people experiencing or at risk of acute food insecurity grew from 135 million in 53 countries prior to the pandemic to 345 million in 82 countries today. High food prices have triggered a global crisis, pushing millions further into extreme poverty and exacerbating hunger and malnutrition (World Bank, 2022). For two decades leading up to the millennium, global food demand had steadily increased in tandem with population growth, record harvests, new technologies, financial gains, and diet augmentation (UN, 2020) and as a result, small-scale farming systems must adapt more quickly as a result of the rapid changes in the economy, technology, and population. Farmers may be influenced or forced to pursue short-term profits while paying less attention to maintaining their agricultural in harmony with ecological conditions by new market opportunities, chemical input promotion, and financial limitations. In the tropics, Agrochemicals, hybrid seeds, and fuel-based machinery are only a few examples of the high levels of external inputs employed in "modern" agriculture that have been the focus of traditional science-based research and extension initiatives (Reijntjes et al, 1992). Though the use of agro-chemicals increase yields and production, it also contaminates the environment that can harm animals and human being. And as for the United Nation Sustainable Development, a new global food system must ensure universal access to sufficient food and significantly reduce poverty without harming the natural environment.

The potato is a root vegetable that is indigenous to the Americas and is a starchy tuber of the plant Solanum tuberosum. The plant belongs to the nightshade family Solanaceae and is a perennial. From the southern United States to southern Chile, various wild potato species can be found. Potato (Solanum tuberosum L.) is a versatile crop that can grow in a variety of agro-ecologies, and there are signs that it may be able to grow even more in other ecosystems (CIP 2017). according to the U.S. Department of Agriculture (USDA) In the United States, potatoes are the most popular vegetable crop, and they are the fourth most consumed crop globally, after rice, wheat, and corn. Potatoes have been a mainstay of human meals for thousands of years, first in the Andes of South America and subsequently everywhere else in the world.. Cooking, the amount of potatoes consumed, and the nutrients in potatoes' bioavailability all have an impact on its contribution to the human diet. In general, heating potatoes effectively preserves the essential components found in them, such as minerals, proteins, and dietary fiber. According to Gabriela Burgos, Thomas Zum Felde, Christelle Andre, and Stan Kubow "The Potato and Its Contribution to the Human Diet and Health," vitamins C and B6 are significantly reduced after cooking, whereas carotenoids and anthocyanins show high recoveries due to an improved release of these antioxidants (Springer, Cham 2020, livescience, 2022).

According to Taiwan Agricultural Research in Taiwan, a cultivar of potato that is resistant to pest and diseases and flooding could help to solve the problem in global shortage of crop and climate as well. The institution noted that the impact of climate change on potato production has resulted in large economic losses due to floods and diseases, and that environmentally tolerant varieties are in great demand (Taiwan news, 2022). Since the potato (*Solanum tuberosum L.*) is a highly nutritious, mildly flavored, easily blended food with numerous options for "building in" desired nutrients. The shape, size, and nutritional content of potatoes are known to vary due to genetic and environmental factors (Arvanitoyannis et al., 2008). Hence, Varietal and environmental versions in addition to their interplay had great effect on tuber yield and the potato's attributes (Tessema et al., 2020). To ensure the quality of the potato and its nutrients a proper treatment, cultivation and type of farming needs to look out for. Since the 1950s, crop advancements have allowed agricultural production to keep up with population expansion. These advancements have been combined with inexpensive agricultural inputs like water, herbicides, and fertilizers (Brummer et al., 2011) and Sustainable and productive agroecosystems that meet today's food and other product needs while preserving the vital natural resource base that will allow future generations to meet their needs must be developed. A solid grasp of agricultural system ecology is necessary to enhance farming tactics based on local resources and create systems that are adaptable in the face of changing climatic conditions.

The way of planting, from the human and animal power a hundred years ago, to the mechanized planting of today, has not only improved significantly in efficiency, but also greatly improved the output. Especially after the Green Revolution, the extensive use of chemical pesticides, chemical fertilizers, and herbicides, as well as the recent genetically modified crops, have increased and exploded agricultural production, reaching a peak. However, this way of planting has cast a shock bomb on the future, leading mankind to the three paths of poisoning, starvation, and fighting. “Death by poisoning”, a large number of pesticides are used, and even black medicine and a variety of pesticides are mixed, causing high toxicity. System-type, contact type, etc. various chemical pesticides, in addition to killing insects, sterilizing and eliminating diseases, also make farming and soil drug testing exceed the standard, and finally return to the dining table and people’s bodies harming their own health.

Another hidden concern is that in addition to eliminating insects in the field, chemical pesticides also completely eliminate microorganisms that are invisible to the eyes, and eventually cause the soil to lose its vitality, which is equivalent to declaring the soil dead. Farmers use chemical fertilizers excessively and singularly to increase production, causing soil antagonism, eventually hardening, stagnation, and even salinization. In the end, the land will eventually decline, or even produce no crops, leaving people facing the dilemma of starvation. “Death in battle”, almost all countries’ agriculture relies on chemical pesticides, chemical fertilizers, herbicides because of the problems caused by the inertial agricultural methods, the food crisis will eventually evolve into a war for food. The current war is no longer guns and explosives. It is a war of various means, such as the Russian-Ukrainian war.

Today, the conventional farming methods of chemical pesticides, chemical fertilizers and herbicides are gradually being replaced. The act of farming begins to revert to the traditional mode of thinking. Thus, the term “organic”; was born accordingly. “Organic”; refers to agricultural products, production and processing processes that do not use chemical synthetic pesticides, chemical synthetic fertilizers, genetically modified organisms, animal and plant growth regulators and other non-natural substances in farming. However, such a production method cannot be said to each other, and they have the final say, so the governments of various countries have formulated a set of regulations to strictly regulate and according to (Francis & Porter, 2011) Organic farming must expand and develop in response to rising organic food demand and growing environmental concerns. This necessitates a greater focus on the goals, values, and principles that underpin organic practices, as well as more research into the impact of organic farming on various aspects of the environment.

But because organic regulations are too cumbersome, enforcement is difficult. As a result, organic has advanced from the 2.0 regulations to the ecological conservation level of organic version 3.0. Because the act of planting is not only from the human level, there are many living organisms living on this land. Therefore, how agricultural operations can take into account more levels, this is the connotation of the organic 3.0 interpretation.

For example, if the red beans are grown in conventional farming methods, herbicides will be sprayed before harvesting, so that the red bean plants will wither at the same time to facilitate machine harvesting. During the withering period, the voles ate red beans and died of poisoning, and then the eagles in the sky ate the voles that died of poisoning, so the eagles also died of poisoning indirectly. Although the field operation behavior has transitioned from conventional to organic, and even considered ecology, there is still a kind of thinking in thinking: as long as the production declines, it will "heavier fertilizer" without thinking. Such thinking and operation, Excessive amounts of single elements (nitrogen, phosphorus, potassium) have been accumulated in the field, and these super-target nitrogen, phosphorus, and potassium have evolved into antagonistic effects in the soil. To put it simply, it is to cause the absorption of other elements to be inhibited, resulting in plant nutrient imbalance and disease.

In addition, for the soil (planting land), only the supplement of a single element has been emphasized for a long time, and the land adopts a continuous and single planting mode to extract all the diverse minerals that originally existed in the soil, creating a soil that is more seriously out of balance. And crops grown in such soils are prone to unmanageable diseases and insect pests in terms of management. In addition to their huge appearance, the fruits have lost their original flavor and quality, and are even more difficult to preserve.

Although organic farming has abandoned the hazards of chemical fertilizers, pesticides, herbicides, etc., for the land, crops, and human body, it can only be called "safe" at best. What needs to be done now is to reposition agricultural operations on "health"

Traditionally, people take food as the sky, medicine and food are of the same origin and other concepts related to “eating”. Today, we can hardly expect to be able to provide our body with balanced nutrition and achieve the goal of health through diet.

It is unrealistic to advocate that farmers return to the way they planted a hundred years ago. Therefore, what we want to restore is not to go back to the past, but the reverence of our ancestors for farming. It is impossible for us to conform to the natural cycle by reducing production, but we can provide the earth with more natural and diverse growth elements under the demand of high production, cultivate healthier crops, and bring health to people. This awe-inspiring spirit can also provide the most practical support under the needs of high production, and continue to maintain a good loop chain. This is the mission of Sea Energy’s natural ionized mineral elements.

Therefore, the healthy farming method of sea energy is based on this concept.

1.2 Purpose of the study

1. Through the application of sea energy purification elements (GC), understand the changes in germination rate and speed

2. Through the application of sea energy purification elements (GA), to understand the influence of soil purification on crop growth and inhibition of pests and diseases

3. Through the application of sea energy purification elements (GB), understand the influence of foliar spraying on crop growth and inhibiting pests and diseases.

The result of the study would help and serve the farmers who have an interest in raising potato and to know the performance of the crops when applied of the Sea Energy ionized minerals, students and fellow researchers who would like to undergo the same research study. This study gives them an essential information on how the sea energy effect on the growth and pest and diseases of the potato since there’s still no much background study about this product.

In connection, this study supports the United Nation: The Development of the Sustainable and food. The Sustainable Development Goals (SDGs), the UN's development plan for the twenty-first century, are centered on food. "End hunger, achieve food security and enhanced nutrition, and promote sustainable agriculture" is the second of the UN's 17 SDGs. A significant transformation of the world's food and agricultural systems is necessary to achieve this aim by the target year of 2030 this according to the state of food security and nutrition in the world (2021). The study aims to cultivate a healthier crop, high production and bring health to people with the help of sea energy ionized minerals.

1.3 Scope and delimitation of the research study

This study was conducted to test the efficacy of Sea energy’s natural ionized mineral elements such as GC, GA and GB to the growth of Potato.

The research was conducted under Nanhua University condition from the month of July to November, 2022. The experiment was laid out with 9 plots which 3 plots were controlled plot and 2 plot for each treatment. The treatments used in the study were as follows: T1: GC, T2: GC+GA, T3: GC+GA+GB.

Data gathered in this study were germination status, growth status such as number of plants, size, color, number of leaves and visual observation by photographing records, disease and pest status by photographing records and soil chemical and physical properties has been undergone soil analysis.

1.4 Objective of the study

1. Through the application of sea energy purification elements (GC), understand the changes in germination rate and speed

2. Through the application of sea energy purification elements (GA), to understand the influence of soil purification on crop growth and inhibition of pests and diseases

3. Through the application of sea energy purification elements (GB), understand the influence of foliar spraying on crop growth and inhibiting pests and diseases.

1.5 Observation focus

1. Germination status (it is counted when the buds are seen visually, and the number and speed of germination is observed)

2. Growth status (number, size, color of leaves, visual observation and photographing records)

3. Result status (tidbit status, number of seeds)

4. Disease status (type of disease, number of diseases, visual observation and photographing records)

5. Pest status (types of pests, number of pests, visual observation and photographic records)

6. Soil pH value and EC value

CHAPTER TWO
LITERATURE REVIEW

2.1 Sea Energy

2.1.1 Definition

Sea energy is company which mission is to provide the earth with more natural and diverse growth elements under the demand of high production, cultivate healthier crops, and bring health to people. This awe-inspiring spirit can also provide the most practical support under the needs of high production, and continue to maintain a good loop chain. Sea energy has been continuously accepting strict inspections and applications for environmental protection labels from various countries, including: non-toxic safety and skin irritation safety test experiments, and bacteriostatic effect experiments; it also continuously conducts various clinical experiments on products, including energy saving carbon reduction, washing cleanliness, ecological purification, bacteriostatic, deodorization, hygienic, effects, expansion of use fields, consumer affirmation, functions of various industries, enhancement of various benefits to various industries and more continuous implementation of health and environmental protection which the work of education for new era in which the concept of the use of cleaners, insecticides, disinfectants must be reinvented (Sea Energy Technology, 2021)

2.1.2 Ionic Minerals

Our primary source of ionic minerals is food, but tragically, poor soil management worldwide is causing a decline in mineral-rich topsoil levels, which results in foods with low mineral content. An ionic mineral is one that can easily bond with water and has a positive or negative charge, making it easier for the body to distribute. Electrical gradients across cell membranes are also maintained by charged minerals, particularly electrolytes (High tech health international, 2020)

2.1.3 Healthy Environment

In order to meet development needs and protect the environment for both current and future generations, the idea of sustainable development is put forth. Human rights instruments may be used to implement the right to a healthy environment and to include it in existing international law. The procedural side of the right to a healthy environment includes the rights to information, to participation, and to efficient redress (Giorgetta, S., 2002).

2.2 Potato (Solanum tuberosum L.)

A root vegetable that is indigenous to the Americas, the potato is a starchy tuber of the plant Solanum tuberosum. It belongs to the Solanaceae family of perennial nightshades. Potato, a food low in fat and high in nutrients, plays a critical role in reducing malnutrition in underdeveloped areas. Key nutrients including vitamin C, potassium, and resistant starch are provided by potatoes to the diets of people all over the world. In addition to vitamins and minerals, colorful potatoes contribute a variety of phytonutrients to the diet that are good for health, like polyphenols (Padmanabhan et al., 2016). While plants grown from seeds exhibit significant variation, those grown from tubers are clones of the parent plant.

2.2.1 Taxanomy and Genetics

Solanum tuberosum belongs to the Solanaceae family. Among the 2000 species that make up this family are the tomato (S. lycopersicum L.), sweet pepper (Capsicum annuum L.), eggplant (S. melongena L. var. esculentum), tobacco (Nicotiana tabacum L.), and petunia (Petunia hybrid L.). The polymorphous, mostly tropical and subtropical genus Solanum contains more than 1000 species (Fernald 1970; Spooner and Knapp 2013). In particular, the Russian names for the S. tuberosum Andigenum group were based on plants developed from germplasm accessions planted in northern Russia, where the long days were uncharacteristic of the landraces' original habitat (Ovchinniko, 2011). All of the tuber-bearing wild and domesticated potatoes, including S. tuberosum, are included in the section Petota. Additionally, it is formally categorized as being a member of the Potato clade, which also includes the tomato and its wild relatives in the section Lycopersicon as well as the closely related section Etuberosum (Bohs 2005; Weese and Bohs, 2007).

2.2.2 Potato Nutrition Facts

It has a moderate amount of iron and is high in vitamin C, which helps the body absorb iron. Vitamins B1, B3, and B6 as well as minerals like potassium, are all found in abundance in potatoes. magnesium and phosphorus. Additionally, potatoes have dietary fiber, which is good for your health, and antioxidants that may help prevent diseases linked to aging. Variety, the growing environment, and the processing techniques have the biggest impacts on it's nutrient content (Tolessa, 2018).

Potato nutrition facts

Total Fat 0g	0%	Total Carbohydrate 26g
Cholesterol 0mg	0%	Dietary Fiber 2g
Sodium 8mg	0%	Sugars 1.7g
Protein 4.3g		
Vitamin A	0%	Calcium

Source: Health benefits of potato, 2022 (https://www.webmd.com/diet/health-benefits-potatoes)

Leszczyski (2000) states that the starch content of fresh potatoes should be around 15% and that the amount of reducing sugars should not be more than 0.5%. It's crucial to keep in mind that chemical composition is influenced by potato cultivar, soil, weather, and agrotechnical elements (Leszczyński 1994, Zimnoch-Guzowska and Flis, 2006). The potato is a common food. It has a modest calorie count and a medium glycemic index. Potatoes are an excellent source of protein, as well as other important vitamins, minerals, and dietary fiber. Very little antinutritive material is present in potatoes, and it is largely found on or just under the skin.

Energy: The amount of energy provided by 100 g of boiled potato tubers ranges from 96.33 to 123.17 kcal (De haan et al, 2019). Potato has a low energy density, with 100 g of boiled potatoes contributing between 4 and 6% of an adult's energy requirement of 50 to 90 kg of weight (using 1.90 as the basal metabolic rate factor), FAO/OMS/UNU, 2004). However, preparing and serving potatoes with high-fat ingredients significantly increases the caloric value of the dish. 100 grams of potato chips and French fries contain 529 and 564 kcal, respectively.

Carbohydrates: Starch is the most abundant carbohydrate in potatoes, accounting for 16.5 to 20.0 g/100 g FW (Liu et al, 2007). Potato starch is biochemically composed of amylose and amylopectin, with the latter molecule typically accounting for 70% of the available starch in the tuber and the remaining portion consisting of amylose (Zeeman et al, 2010).

Sugar: Potato tubers also contain significant amounts of free sugars, with glucose and fructose serving as the primary monosaccharides and sucrose serving as the primary disaccharide.The concentrations of glucose, fructose, and sucrose in raw tetraploid potato tubers range from 3.25 to 255 mg/100 g FW, 2.5 to 153.7 mg/100 g FW, and 43 to 159.7 mg/100 g FW, respectively (Amrein et al, 2003; Rodriguez et al, 2010). Acrylamide precursors include the reducing sugars glucose and fructose, as well as free asparagine. Acrylamide is formed during high-temperature cooking such as frying, roasting, or baking due to the Maillard reaction (Muttucumaru et al. 2008). Acrylamide has been designated as "probably carcinogenic to humans" by the World Health Organization and the International Agency for Research on Cancer. As a result, the reducing sugar content of potatoes should not exceed 100 mg/100 g FW in order to keep acrylamide formation to a minimum (Kumar et al. 2004).

Protein: Depending on the cultivar, the protein content of potatoes ranges from 1 to 1.5 g/100 g FW, according to (Camire et al., 2009). Potato protein content is generally low when compared to other major staples such as maize and beans, despite the fact that potatoes yield more protein per unit growing area than cereals (Bamberg and Del Rio 2005). Furthermore, the quality of potato protein is excellent, reflecting its digestibility and essential amino acid content.

Fiber: Potato cell walls contain dietary fiber, particularly the thickened cell walls of the peel (Camire et al. 2009). Cooked potatoes without skin contain 1.8 g fiber/100 g FW, whereas cooked potatoes with skin contain 2.1 g fiber/100 g FW. Potatoes have less fiber (7.3 g/100 g) than whole-grain cornmeal, but more fiber than white rice (0.3 g/100 g) or whole-wheat cereal (1.6 g/100 g).

Minerals: Potassium is the most abundant mineral in potatoes, ranging from 150 to 1386 mg/100 g FW (Nassar et al. 2012). Potato contains moderate amounts of phosphorus and magnesium, ranging from 42 to 120 mg/100 g FW and 16 to 40 mg/100 g FW, respectively (Bonierbale et al. 2010). Raw potato iron and zinc concentrations range from 0.25 to 0.83 mg/100 g FW and from 0.23 to 0.39 mg/100 g FW, respectively (Burgos et al. 2007). The growing environment has a significant impact on iron and zinc concentrations.

Interestingly, Lombardo et al. (2013) reported that soil composition influences crop mineral concentration, with sandy soil texture favoring iron oxidation processes to insoluble polymers and, as a result, reducing iron availability to the plant.

Burgos et al. (2007) discovered iron and zinc levels in cooked potatoes. Varying between 0.29 and 0.69 mg/100 g FW and 0.29 to 0.48 mg/100 g FW, respectively.

2.2.4 Potato pest and diseases

Numerous diseases can infect the potato (*Solanum tuberosum*). Infestation and the transmission of pathogens through the soil or tubers left in the bed are frequently caused by replanting the nutrient-rich tubers in the same location (Plantura, 2017). Many things affect crop output, but diseases like late blight (*Phytophthora infestans*) and bacterial wilt (Ralstonia) are among them. These organisms, (Pseudomonas) solanacearum, are crucial. Severe bacterial diseases including soft rot, common scab, bacterial wilt, and brown rot as well as major fungal diseases like late blight, early blight, black scurf, fusarial wilt/dry rot, wart, powdery scab, and charcoal rot significantly reduce potato yield in fields (Demissie, 2019).

Bacterial Potato Diseases

Potatoes with soft, rotting areas are typically entirely inedible due to bacteria. The best method of prevention is to purchase certified, healthy seed potatoes because diseased tubers are the main source of bacterial infections (Plantura, 2019). Bacterial diseases of potato (*Solanum tuberosum*) considered as the most important diseases to look out for. Back leg and bacterial wilt are regarded as the two most serious illnesses, whilst potato ring rot, pink eye, and common scab are the three lesser ones (Charkowski et al., 2020). Lacking any curative chemical control techniques, the availability of pathogen-free planting material and good surveillance and monitoring to safeguard areas free of the bacteria are the mainstays of bacterial wilt prevention. In official seed certification procedures, the use of restricted generation seed multiplication from pathogen-free nuclear stocks with zero tolerances for the disease has mostly led to effective disease management for potatoes. To prevent the spread of latent diseases, seed potato tubers must often undergo routine post-harvest testing.

A member of the ß-Proteobacteria in the family Pectobacteriaceae of the order Enterobacterales is the genus Pectobacterium. The *genera Brenneria, Dickeya, Lonsdalea, and Sodalis* are also members of the Pectobacteriaceae family (Adeolu et al., 2106). Infected plants' xylem vessels allow bacteria to enter, which then spread throughout the plant to colonize it completely. *Clavibacter* is a phytopathogen that attracts resources from the xylem, including sugars and carboxylic acids (Eichenlaub and Gartemann, 2011). As describe by (Buchman et al., 2012) The effects of zebra chips are very noticeable on both the leaves and the tubers. The upper portions of infected plants exhibit early necrosis and death, leaf curling, chlorosis, shorter internodes, aerial tubers, and chlorosis.

Fungal diseases of potato

Several different potato diseases are brought on by fungi. Here, prevention is by far the most effective form of defense. However, once the symptoms of some diseases develop, the plants cannot be saved.

- ***Black dot (Colletotrichum coccodes*)**: During very hot and dry years, this soil-borne fungus kills entire shoots. On the stem, which frequently remains green, the leaves dry up, wither, and quickly turn brown. The roots are fragile and rotting, and there are small black spots near the base of the stem. The tubers could be impacted as well (Plantura, 2017). The fungus *Colletotrichum coccodes* is the source of the foliar disease and tuber blemish known as "black dot" on potatoes (synonyms C. atramentarium and C. phomoides). (Dickson1926) provides a thorough description of the disease's earliest reports in potato and tomato, which date back to the early 19th century. The heel end of the tuber is where symptoms are frequently seen, and the lesions may be brown in color with a sluggishly defined edge. In contrast, lesions from silver scurf are silver in color with a distinct border. Observing the distinctive black microsclerotia of black dot or *H. solani* conidiophores on tubers with a hand lens or microscope is required to positively identify these two diseases (Errampalli et al., 2001). As for chemical control, Studies on the possibility of seed treatments used for other seedborne infections, like *R. solani and H. solani*, have concentrated on the black dot in potatoes because no specialized fungicides have been produced to control it. The best way to define chemical control of black dot at this time is ineffectual.

- ***Common scab (***Streptomyces scabies***):*** It is a disease that spreads through soil, causes scab, and is challenging to control in the field. Common scab is caused by numerous species of Streptomyces, including *S. scabiei, S*. Potato scab solely affects appearance and has no impact on taste or yield. The simple solution to preventing potato scab is to plant resistant types. In addition, the pathogen is opposed by healthy soil life. Before planting the potatoes, avoid adding lime to the soil (Plantura, 2017). According to Plant disease Diagnistic Clinic of Cornell University, tubers begin to form when scab first appears. The spots might not be spotted at first since they are so little. These reddish-brown patches spread out more and more as the tuber grows. An older tuber's protective covering is too thick for invaders to easily penetrate.

Virus disease of Potato

Even though more than 50 distinct viruses and one viroid have been found to infect potatoes globally, only a small number of them are known to cause significant losses on a global scale. However, some are only globally of little relevance at the moment, while others are only regionally and/or momentarily relevant**.** Aphid-transmitted viruses are among the most significant ones. Long-standing knowledge that insecticides only work against persistently transmitted viruses accounts for the reduction in PLRV prevalence seen over the past 50 years in both affluent and developing nations. In warmer climates, viral outbreaks in potato continue to be brought on by thrips and whiteflies (Campos and Ortiz, 2020).

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Study Area

The experiment was carried out from the College of Science and Technology of Nanhua University's Sustainable Farm, located in Dalin Township, Chiayi District, Taiwan. The reason for choosing this area was because it is inside the school campus which make it easier and convenient for conducting research for the researchers of this study. The area has a suitable condition for growing crops such as temperature, humidity and has access to sunlight. Thus becoming a good area for research and analysis.

The experiment was laid with 9 plots for the research study which 3 plots for control and 2 plots for each treatment. The experimental plot size was 7.2 m^2 planted with 2 rows spaced 0.75m to each other and 0.25 m plant to plant spacing in a row. The space between blocks were .25 m respectively.

3.2 Cultural Management

3.2.1 Land preparation

An area of 16x5 meter square has been used in this study. The land was plough repeatedly to have enough aeration for the soil. After ploughing of the soil, a 15 sacks of goat manure were spread manually on the area where the experiment conducted. The area was plough again using the ploughing machine to ensure that the goat manure was mixed thoroughly with the soil.

Figure 1. The land preparation for this study.

Source: this study

3.2.2 Green Manuring before planting

After mixing the goat manure, a 1kg of *sesbania* seed was spread on the area to improve soil fertility, soil organic matter, water infiltration and because it was a leguminous plant it served as nitrogen fixing bacteria to make the nitrogen in the atmosphere available to plant. 2 weeks after and *sesbania* had been grown where there were enough nodules which can be seen in figure 2, the area was plough again repeatedly.

Figure 2. The growth of sesbania after 2 weeks of planting.

Source: this study

3.2.3 Bed preparation

The area was divided into 9 plots and each plot measured 4.8x1.5-meter square. 3 plots for control, 2 plots for each treatment. The treatments used were as follows: T1: GC, T2: GC+GA and T3: GC+GA+GB.

Figure 3. The preparation of the plot for potato.

Source: this study

3.2.4 Soil Testing

With the used of soil auger, the researcher collected soil sample in each plot. The soil sample was brought to soil sample research center for inspection to know its bulk density and chemical properties.

Figure 4. The soil sample collected in each plot

Source: thus study

3.2.5 Preparation of seedlings of potato

An American variety of potato was used in this study. The potato was cut into parts, each cut had at least 2 eyes to ensure that it would sprout. 300 seedlings had been prepared and the 200 seedlings were applied with the 1st treatment which was the GC of sea energy ionized minerals while the remaining 100 seedlings of potato were leave as it was for control.

3.2.6 Fertilizer application

1st treatment- GC (seed germination)

GC ingredients: Aqua, Mineraal salts, Sea water Extract, Cocos Nucifera (Coconut) oil, Citrus Medica Limonum (Lemon) and fruit extract.

Functions: No additional chemical ingredients. Soaking plants to make the seeds germinate and grow healthy. Redude seed contamination, enhance disease resistance and make seedlings develop rapidly, neatly and robustly.

A dilution of 1:500 of GC for about 60 seconds.

2nd treatment- GA (soil improvement)

GA ingredients: Pure water, sodium carbonate (In line with standards specifications of food additives in my country), mineral salts (magnesium, sodium, potassium), coconut oil.

Functions: Deepen selection to reduce or eliminate pollutants and toxins in the soil. Cleanse the pollutants and activates the soil to maintain ecological balance. It can be used to keep the soil warm, clean, healthy and fertile. Purify and cultivate healthy soil to maximize production function. Sinicized oil washes toxins in the soil, improves soil acidification, increases water permeability and air permeability. Adjust the acidity and sodium of the soil and improve health of soil microorganisms.

A dilution ratio of 1:100, 100kg/ each time

Process of spraying: GA sprayed before planting of potato and seedlings and sprayed again after planting.

3rd treatment- GB (promote plant and fruit growth)

GB ingredients: water, sodium acid, minerals salts (magnesium, sodium, potassium), coconut.

Functions: wash pollution, promotes the reproduction of microorganisms on the surface of plants and helps plants grow. Purify and clean chemical residues, increase the growth environment of beneficial microorganisms and helps plant grow healthily and promotes plants root growth.

A dilution 1:200 cc

Potato seedlings grow 4-6 leaves spray the first GB dilution.

Second spray: 2 weeks before the flowering period.

Spray the whole plant from bottom to the top.

3.2.7 Water management

Too much water prevents oxygen from getting to the potato plant's underground sections, which leads to poor root growth and rotting of the freshly created tubers. Tuber rot is particularly prone to affect seed tubers (Haverkort, 1982). To avoid rotting or wilting of newly planted potato seedlings, only a whisk of water has been applied after planting and allows the seedlings of the potato to settle for 3 days before watering again. Watering of the plants was depend on the climate condition and according to USAID, the potato plant required 400 to 800 mm of water.

The potato was watered manually by the use of sprinkler. An ample amount of water has been applied and made sure it was not over irrigated.

Figure 5. Watering of the plants

Source: this Study

3.2.8 Weed control

Potato plants may face competition from weeds for nutrients, water, and light. Weeds may serve as hosts for various pests, such illnesses, insects, or nematodes, and they may operate as a field's pest reservoir so it is important to control weed ahead of time. To support the goal of the United nation for Sustainable Development about zero carbon emission or zero foot prints we used the natural resources from the surroundings of the Science and technology sustainable farm in Nanhua University to control weeds. Therefore, the used of dried leaves and other soft residual of the branches has been used for mulching to prevent the growing of weeds on the plot of the potato as can be seen in figure 3.6 of this study.

According to Eberlein C., et al (1997), hilling combined with cultivation can be an effective method for weed control which was done in the study also. The soil has been cultivated and each plant has been hilled.

Figure 6. The mulching of dried leaves on the potato cultivation

Source: this Study

3.3 The collection of data and analysis

The collection of data had been recorded from the germination rate and time to germinate upon the sprouting of the potato seedlings, everything has been captured by photographing records, the growth of potato has been measured by length and by number of days, the pest and diseases that have been seen in the study was recorded and lastly the shape and fruits of potato seedling were counted for further analysis.

The equation used to get the germinaton rate:

Average of plants germinated per treatment / total number of plants planted per treatment x 100.

3.3.1 Physical Tuber Characteristics

The physical characteristics of the tubers including, shape, size and flesh colour were determined according to the methods described by Abong (2008). The shape of tubers was determined using the objective description of USDA (2012). The shape that has been stated were compressed, oval, round and oblong or long.

3.3.2 Stem Wings Identification

Stem wings can be identified as weak, medium and strong as determined according to the designed by plant variety of plant protection of USDA (2012).

CHAPTER FOUR
RESULTS AND DICUSSION

Table 1. Bulk Density of the soil used in the study

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9
Dry weight of soil sample (gram)	451	410	467	471	454	439	453	469	441
Bulk density (gram/cm3)	1.109	1.008	1.148	1.158	1.116	1.079	1.114	1.153	1.084

4.1 Critical values for compaction

According to Hunt and Gilkes (1992), the critical bulk density for limiting root growth varies depending on the kind of soil, but generally, bulk densities larger than 1.6 g/cm3 tend to do so (McKenzie et al., 2004). Due to their bigger yet fewer pore spaces, sandy soils often have greater bulk densities (1.3-1.7 g/cm3) than fine silts and clays (1.1-1.6 g/cm3). Because the particles are so small and fit between so many microscopic pore spaces in clay soils with good soil structure, there is more pore space. Peaty soils, for example, which are rich in organic matter, can have densities of less than 0.5 g/cm3.

The result of samples mainly shows that the bulk density of 9 different samples is in

the range of 1.1-1.6 g/cm^3 which clearly show the properties of soil as the fine and clays.

4.2 Soil Analysis and Chemical properties

Table 2. Soil analysis and chemical properties of 9 soil sample of the study

Soil Sample	**Soil pH**	**Soil pH temperature**	**Conductivity µS/cm**	**P (mg/kg)**	**Ca (mg/kg)**	**Mg (mg/kg)**	**Fe (mg/kg)**	**B (mg/kg)**	**Cu (mg/kg)**	**Zn (mg/kg)**
1	6.85	25.8	812	77.29	3945.08	990.86	220.40	1.39	2.06	5.59
2	7.09	25.7	698.69	94.97	2925.15	372.76	251.79	0.95	2.16	6.65
3	6.89	25.6	151.11	123.16	3359.17	390.09	249.28	0.93	2.79	10.83
4	6.78	25.7	309.74	81.52	1901.00	774.58	182.66	0.36	1.73	3.39
5	7.06	25.7	52.04	48.13	1907.01	292.97	311.65	0.53	1.48	2.98
6	6.93	25.6	56.65	53.17	2101.70	362.30	176.83	0.57	1.69	5.23
7	6.99	25.6	73.46	86.52	1647.65	788.55	177.00	0.24	1.38	2.38
8	7.11	25.9	146.79	63.10	2001.93	518.64	238.71	0.45	1.70	4.02
9	6.88	25.7	26.43	62.90	1750.21	415.02	256.43	0.47	1.72	3.54

Table 3. Organic and other chemical properties of the soil

CEC	Organic matter-TOC		ICPMS-Aqua As-Se				
CEC	Organic matter	TOC	arsenic	gallium	molybdenum	selenium	Indium
(cmol/kg)	(%)	(%)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
17.84			5.92	15.17	0.37	0.31	0.06
10.71			4.17	9.38	0.28	0.25	0.03
9.97			4.99	7.61	0.35	0.19	0.02
14.85			8.61	12.36	0.26	0.26	0.05
9.13			3.94	7.88	0.18	0.21	0.04
10.75			3.31	7.38	0.28	0.18	0.03
12.10			4.74	12.21	0.22	0.27	0.05
10.88			4.49	8.37	0.19	0.22	0.03
9.14			4.38	6.43	0.20	0.22	0.02

The pH level of the soil is the most important aspect because of how it affects all other soil parameters.

As a result, pH is taken into account while analyzing any type of soil. A soil is described as acidic if the pH is less than 6, normal if the pH is between 6 and 8, and alkaline if the pH is greater than 8.5 (Nisha et al, 2017). As per for the result of the soil analysis of this study, it showed all the sample soil taken from the area of Nanhua Sustainable Farm, the soil pH ranges to 6-7 soil pH which was a normal range of soil pH. Though the soil type of the soil is fine and clayey, after planting sesbania which serve as the NBF (Nitrogen Fixing Bactercia) considered to be effective in improving soil fertility (Mahamat et al, 2021) and soil pH and soil chemical properties (Loganathan, 2014). The above table showed the result of the basic soil chemical properties, the soil analysis was taken after planting of sesbania and before planting of the potato seedlings. The data could be used for further study to compare the soil properties before and after planting of potato cultivation with application of Sea Energe ionize minerals.

However, for sustainable management and enhancing the fertility condition of the soils, the application of additional labile organic inputs, liming materials, and adequate inorganic fertilizers (N-P-K) would be effective (Nisha et al, 2017).

4.3 Germination Rate and Speed

Table 4. Average germination rate and time to germinate of potato applied with SeaEnergy ionic minerals

TREATMENTS	**AVERAGE GERMINATION RATE**	**TIME TO GERMINATE**
CONTROL	39.16%	2 WEEKS
GC	39.062%	2 WEEKS
GC+GA	70.31%	2 WEEKS
GC+GA+GB	54.69%	2 WEEKS

Each plot was planted with 32 tubers of potato. Since the control had 3 sample plots, the control germinated had 23, 12, 4 tubers in each plot respectively which accumulated with 39.16% of germination rate. Whilst, for the Sea Energy treatments such as follows: GC, GC+GA and GC+GA+GB, each treatment had 2 plots for sample plants. The GC treatment of Sea Energy garnered a 39.06% of germination rate in which the first plot had 15 tubers germinated and the other plot had 10 tubers germinated which is not significantly different with the germination rate of the control. However, the GC+GA treatment of Sea Energy ionized minerals which was highly significantly different from the germination rate amongst treatment got 70.31% of germination after two weeks of planting. And the last treatment which is the GC+GA+GB placed second for the highest germinate rate which was 54.69% of germination, the first plot had 20 and 15 tubers germinated respectively. For the germination time, almost all of the seedlings germinated after two weeks of planting. Therefore, with the result of the germination rate performed by the potato cultivars it's really obvious that with the combination of GC+GA treatment had a significantly effect on the germination of the potato.

Figure 7. After two weeks of planting, the potato tubers have been sprouted

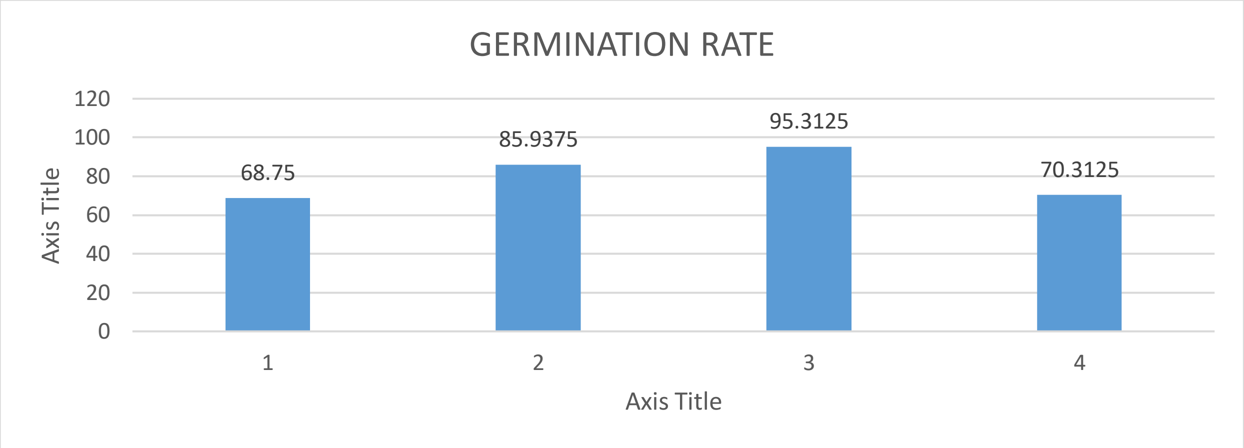

Figure 8. The germination rate after 3 weeks of planting (1: Control, 2: GC, 3: GC+GA, 4: GC+GA+GB)

After 3 weeks, the researchers gather the data again for the germination rate. The data above is the germination rate of potato seedlings after 3 weeks of transplanting and it showed that with the application of sea energy ionized minerals a 95% germination could be obtained especially with the application of GC+GA, while on the other hand, the plot without the application of SeaEnergy ionized minerals got 68.75% of germination rate which had only 66 of potato out of 96 seedlings survived throughout the experiment. Meanwhile, the treatment 2 and 4 which were T2: GC and T4: GC+GA+GB had 85.94% and 70.31% of germination rate respectively. In some studies, such as the used of activated charcoal to enhance germination rate of potato seeds (Bamberg et al, 1986) the optimum germination was approximately 77%, which is in contrast with the study conducted by (Kandil et al., 2012) that the use of GA_3 concentration could enhance the germination rate of potato and shorten the germination time to 17 days, which can compare to the performance of Sea energy Ionized Minerals on the germination rate and speed of Potato (*Solanum tuberosum.* As stated at (PotatoPro, 2021), the yield is determined by the germination percentage. If only half of the seeds germinate, the grower will not get a good return on investment, and hybrid potatoes will lose out to competition from other potato varieties. Therefore, the used of GC+GA of Sea Energy Ionized Elements could ensure farmers and other potato raisers the expected higher yield.

4.4 Flower Rate

Commercial potato cultivars are less likely to flower since they are primarily vegetative propagated, and breeders do not look for characteristics that make the flower appealing to bee's pollinators. But maintaining the variety of farmer-developed potato cultivars that are suited to regional environmental circumstances still depends on natural potato pollination. (Lutoladio and Cataldi, 2009). According to (Tekalign and Hammes, 2005), Fruit development increased crop growth rates and net assimilation rates while decreasing leaf area index, tuber growth rate, and partitioning coefficient. The researcher gathered the flower rate at the end of the study and it showed that with the application of GC of Sea Energy Ionized minerals lowered the flowering rate of a potato plant which has a highly significantly different from the rest of the treatments such as Control (without the application of Sea Energy), GC+GA and GC+GA+GB as shown in in Figure 9. According to research on other crops, producing flowers and fruit competes with them for nutrients, which inhibits the growth of subterranean storage organs like those in sugar beets (Wood and Scott, 1975) and onion (Khan and Asif, 1981) and artichoke (Rice et al., 1990). In this study, the potato without the application of Sea Energy Ionized Minerals had 50% of flowering rate. Therefore, with the application of GC could lower the flowering rate up to 88% approximately.

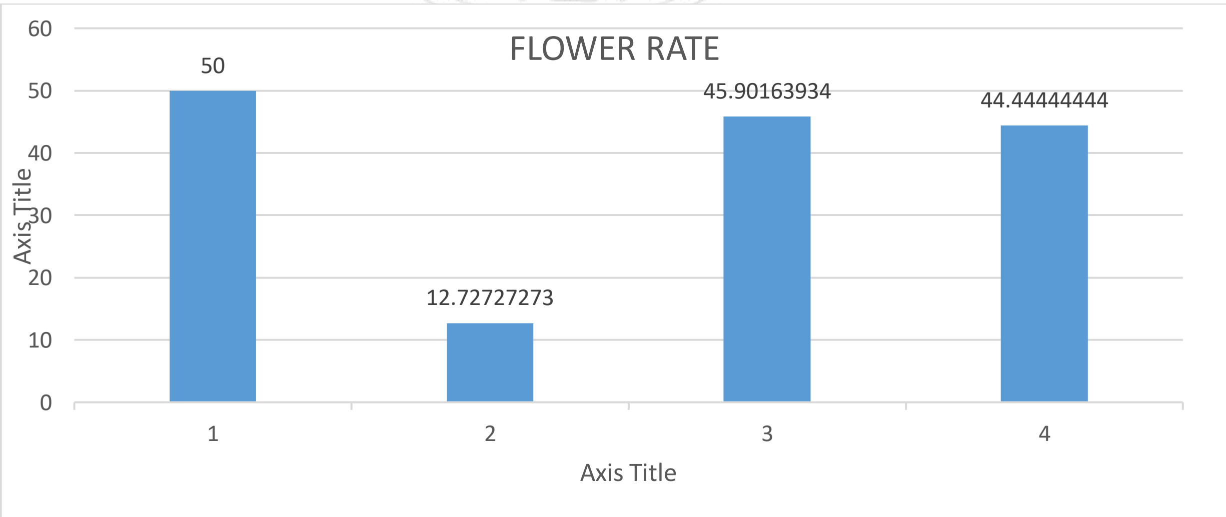

Figure 9. Flower rate of potato plant (1: Control, 2: GC, 3: GC+GA, 4: GC+GA+GB)

Figure 10. Flowering photo of potato during its growth development

4.5 Infestation Rate

One of the objectives of this study was to know the disease and pest status of potato plant with the application of Sea Energy Purifications Elements, the diseases and pest that inhibits the area or plant during the study has been recorded. In this regard, the infestation rate especially on the leaves of the plant has been shown in table 5 and figure 11.

Table 5. Infestation rate per treatments and as per plot.

Treatments	infestation rate/ plot 1	infestation rate/ plot 2	infestation rate/ plot 3
Control	23.08%	30%	10%
GC	7.69%	6.90%	x
GC+GA	33.33%	9.67%	x
GC+GA+GB	29.17%	42.86%	x

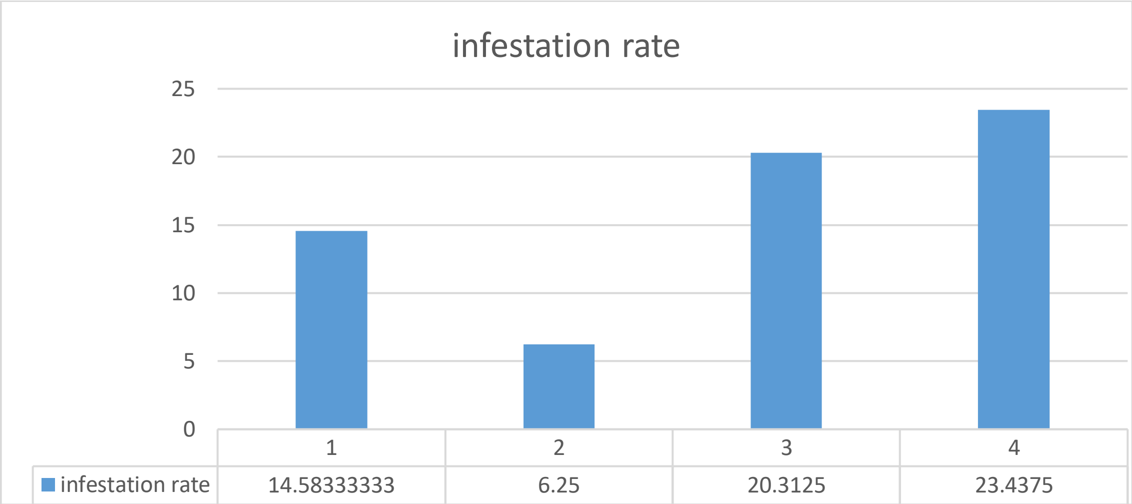

Figure 11. Infestation rate per treatments (1: Control, 2: GC, 3: GC+GA, 4: GC+GA+GB)

As shown in the table and figure above, the treatment of Sea Energy purification elements such as GC had a lower percentage of infestation. As far as the researchers observe throughout the study, the insects that can be seen most are grasshoppers. The present of this kind of pest could be environmentally which is depends on the place.

Stem wilt is the most evident indication of an infestation in potatoes. Because of the presence of the excrement that larvae emit while feeding inside the stem, the entrance hole is located in the stem and is simple to find. Being around larvae can be proven by chopping the stem (Campos and Ortiz, 2020). Wilting and yellowing of the foliage are caused by stem infection.

Figure 12. Discoloration and wilting of stem of *Solanum tuberosum*

As the researcher observed, the most plot without the application of Sea Energe ionize minerals mostly affected with stem wilt and suspected of having late blight diseases.

CHAPTER FIVE
CONCLUSIONS AND SUGGESTIONS

5.1 Research Conclusion

The objective of this study is to know the efficacy of Sea Energy Ionized minerals to the germination, growth and inhibition of pest and diseases to the potato. With the result of the data taken at the end of the study the researchers concluded that with application of Sea Energy purifications elements could improve the germination rate and speed of the potato such as with the treatment of Sea Energy GC+GA that resulted with the optimal of 95% germination rate while on the other hand, the application of Sea Energy Ionized minerals such as GC could lower the flower rate of the potato plant as well as the infestation rate. Since we are not the expert here, the researcher suspected the late blight diseases on the plot without the application of Sea Energe ionize minerals elements as it was observing during the study. The potato plant with application of Sea Energe Ionize minerals can be seen that it performed well when compare to its leaves color and plant vigors than without the application of the said mineral elements.

5.2 Researchers Recommendation

The researchers recommended the following:

1. In order to increase the germination rate of the plant, Sea Energy Purifications Elements such as GC+GA can be used.
2. To lower the flowering rate of the plant especially for the tuber kind of crops, since the flower compete with the nutrients in take with the tubers the application of Sea Energy Purifications Elements such as GC can be used.

3. There is no much study conducted about the efficacy of Sea Energy Ionized minerals, therefore, the researchers recommended to have a further study about its application and efficacy on different crops.

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