BIBLIOGRAPHY

PATERNO, ARLYN C. MAY 2011. Organic Carrot *(Daucus carota)* Production as Influenced by Rates of Formulated Organic Liquid Fertilizers. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted to determine the: 1) effects of formulated organic liquid fertilizers on the growth and yield of carrot, 2) the best rate of the formulated organic liquid fertilizers for the production of carrot, and 3) the effects of the formulated organic liquid fertilizers on some physical and chemical of the soil.

The effect of the different rates of formulated organic liquid fertilizers on carrot differed significantly in terms of the marketable and total yield of carrots. Application of formulated organic liquid fertilizers at the rate of 70:20:10, 20:70:10 and 10:20:70 during its seedling, vegetative and root bulking stage, respectively, produced the highest marketable and total yield. Furthermore, application of formulated organic liquid fertilizers significantly affected the organic matter and total nitrogen content of the soil wherein the rate 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) resulted to the highest organic matter content of the soil after harvest.

However, the application of formulated organic liquid fertilizers at different rates did not differ significantly in terms of plant height, insect pest infestation and powdery mildew infection, soil bulk density, soil pH, available phosphorus content and potassium content.

INTRODUCTION

The carrot (*Daucus carota*) belongs to the Umbelliferae family which also includes celery, parsnips and parsley (Ware, 1975). Furthermore, it has been reported that the carrot with purple roots was domesticated in Afghanistan and spread to the Mediterranean area under Arab influence in the tenth to twelfth centuries and to Western Europe in the fourteenth and fifteenth centuries. In the New World, carrot became popular among the Indians.

Carrot is the third most important crop in the Cordillera and some areas in the country (Bawang, 2006). It has the highest return on investment (R.O.I.) among the major vegetables in the industry. Moreover, it was reported that for every 100 grams of edible portion, carrot contains 18,520 (I.U,) vitamin A, 60 g calcium, 55 calories food energy, 32 mg sodium, 28.3 mg potassium, 28 mg phosphorus, 12.4 carbohydrates and 9 mg ascorbic acid. Meanwhile, Thompson and Kelly (1975) reported that carrot is rich not only in carotene, but also in thiamine and riboflavin and sugar.

Jones (1982) stated that the soil on which plants grow provides a storehouse of mineral, chemicals, water and air. According to Thompson and Kelly (1975), a yield of 9,072 kilograms of carrots will remove about 45.36 kilograms of potash, 14.52 kilograms of nitrogen and 8.16 kilograms of phosphorus from the soil used. Brady and Weil (2002) claimed that the removal of nutrients in crop or timber harvest reduces the soluble ion pool, and it may need to be replenished with manures or chemical fertilizers to avoid nutrient deficiencies.

However, chemical fertilizers are generally acidifying and aside from this, they are becoming expensive. It also contributes to the accumulation of toxic materials in the underground water reserves (Bawang, 2009). It makes crops attractive to pests since chemical fertilizers change the quality of plant sap. Moreover, continuous application of chemical fertilizers affects the conditions of soils.

In 2008, Brady and Weil reported that the worldwide use of fertilizers on farms increased dramatically since the middle of the twentieth century, accounting for a significant dramatic increase in crop yields during the same period. PCARRD (2006) reported that most of the chemical fertilizers used on agricultural crops in the Philippines are imported. Lately, the government has been encouraging the use of a combination of organic and inorganic fertilizers for rice, called the "balanced fertilization" wherein five bags of organic fertilizers are applied with chemical fertilizers. Furthermore, the application of organic materials is a common agricultural practice for maintaining nutrient levels and ameliorating soil physical properties to sustain crop production.

Organic agriculture features the diminishing use of chemical fertilizers and pesticides in the production schemes in favor of cheaper and locally abundant agricultural waste products, like organic fertilizers and materials such as compost to recondition, revitalize and maintain soils acidic balance, structure stability, desirable chemical properties and plant life sustaining capacity (Bawang, 2009). However, in using fertilizers, as Parnes (1986) stated, two major questions confront most people — what specific fertilizer to use and how much should be spread. According to Sahadevan (1987), more frequent and smaller doses should be applied generally on a sandy soil as compared to clayey one.

Fertilizers can be applied through the foliage instead of the soil (Poincelot, 1980). Foliar application is used to deal with special problems that cannot be solved readily through fertilization of the soil. If a quick response is needed, such as with a sudden deficiency of a nutrient or a very rapid use of nutrients during a period of intense growth, foliar feeding responses are more rapid than conventional soil fertilization. Furthermore, Donahue (1970) reported that most of the 16 elements essential for plant growth can be absorbed by the leaves and stems of plants when the elements are sprayed on them. Absorption takes place from both the upper and the lower surfaces of the leaves. The rate of movement of nitrogen, phosphorus and potassium inside the plant when applied as a spray on the leaves of plants, is approximately one foot an hour. The movement may be upward to the leaves or downward to the roots. Phosphorus, for instance, is capable of being utilized by the plant when it is sprayed on the leaves. One reason is that in most soils only a small percentage of phosphorus is recovered by the plant; whereas, when phosphorus is sprayed on the leaves, nearly all of it is absorbed.

This study was conducted to determine the:

1. Effects of formulated organic liquid fertilizers on the growth and yield of carrot;

2. Best rate of the formulated organic liquid fertilizers for the production of carrot; and,

3. Effects of the formulated organic liquid fertilizers on some physical and chemical properties of the soil.

The study was conducted at the Balili Experimental Area, Benguet State University, La Trinidad, Benguet from November 2010 to April 2011.

REVIEW OF LITERATURE

Growth and Requirements of Carrots

Michalak and Peterson (1995) stated that ideal soil conditions for carrots are deep, friable, light soils without stones or other obstructions. Furthermore, the ideal pH is from 5.5-6.8 and the soil should be kept moist until the carrots are up.

Carrots respond to nitrogen fertilizer (Reiley and Shry, 1991). Tindall (1983) added that dressing of nitrogen is also frequently beneficial and potassium is often required in the form of an additional surface dressing when the plants are well established since carrots have a relatively high demand for this element. Parnes (1986) reported that biennials, including root crops and perennials have a special need for potassium to synthesize the starches needed to carry the plant over winter into the following year. Meanwhile, Holttum and Enoch (1991) also mentioned that it is best to use liquid manure, but the soil should not be recently applied with manure. Thompson and Kelly (1975) stated that fresh manure should not be applied immediately before planting carrots. If manure is to be used, it should be applied to the crop preceding carrots, or only well- rotted or leached manure should be used.

Twisted roots are caused by inadequate thinning while forked or deformed roots results if the seedbed is not fine enough. On the other hand, the hairy roots are caused by excessive soil fertility. Splitting of carrots occurs when heavy rain follows a long dry period (Michalak and Peterson, 1995).

Lorenzo and Maynard (1988) stated that the suggested rates for root crops are 68.0388 kilograms per acre of N, 45.359 kilograms per acre of P_2O_5 and 113.398 kilograms of K_2O per 0.4046 hectares.

Whereas, Parnes (1986) affirmed that the average nutrient requirement for carrot is 1.36 kilograms, 0.408 kilograms and 2.72 kilograms per 92.9 square meters of N, P_2O_5 and K_2O respectively. Carrots develop a deep, extensive and absorbing root system. During the seedling stage, the absorbing roots develop rather slowly, but as the edible portion enlarges, it gives rise to a large number of fine absorbing roots (Ware, 1975).

Important Plant Nutrients

The principal nutrients added to the soil are nitrogen, phosphorus and potash. The shortage of nutrient elements in a given soil for a given crop is corrected by the application of fertilizers.

Nitrogen in the soil. The nitrogen in the soil is derived originally from air, which contains about 34,000 tons over each area of land (Martin *et al.*, 1976). Soils with sufficient amounts of available nitrogen in the soil make a thrifty, rapid growth with a healthy deep, green color. Upon decomposition of the organic matter, some of the nitrogen passes into the air as elemental nitrogen or ammonia, while the part that remains in the soil is converted into ammonia and nitrites, and finally into nitrates. The nitrogen supply of the soil may be maintained by growth of legumes, use of manures and by addition of nitrogen fertilizers. Parnes (1986) stated that nitrogen accumulates when rainfall absorbs nitrates in the atmosphere. Some nitrogen is fixed by soil organisms associated with legumes, fixed by organisms associated with non-legumes and some is fixed by free-living organisms not associated with any plants. Aside from being fixed with other elements through the activities of soil bacteria, the gaseous nitrogen is also being fixed artificially.

The nitrogen content of surface mineral soils normally ranges from 0.02 to 0.5%; a value of about 0.15% being representative for cultivated soils (Brady and Weil, 2002). Thompson and Troeh (1978) reported that soil rarely contain enough nitrogen for maximum plant growth. The concentration of nitrogen in igneous rocks is so low that it is negligible for meeting plants needs.

Donahue (1970) stated that there are nearly 12 pounds of nitrogen in the air above every square foot of the surface of the earth, yet nitrogen is one of the most critical elements for plant growth. The reason is that plants cannot utilize nitrogen as a gas; it must first be combined into some stable form such as ammonium nitrate fertilizer. Plants absorb nitrogen either as the ammonium or the nitrate ion. The ammonium ions can be held in an exchangeable and available form on the surface of clay crystals and humus, but bacteria soon transform the ammonium to nitrates, which are readily leachable. There is no good storehouse for available nitrogen. The only storehouse of any kind for nitrogen is soil organic matter, which must decompose before the nitrogen can be absorbed by plants.

Nitrogen in the plant. Nitrogen represents life (Parnes, 1986). It is an ingredient of proteins and distinguishes them from carbohydrates. Carbohydrates are passive, storing energy or providing support, but protein controls the movement of energy and materials and the growth of the plant. Brady and Weil (2002) further affirmed that nitrogen is an integral part of amino acids which are the building blocks of all proteins including enzymes, which control virtually all biological processes. Other critical nitrogenous plant components include the nucleic acids, in which hereditary control is vested, and chlorophyll; which is at the heart of photosynthesis. Moreover, healthy plant foliage generally contains 2.5% to 4.1% nitrogen, depending on the age of the leaves and whether the plant is a legume. According to Adams *et al.* (1995), nitrogen compounds comprise about 50% of the dry matter of protoplasm, the living substance of plant cells. The higher mobility of nitrogen in the plant to the younger active leaves causes the old leaves to show symptoms first. Thompson and Troeh (1978) stated that plants absorb nitrogen whenever they are actively growing but not always at the same rate. The amount of nitrogen absorbed per day per unit of a plant weight is at a maximum when the plant is young high and gradually declines with age. Nitrogen therefore, constitutes a larger percentage of the dry weight of a young plant than of an older plant. Growth cannot get ahead of nitrogen uptake because the plant must have nitrogen on hand before it can make new cells. Also, plants can absorb extra nitrogen when it is available and store it to be used later if needed. The maximum rate of nitrogen absorption on an absolute basis usually comes during the early stages of vigorous growth.

Deficiency of nitrogen results in low production due to poor quality plants. An oversupply of nitrogen in the soil tends to cause lodging, late maturity, poor seed development in some crops and greater susceptibility to certain diseases. Ample nitrogen has a tendency to encourage stem and leaf development (Martin *et al.*, 1976).

Organic sources of nitrogen. Almost all soil nitrogen comes from living things, but they are a secondary source. The primary nitrogen source is the atmosphere. Nitrogen fertilizers may be either mineral or organic. Organic forms include the application of animal manure and composts (Thompson and Troeh, 1978). Fish scraps, azolla and wild sunflower are among the potential sources of nitrogen for plant growth.

Tisdale and Nelson (1975) reported that fish scraps are rich in nitrogen, either acidulated which contains 5.7% nitrogen as compare to 3% P_2O_5 or dried which on the other hand contains 9.5% nitrogen and 6% P_2O_5.

Meanwhile, in a study of Pandosen (1986), it was stated that the chemical analysis of fresh sunflower revealed that it had a chemical composition of 3.76% nitrogen, 0.007% phosphorus, 1.90% calcium and 0.395% magnesium. When this was mixed with to produce sunflower-based compost, it contains 3.22% nitrogen, 0.00449% phosphorus, 0.1884% potassium, 44.891 me/100g calcium, 9.9536 me/100g magnesium, 39.7 me/100g cation exchange capacity, 6.108% organic matter and a moisture content of 26%. However, fresh chopped wild sunflower when applied to snap bean plants it gave better results in terms of growth and yield, chemical and physical properties and microbial population in the soil and the nutrient content of the plants than sunflower-based compost. Moreover, Malucay (2008) reported that the application of formulated fermented wild sunflower extract can enhance better growth and development of cabbage. The formulated wild sunflower extract has essential nutrients such as nitrogen (0.30%), phosphorus (0.12%), potassium (0.92%), calcium (0.20%), magnesium (0.10%), sodium (0.10%), zinc (2.5 ppm), copper (trace), manganese (37.50 ppm), and iron (95 ppm) and a pH of 7.3 which are very important for the growth and yield of plants.

On the other hand, azolla which belongs to the family Azollaceae and a heterosporous free-floating fern, is capable of fixing atmospheric nitrogen by a symbiotic mechanism in living with the blue-green alga (*Anabaena azollae)* which is almost always present in their leaves (Khan, 1988). As azolla decomposes, nitrogen is released into the soil and becomes available to the companion or subsequent crops. Azolla has a desirable mineral nutrient composition in the plant body: nitrogen 4-5%; phosphorus 0.5- 0.9%; potassium 2-4.5%; calcium 0.4- 1.0%; magnesium 0.5-0.6%; manganese 0.11- 0.16 and iron 0.06- 0.26%ash 10.5%; crude fat 3-3.6%; crude protein 24-30%; soluble sugar 3.4.- 3.5%; starch 6.54%; chlorophyll 0.34- 0.55%;. The fertilizer value of azolla is comparable to that of other commercial organic fertilizer materials since 10 tons of fresh azolla would provide the fertilizer benefit equivalent to one bag (50 kg) of urea or two bags of ammonium sulfate. In addition, according to PCARRD (2006), azolla can be used for green manuring, which could contribute from 20-60 kg/ha per season and it is considered an efficient scavenger for potassium. Azolla grown as an intercrop with rice can accumulate from 25-170 kg N ha^{-1}, 40 kg N ha^{-1} on average (Giller, 2001). Bentrez (1997) in her study found that the addition of azolla in the grasses, vegetable refuse and sunflower composts in increasing rates significantly increased the total nitrogen and available phosphorus contents and the percentage recovery. Increasing the amount of azolla from 10-50% increases the total nitrogen contents of the compost from 1.19-2.24%. Likewise, the available nitrogen was increased ranged from 0.17-0.20%. Meanwhile, Chimicag (1995) also found in her study that the higher the azolla compost applied, the higher was the yield of celery plants. It was shown that pure azolla compost had the highest nitrogen content which significantly differed from the nitrogen content of 75% azolla compost and highly different to the 50% or 25% azolla compost and without azolla compost.

The organic nitrogen in large, complex molecules is unavailable to higher plants and would remain so if it were not released by microorganisms (Thompson and Troeh, 1978). The organic nitrogen can be considered as a reservoir of up to 50% available nitrogen each year under tropical condition.

The element phosphorus. Next to nitrogen, phosphorus has more widespread influence on both natural and agricultural ecosystems than any other essential element. In agricultural ecosystems, phosphorus constraints are much more critical because phosphorus in the harvested crops is removed from the system, with only limited quantities being returned in crop residues and animal manures (Brady and Weil, 2002).

Work and Carew (1955) stated that phosphorus content in fertilizers is stated as phosphorus pentoxide, P_2O_5.

Phosphorus in the soil. Donahue (1970) reported that the total supply of phosphorus in most soils is usually low. The total phosphorus in an average arable soil is approximately 0.1 percent. There is no efficient mechanism on clay crystals or on humus particles for holding exchangeable and available phosphorus. Phosphorus availability is low in strongly acid soils because of the formation of iron and aluminum phosphates, from which phosphorus is very slowly available. In alkaline soils, tricalcium phosphate forms readily to reduce the availability of soil phosphorus.

Phosphorus can be bound up by soil organisms, by mineral elements (particularly aluminum and calcium), and by clay minerals containing aluminum or iron.

Consequently, phosphorus does not remain in a free state for long, and any phosphorus picked up by the roots usually comes from some place no further than a small fraction of an inch away. As a result, phosphorus is slowly available to plant. Furthermore, in cool weather, biological activity is slow, and phosphorus availability may be low even though a soil test may indicate an adequate amount. Phosphorus released by decaying residues is highly available, and any phosphorus trapped by soil organisms eventually becomes available upon their death and decay (Parnes, 1986).

Phosphorus in the plant. Adams *et.al* (1995) affirmed that phosphorus is important in the production of nucleic acid, and large amounts are concentrated in the meristem. Furthermore, organic phosphates that are vital for the plant's respiration are particularly required in active organs such as root and fruit, while the seed must store adequate levels for germination. Moreover, Brady and Weil (2002) reported that phosphorus is an essential component of the organic compound often called the energy currency of the living cell: adenosine triphosphate (ATP). Likewise, it is an essential component of deoxyribonucleic acid (DNA), the seat of genetic inheritance, and of ribonucleic acid (RNA), which directs protein synthesis in both plants and animals. Furthermore, for most plant species, the total phosphorus content of healthy leaf tissue is not high, usually comprising only 0.2 and 0.4% of the dry matter. The nucleus of each plant cell contains phosphorus; for that reason, cell division and growth are not possible without adequate phosphorus. Phosphorus is concentrated in cells near the most actively growing part of both roots and shoots, where cells are dividing rapidly (Donahue, 1970).

Thompson and Troeh (1978) stated that phosphorus have been called ‘the key to life’ because it is directly involved in most life processes and is a component of every living cell and tends to be concentrated in seeds and in the growing points of plants. Meanwhile, Parnes (1986) stated that phosphorus is the Power Broker because it handles all of the energy trapped by photosynthesis preparatory to storing that energy in sugars. Phosphorus also distributes the energy given up by sugars and starches.

Lockhart and Wiseman (1978) reported that phosphorus speeds up growth of seedlings; increases root development and hasten leaf growth and maturity. Root crops are most likely to suffer from the deficiency of this element.

Seeds contain a large amount of phosphorus. A deficiency of this element may reduce the number and size of seeds. Phosphorus is a very important as a stimulus to root development. Root branch out and root hairs form profusely in the vicinity of a source of phosphorus. It is also a major factor in determining the early growth of a plant and its vigor throughout the season (Parnes, 1986).

Organic sources of phosphorus. Hignett (1985) stated that the first phosphate fertilizer was ground bones and was used widely in Europe during the early part of the nineteenth century. When the supply of animal bones ran short, human bones were gathered from battle fields or burial places.

Bone meal is the oldest phosphorus fertilizer (Parnes, 1986). At one time, farmers manufactured their own bone meal by roasting bones in urine or water and allowing them to ferment. Bones also have been composted by mixing them with wood ashes or quicklime and covering them with soil for several weeks.

Tisdale and Nelson (1975) stated that bone meal contains relatively high phosphorus content, both raw (3.5% N and 22.0% P_2O_5) or steamed (12.0% N and 28.0% P_2O_5). Miller and Jones (1995) on the other hand, mentioned that oyster shells are rich in phosphoric acid (10.38%) compared to nitrogen (0.36%) and potash (0.09%).

The element potassium. Of all the essential elements, potassium is the third most likely, after nitrogen and phosphorus, to limit plant productivity. Work and Carew (1955) reported that potassium is expressed in potash (K_2O) wherein the ancient source is the ancient lake deposits in the southwestern states.

Parnes (1986) stated that potassium's unique function is as a regulator of metabolic activities. In some plants, more is required than any other soil nutrient. It is a major antidote to a nitrogen excess.

Potassium in the soil. Potassium is present in the soil solution only as a positively charged cation, K^+ (Brady and Weil, 2002). Like phosphorus, potassium does not form any gases that could be lost to the atmosphere. Its behavior in the soil is influenced primarily by soil cation exchange and mineral weathering, rather than by microbiological processes. However, it causes no off-site problems when it leaves the soil system. McLaren and Cameron (1994) stated that the amount of potassium in soil solution at any one time is approximately 0.1-0.2% of the total soil potassium. Soils generally contain large amounts of total K (0.1-0.4% on a weight basis) but majority of soil K (90-98%) is found in soil minerals.

Donahue (1970) stated that the amount of total potassium in all soils is sufficient to last forever yet the money spent for potassium fertilizers is constantly on the increase since most of the potassium is a part of the molecule of every slowly soluble soil mineral such as orthoclase. Soils may contain two per cent (2%) total potassium, only one-fifth (1/5) of which is in a readily available form at any one time. However, during the growing season, approximately half of the potassium absorbed by the plant may come from the exchangeable form and the other half from relatively insoluble minerals which decompose and thereby release their potassium.

Parnes (1986) reported that soil organisms have a much lower requirement for potassium than plants do. Consequently, as organic residues decompose, most of the potassium is quickly released, and very little is retained in the soil humus.

Potassium in the plant. Adams *et.al* (1995) stated that there is relatively large amount of potassium in plant cells and it acts as an osmotic regulator, and is involved in resistance to chilling injury, drought and disease. Moreover, potassium has high mobility towards growing points. Brady and Weil (2002) stated that potassium is a component of plant cytoplasmic solution and plays a critical role in lowering cellular osmotic water potentials, thereby reducing the loss of water from leaf stomata and increasing the ability of root cells to take up water from the soil. The potassium content of normal, healthy leaf tissue can be expected to be in the range of 1-4% in most plants, similar to that of nitrogen but an order of magnitude greater than that of phosphorus. Good potassium nutrition is linked to improved drought tolerance, improved winter-hardiness, and better resistance to certain fungal diseases and greater tolerance to insect pests. It also enhances the quality of flowers, fruits and vegetables by improving flavor and color and strengthening stems (thereby reducing lodging). Plants take up very large amounts of potassium, often 5-10 times as much as for phosphorus and about the same amount as for nitrogen. It remains in the ionic form (K^+) in solution in the cell, or acts as an activator for cellular enzymes. It is known to activate over 80 different enzymes responsible for such plant and animal processes as energy metabolism, starch analysis, nitrate reduction, photosynthesis and sugar degradation.

Potassium is referred to as The Great Regulator (Parnes, 1986). It is active in numerous enzyme systems which control metabolic reactions, particularly in the synthesis of proteins and starches. It is not a constituent of the plant tissue, but rather of the fluids which flood the tissue. Potassium affects the balance in water pressure inside and outside the plant cells. When potassium is deficient in the plant, water fills the plant cells, and they become flabby. A potassium deficiency also causes plants to be more sensitive to drought, frost and a high salt content. Lockhart and Wiseman (1978) affirmed that potatoes, carrots, beans, barley, sugarbeet suffer from its deficiency.

Organic sources of potassium. Hignett (1985) reported that early sources of potash were wood ashes, sugar beets and saltpeter. Potash was first mined commercially as carnallite ore.

Miller and Jones (1995) reported that banana skins and stalks ash contains 2.3- 3.25% phosphoric acid and a very high potassium content of 41.76-50%. Furthermore, citrus wastes such as lemon skins in ash form contain 6.30% phosphoric acid and 31% potash and orange skins in ash has 2.90% phosphoric acid and 27.0% potash. In addition, Sangatanan and Sangatanan (2000) affirmed that the peels of oranges, lemon and other citrus fruits contains compounds called Limonene and Linalool which over stimulate some insects causing convulsion and damage to the nervous systems especially leaf-eating caterpillars, potato beetles, aphids and mites.

Organic Liquid Fertilizer

The most commonly deficient nutrients are nitrogen and phosphorus, followed by sulfur, potassium and zinc. Ideally, the application methods and timing maximize the uptake of fertilizer nutrients by the crop, minimize nutrient losses and reduce the impact of nutrient immobilization in the soil (Singer and Munns, 2002). Further, foliar spray gives quick response, accurate timing and no immobilization in the soil, but only limited amounts can be applied, because the leaf surfaces hold little water before the surplus drips off, and concentrated solutions damage the plants. Foth and Turk (1972) defined liquid fertilizer as a solution containing one or more water-soluble forms of nutrients. Liquid forms of fertilizers are sprayed on the leaves of plants to give a uniform distribution (Thompson and Troeh, 1973).

Effect of Organic Fertilizers on Plant Growth

Organic fertilizers are diverse, but are ultimately derived from plants (Singer and Munns, 2002). Some consist of unprocessed plant materials such as tree leaves, grass clippings, crop residues and green manure crops. Others have been processed by industry (cannery wastes), by animals (manure, litter, blood, bone, sewage sludge) or by microbes (from fermentation and compost). Furthermore, organic fertilizers are likely to contain all the essential plant nutrient elements but are released slowly as they decay. Brady and Weil (2008) reported that organic compounds are absorbed by higher plants and that growth promoting compounds such as vitamin, amino acid, auxins and gibberellins are formed as organic matter decays. These then stimulate growth and yield in both higher plants and microorganisms.

Organic fertilizers as reported by Martin *et al.,* (1976) are applied to the soil to promote greater plant growth and better crop quality. Ball and Kourik (1992) stated that a soil well amended with organic matter fosters a moderate but steady rate of root growth for most plants. Moreover, uniform growth is a result of the consistent supply of water, air and the nutrients that the organic amendment supplies to plants. Soils amended with organic fertilizers holds moisture, which plants can absorb according to their particular needs. Furthermore, the plants are resistant to insect and disease due to a more active and larger population of beneficial soil microorganism which control harmful microorganisms. PCARRD (2006) reported that organic matter stimulates activity of soil organisms by providing energy and carbon source, and suppresses plant pathogens through the production of antibiotics.

Bagyan (1980) found out in his study that the heaviest mean marketable yield per plot of carrots was obtained from weekly application and at 50 kg/ha foliar plus 40 kg/ha soil application. Meanwhile, Tisdale and Nelson (1970) as cited by Fateg (2003) mentioned that the most important use of foliar sprays has been in the application of micronutrients. Further, in the study of Fateg (2003), it was concluded that the application of formulated liquid fertilizer had a high significant effect on the growth and yield of Chinese cabbage and in some chemical properties of soil.

Effect of Organic Fertilizers on the Properties of Soil

Chapman and Carter (1976) stated that when a crop producer harvests any plant product, he is harvesting soil minerals. The supply of these minerals is not exhaustible and sooner or later, they must be replaced.

The crop plants vary considerably in the nutrients which they absorb from the soil. When crops are harvested and removed from the soil where they were grown, the soil loses the nutrients and gradually becomes depleted (Donahue, 1970). Hence, to maintain the productivity of the soil, the loss of nutrients by plant removal must be replaced either by the slow decomposition of soil minerals or by manure, lime and fertilizer.

Brady and Weil (2008) reported that the plant nutrients and organic matter are recycled and returned to the soil. Meanwhile, PCARRD (2006) stated that organic matter is usually used as an index of soil fertility, and by itself, is a source of other major and secondary nutrient elements. About 92-94% of soil nitrogen and 15-18% of total phosphorus are released from organic matter. Organic matter affects the properties of soil.

PCARRD (2006) further stated that organic matter promotes granulation of soil properties into water-stable aggregates, reduces runoff due to high water- holding capacity, and increases the supply and availability of nutrients since it contains nearly all the essential elements. Schjonning *et al.*, (2004) reported that organic matter supports life processes from a wide range of species of microbes and fauna. The decomposition of organic matter yields NH_4^+, NO_3^-, PO_4^{3-}, SO_4^{2-}, micronutrients and CO_2 which provides metabolic energy for soil microorganism and fauna. It helps in the chelation of metals, buffer in slightly acid and alkaline soils and cements soil particles into aggregates and contributes to water retention.

Thompson and Troeh (1973) mentioned that fertilizers are sources of plant nutrients that can be added to soil to supplement its natural fertility.

Lingaling (2006) found in his study that the different organic fertilizers (compost, wild sunflower, mushroom compost, chicken dung, hog manure and cow manure) increased the pH, organic matter content, cation- exchange capacity and water- holding capacity of the soil. On the other hand, the different organic fertilizers significantly decreased the available phosphorus, exchangeable potassium and bulk density of the soil.

MATERIALS AND METHODS

The materials used in the study were carrot (var. Kuroda Gold) seeds, fresh sunflower leaves, fresh azolla, fish scraps, molasses, grass-eating animal bones, shells, citrus wastes, banana peels, coconut vinegar and molasses. These were the ingredients that were fermented. Containers, strainers, net and plastic bottles were also used for the fermentation. Wooden planting guide, identifying tags, weighing balance, measuring devices, farm implements and recording materials were also required.

The study was conducted in a 75 m^2 area at the Balili Experimental Area from December 2010 to March 2011. The area was divided into three blocks. Each block was further subdivided into five plots measuring 1x5 m each. The experimental design used was the simple Randomized Complete Block Design (RCBD).

The treatments are the following:

T_1- control

T_2- 60:30:10 (seedling stage, SS)

30:60:10 (vegetative stage, VS)

10:30:60 (root bulking stage, RB)

T_3- 70:20:10 (seedling stage, SS)

20:70:10 (vegetative stage, VS)

10:20:70 (root bulking stage, RB)

T_4- 80:10:10 (seedling stage, SS)

10:80:10 (vegetative stage, VS)

10:10:80 (root bulking stage, RB)

T_5- 90:5:5 (seedling stage, SS)

5:90:5 (vegetative stage, VS)

5:5:90 (root bulking stage, RB)

The fertilizers were formulated prior to planting. The concoctions were prepared separately before mixing and arriving at a single organic liquid fertilizer containing either the highest N, P or K contents based on the source of raw organic materials.

Preparation of Organic Liquid Nitrogen
Fertilizers (Formulation 1)

The fermentation that was followed in the preparation of liquid nitrogen fertilizer was derived from the ideas of Lim (2008) and Virlanie Natural Farming School (2009).

Fermentation of azolla. Two kilograms of azolla was gathered early in the morning where plants have the most nutrients. One kilogram of brown sugar was placed in a container of appropriate size. A heavy weight (stone) was placed on the top of the mixture to expel the air and brought the molasses and azolla into close contact. After five hours, the weight was removed and the container was covered with a clean manila paper and tied with a string. The mixture was fermented for seven days in a cool dry shaded place, and after which, the liquid was drained and placed on clean plastic bottles.

Fermentation of sunflower. The procedure in fermenting the sunflower leaves was the same with the process of fermenting azolla. However, sunflower leaves which were also gathered early in the morning were chopped into smaller pieces before mixing with the molasses.

Fish Amino Acid. For the preparation of Fish Amino Acid (FAA), two kilograms of fresh fish wastes such as head, bone and intestines were collected. Brown sugar of the same weight (1:1 ratio) was added. The container was then covered with its own lid.

In three to four days, the fish started to liquefy through the osmotic pressure generated by the molasses and underwent fermentation. After 10-15 days, the FAA was extracted and used.

Preparation of Organic Liquid Phosphorus
Fertilizer (Formulation 2)

The preparation of CalPhos followed the procedures of Tinoyan (2006).

Bones. Animal bones from grass eating animals were gathered. One kilogram of animal bones was boiled to remove and separate the meat and fats. It was then air-dried, broiled until black and crushed. The pulverized bones were placed in a plastic container with 10 liters of coconut vinegar for 30 days and strained.

Shells. Oyster and mussel shells were gathered and the same procedure with CalPhos was followed.

Preparation of Organic Liquid Potassium
Fertilizer (Formulation 3)

The concoction process that was done was derived from the procedures of preparing fermented plant juice.

Banana peels. One kilogram of chopped banana peels and 1 kilogram of brown sugar were mixed. It was placed in a container, and covered with its own lid. It was then fermented in a cool shaded place.

Citrus wastes. The citrus peels were gathered and the same fermentation process was followed.

Seed Planting

Prior to planting, the BSU compost was applied as a basal fertilizer at the reduced rate of five tons per hectare. The recommended rate of organic fertilizer for carrot is ten tons per hectare.

Seeds were sown with the use of wooden planting guide in order to have equal distance and number of hills per plot. The pegs of the planting guide were spaced 8 cm x 15 cm between hills and rows, respectively. Five to eight seeds were dropped in each hill and covered with a thin layer of soil. The plants were thinned three weeks after emergence. This was done to limit seedlings to one plant per hill and to remove weak and stunted or abnormal seedlings and to ensure good yield and uniform roots.

Application of NPK Fertilizer

Application of foliar fertilizer was done at an interval of eight days. The application started 15 days after seedling emergence. For the vegetative stage, applications started at 39 DAP. Meanwhile, the applications for the root bulking stage started at 60 DAP.

To prepare a ratio of 60:30:10, 600 ml of Formulation 1, 300 ml of Formulation 2 and 100 ml of Formulation 3 were mixed to come up with a liter of NPK fertilizer. After which, 2 tablespoon of the formulated organic liquid fertilizer was added in a liter of water and was then applied to the foliage of carrots. The same preparation was done for the other ratios (Figures 1-3).

Figure 1. Prepared rates of formulated organic liquid fertilizers for the seedling stage

Figure 2. Prepared rates of formulated organic liquid fertilizers for the vegetative stage

Figure 3. Prepared rates of formulated organic liquid fertilizers for the root bulking stage

Statistical Analysis

The data gathered were statistically analyzed using the ANOVA. The significance between means was analyzed using the Duncan's Multiple Range Test (DMRT).

Data Gathered

A. Analysis of Formulated Organic Foliar Fertilizers

The different formulations were analyzed at Bureau of Soils and Water Management (BSWM), Quezon City. Formulation 1 which is composed of fermented azolla, sunflower and fish amino acid; formulation 2 which is composed of fermented animal bones and shells; and formulation 3 from fermented citrus wastes and banana were analyzed for their pH, total nitrogen, total phosphorus, total potassium, total calcium, total magnesium, sodium, zinc, copper, manganese, iron and organic carbon contents.

B. Growth and Yield Parameters

1. Plant height (cm). The heights were taken by measuring 10 samples of the carrot plants from the base to the tip during its seedling, vegetative and root bulking stages.

2. Marketable yield (kg). This was taken by weighing all roots harvested per plot excluding the damaged roots.

3. Total yield (kg). It was taken by weighing all roots harvested per plot which includes the marketable and non-marketable roots.

C. Insect Pest Incidence

The plants were observed and the occurrence of insect pests was noted. The insects that attacked the carrots and the damage caused were monitored and recorded. The arbitrary rating scale used by Halog and Molina (1981) is shown below.

Scale	Description
1	Sound, leaves with no damage
2	Slight, 1-3 leaves affected
3	Moderate, 4-6 leaves affected
4	Severe, most of the leaves affected
5	Skeletonized, all leaves affected

D. Disease Incidence

The plants were observed and the occurrence of diseases was recorded. Diseases such as powdery mildew, was rated using the arbitrary rating scale used by Lasilas, (2010) is shown below.

Scale	Description
1	No infection
2	1-25% of the total plant
3	26-50% of the total plant
4	51-75% of the total plant
5	76-100% of the total plant

E. Soil Properties

1. Soil pH. The initial and final soil pH were determined using the distilled water by electrometric method.

2. Bulk density (g/cm^3). The core method was used in the determination of the bulk density wherein a cylindrical core sampler was slowly pressed deep into the soil. Finally, it was placed in the oven for at least 24 hours at 105°C and weighed after being cooled in the dessicator. The formula used to compute the bulk density was:

$$D_b = \frac{\text{Oven Dry Weight of the Soil (g)}}{\text{Volume of the Soil (cm}^3\text{)}}$$

3. Organic matter content (%). The organic matter content was determined using the Walkley-Black Method.

4. Total nitrogen content (%). The nitrogen content of the soil was determined using the formula:

$$\text{Total N} = \%\ \text{OM} \times 0.05$$

5. Available phosphorus content (ppm). The spectrophotometer was used in the determination of phosphorus.

6. Exchangeable potassium content (ppm). This was determined using the Flame photometer.

F. Return on cash expense (ROCE, %)

This was determined by recording all the expenses and after which was computed using the formula:

$$ROCE\ (\%) = \left[\frac{\text{Gross Income} - \text{Total expenses}}{\text{Total expenses}}\right] \times 100$$

RESULTS AND DISCUSSION

Chemical Analysis of the Formulated Organic Liquid Fertilizers

Chemical analysis of formulated liquid organic fertilizer is presented in Table 1. Results revealed that the formulated liquid organic fertilizer contains macro and micronutrient elements.

Table 1. Chemical analysis of formulated organic liquid fertilizers (BSWM, 2011)

CONSTITUENTS (CONTENT)	FORMULATIONS		
	F1	F2	F3
Total Nitrogen (N), %	0.13	0.05	0.04
Total Phosphorus (P_2O_5), %	0.004	0.07	Trace
Total Potassium (K_2O), %	0.17	0.08	0.22
Total Calcium (CaO), %	0.08	0.99	0.02
Total Magnesium (MgO), %	0.05	0.08	0.03

pH	3.4	3.9	3.6
Sodium (Na), %	0.006	0.003	0.0003
Zinc (Zn), ppm	1.48	Trace	Trace
Copper (Cu), ppm	Trace	Trace	Trace
Manganese (Mn), ppm	39.07	13.88	5.20
Iron (Fe), ppm	64.79	16.01	12.30
Organic Carbon, %	21.16	1.06	21.81

Formulation 1 (F1) which is composed of fermented azolla, sunflower and fish amino acid contains 0.13% total N, 0.004 % total P, 0.17 % total K, 0.08 % total Ca, 0.05 % total Mg, 0.006 %Na, 1.48 ppm Zn, Cu (Trace), 39.07 ppm Mn, 64.79 ppm Fe, 21.16% organic carbon and a pH of 3.4. On the other hand, formulation 2 (F2),which is composed of fermented animal bones and shells, contains 0.05 % total N, 0.07 % total P, 0.08 % total K, 0.99 % total Ca, 0.08% total Mg, 0.0003 % Na, Zn and Cu (Trace), 13.88 ppm Mn, 16.01 ppm Fe, 1.06 % organic carbon and a pH of 3.9. Moreover, formulation 3 (F3) from fermented citrus wastes and banana contains 0.04 % total N, total P (Trace), 0.14 % total K, 0.4 % total Ca, 0.05 % total Mg, 0.0003 % Na, Zn and Cu (Trace), 24.31 ppm Mn, 27.29 ppm Fe, 12.63 % organic carbon and a pH of 2.9.

It was observed that F1 contains a relatively high total N and K content, F2 has higher Ca, K and P, and F3 has higher K content.

The principal nutrients added to the soil are nitrogen, phosphorus and potassium, the shortage of nutrient elements in a given soil affects plant processes. Parnes (1986) stated that nitrogen represents life, since it is an ingredient of proteins and distinguishes them from carbohydrates. The potassium, on the other hand, is the Power Broker because it handles all of the energy trapped by photosynthesis preparatory to storing that energy in sugars and phosphorus distributes the energy given up by sugars and starches; while, the Great Regulator, potassium, is active in numerous enzyme systems which control metabolic reactions, particularly in protein and starches synthesis.

Calcium is mainly used by plants to build cell walls and is then needed in the roots and shoot tips where cells are actively dividing, while magnesium is the essential ingredient in chlorophyll and aids in the uptake of other elements (Plaster, 1997). Meanwhile, Thompson and Troeh (1978) reported that sulfur is essential for the action of enzymes involved in nitrate reduction and it speeds up the formation of all amino acids.

Sodium is thought to be able to substitute potassium in some functions in the plant. However, the sodium cation cannot substitute K^+ in activating enzymes despite other univalent cations (McLaren and Cameron, 1994). Further, copper is involved in photosynthesis, protein and carbohydrate metabolism and is a requirement for nitrogen fixation by *Rhizobia*. Manganese is also essential in photosynthesis, N metabolism, N assimilation and is involved in oxidation-reduction processes; Zinc is present in several important enzymes, promotes growth hormones and starch formation and is involved in seed maturation and production; and, iron is present in hemoglobin and it is involved in the synthesis of chlorophyll.

Agronomic Parameters

Plant Height as Influenced by Rates
of Formulated Organic Liquid Fertilizer

The effect of different rates of formulated organic liquid fertilizer on the height of carrot plants during seedling, vegetable and root bulking stage is shown in Table 2. No significant differences were noted from the treatments. However, results show that during the seedling and vegetative stages, the plants applied with a rate of 60:30:10 (SS)/30:60:10 (VS) had the tallest plants (11.37 cm and 25.17 cm respectively). Meanwhile, during the root bulking stage, plants applied with the rate of 5:5:90 (RB) had the highest height of 39.13 cm. Figures 4 and 5 show the carrot plants during seedling and vegetative stages and seven days before harvesting.

Table 2. Plant height (cm) as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	Initial(24 DAP)	SS (38 DAP)	VS (59 DAP)	RB (87 DAP)
Control	6.87[a]	10.91[a]	24.17[a]	38.14[a]
60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB)	6.51[a]	11.37[a]	25.17[a]	37.61[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	6.01[a]	10.81[a]	23.09[a]	37.55[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	6.17[a]	10.71[a]	23.90[a]	35.53[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	6.76[a]	11.19[a]	23.84[a]	39.13[a]

Means with the same letter/s are not significantly different by DMRT

Figure 4. Overview of carrot plants during its seedling and vegetative stages

Figure 5. Carrot plants sprayed with different rates of formulated organic liquid fertilizers 7 days before harvesting

Computed Total Yield of Carrot in Tons per Hectare
as Influenced by Rates of Formulated
OrganicLiquid Fertilizers

The total yield of carrots as affected by the formulated organic liquid fertilizers is shown in Figures 6 and 7. It was observed that the application of formulated organic liquid fertilizers significantly affected the total yield. The highest harvested yield was obtained from plots applied at the rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) with a mean of 24.09 tons/ha. Meanwhile, plants that were not applied with formulated organic liquid fertilizer registered the lowest yield of 20.50 tons/ha. It is therefore implied that the application of formulated organic liquid at any rate increases the yield of carrots. This could be attributed to the nutrients from the organic fertilizers that were released and were used by the plants. Organic fertilizers are likely to contain all the essential plant nutrient elements (Singer and Munns, 2002). Moreover, Brady and Weil (2008) reported that organic compounds are absorbed by higher plants and that growth promoting compounds such as vitamin, amino acid, auxins and gibberellins are formed as organic matter decays. These then stimulate growth and yield in both higher plants and microorganisms.

Computed Marketable Yield of Carrot in Tons per
Hectare as Influenced by Rates of Formulated
Organic Liquid Fertilizer

Figure 7 shows that the marketable yield of carrot was enhanced with the application of formulated organic liquid fertilizers. The application of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) rate registered the highest marketable yield of 20.17 tons/ha, followed by the application of 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) rate

T_1- control

T_2- 60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB)

T_3- 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)

T_4- 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)

T_5- 90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)

Figure 6. Yield of carrots sprayed with different rates of formulated organic liquid fertilizers

with a mean of 17.59 tons/ha. The control yielded the lowest with a mean of 15.00 tons/ha. It is therefore implied that the application of formulated organic liquid at any rate increases the marketable yield of carrots. This could be attributed to the nutrients released and were absorbed for photosynthesis. Poincelot (1980) stated that for a quick response, such as a very rapid use of nutrients during a period of intense growth, foliar feeding responses are used. Furthermore, Donahue (1970) reported that most of the 16 elements essential for plant growth can be absorbed by the leaves and stems of plants when the elements are sprayed on them. Phosphorus, for instance, is capable of being utilized by the plant when it is sprayed on the leaves. One reason is that in most soils only a small percentage of phosphorus is recovered by the plant; whereas, when phosphorus is sprayed on the leaves, nearly all of it is absorbed.

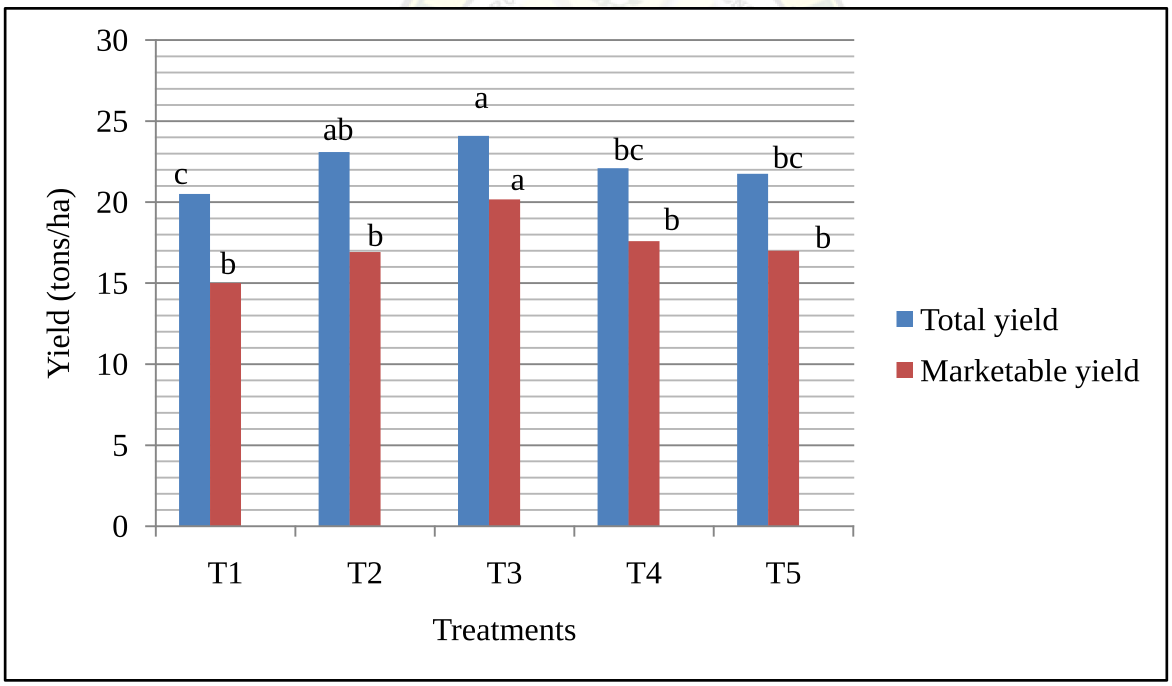

Figure 7. Yield of carrot as influenced by rates of formulated organic liquid fertilizers
Means with the same letter/s are not significantly different by 5 % DMRT

Cutworm Infestation 40 DAP and 50 DAP

No significant effect of the formulated organic liquid fertilizer was observed on cutworm infestation 40 DAP and 50 DAP as presented in Table 3. Highest cutworm infestation rate was however observed in plants applied with the rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) at 40 DAP with a mean of 1.133. Further, the highest cutworm infestation was observed in control plots at 50 DAP (Figure 8).

Figure 8. Carrot plant infested with cutworm (*Agrotis segetum*) during its seedling stage

Table 3. Cutworm infestation as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	40 DAP	50 DAP
Control	1.033[a]	1.100[a]
60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB)	1.067[a]	1.033[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	1.133[a]	1.033[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	1.033[a]	1.033[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	1.033[a]	1.033[a]

Means with the same letter/s are not significantly different by DMRT

Insect pest infestation rating: 1- Sound, leaves with no damage; 2- Slight, 1-3 leaves affected; 3- Moderate, 4-6 leaves affected; 4- Severe, most of the leaves affected; 5- Skeletonized, all leaves affected (Halog and Molina, 1981)

Looper Infestation 50 DAP and 60 DAP

Table 4 presents the infestation of looper in carrot plants at 50 DAP and 60 DAP. It is shown that there is application of formulated organic liquid fertilizers has no significant effect on cutworm infestation. However, the highest looper infestation rates at both 50 DAP and 60 DAP was observed in plots applied with the rate of 60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB), 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) and control plots. Loopers are found in small numbers throughout the season. Sixty DAP has a higher insect pest infestation because the loopers increased in population (Figure 9).

Table 4. Looper infestation as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	50 DAP	60 DAP
Control	1.067[a]	1.40[a]
60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB)	1.067[a]	1.40[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	1.000[a]	1.23[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	1.067[a]	1.40[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	1.000[a]	1.37[a]

Means with the same letter/s are not significantly different by DMRT

Insect pest infestation rating: 1- Sound, leaves with no damage; 2- Slight, 1-3 leaves affected; 3-Moderate, 4-6 leaves affected; 4- Severe, most of the leaves affected; 5- Skeletonized, all leaves affected (Halog and Molina, 1981)

Figure 9. Carrot plant infested with looper (*Trichoplusia ni*)

Semi-looper Infestation 50 DAP and 60 DAP

Semi-looper infestation is presented in Table 5. No significant effect of the application of formulated organic liquid fertilizers was observed. Application of the rate 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) however had the highest semi-looper infestation rate.

Powdery Mildew (*Erysiphe polygoni*)
Infection 80 DAP and 87 DAP

Powdery mildew infection at 80 DAP and 87 DAP is presented in Table 6. Results show that no significant effect of the different rates of organic liquid fertilizer on powdery mildew infection was observed. It was observed however, that at 80 DAP, plots applied with the rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) obtained the highest powdery mildew infection and at 87 DAP, control plots obtained the highest powdery mildew infection rate. The 87 DAP has the higher rate of powdery mildew infection because the disease affected a wider area of carrot leaves than 80 DAP (Figure 10).

Figure 10. Carrot plants infected with powdery mildew (*Erysiphe polygoni*)

Table 5. Semi-looper infestation as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	50 DAP	60 DAP
Control	1.100[a]	1.267[a]
60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB)	1.033[a]	1.300[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	1.000[a]	1.200[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	1.133[a]	1.200[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	1.000[a]	1.400[a]

Means with the same letter/s are not significantly different by DMRT

Insect pest infestation rating: 1- Sound, leaves with no damage; 2- Slight, 1-3 leaves affected; 3- Moderate, 4-6 leaves affected; 4- Severe, most of the leaves affected; 5- Skeletonized, all leaves affected (Halog and Molina, 1981)

Table 6. Powdery mildew infection as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	80 DAP	87 DAP
Control	1.87[a]	2.27[a]
60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB)	1.67[a]	1.87[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	1.90[a]	1.90[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	1.63[a]	1.80[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	1.83[a]	1.90[a]

Means with the same letter/s are not significantly different by DMRT

Powdery mildew infection rating: 1-No infection; 2- 1 to 25% of the total plant was infected; 3- 26 to 50% of the total plant was infected; 4- 51 to 75% of the total plant was infected; 5 - 76 to 100% of the total plant was infected (Lasilas, 2010)

Return on Cash Expenses

Highest return on cash expense was noted from the application of 70:20:10 (SS), 20:70:10 (VS), 10:20:70 (RB) with a value of 149.05% which was due to higher marketable yield (Table 7). This means that for every peso spent to produce a kilogram of carrot, it generated a net income of 149.05. Whereas, the lowest return on cash expense was obtained from the control plots which was due to lower marketable yield. It is however presented that there is no significant difference on the return on cash expenses of plots applied with different rates of formulated organic liquid fertilizer. Carrot is the third most important crop in the Cordillera and some areas in the country (Bawang, 2006). It has the highest return on investment (R.O.I.) among the major vegetables in the industry. The average selling price of carrot is Php 80.00 basing on organic price in the market for the month of March 2011. Furthermore, the average price of the organic liquid fertilizers is Php 100.00 per liter.

Table 7. Return on cash expense of carrots as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	ROCE (%)
Control	105.55[a]
60:30:10 (SS)/ 30:60:10 (VS)/ 10:30:60 (RB)	108.95[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	149.05[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	117.49[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	109.94[a]

Means with the same letter/s are not significantly different by DMRT

Soil Properties

Bulk Density of the Soil as Influenced by Rates of Formulated Organic Liquid Fertilizers

Table 8 shows that the bulk density of the soil was not significantly affected by the rates of formulated organic liquid fertilizers. However, the lowest bulk density was obtained from the soil applied with the rate of 60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB) with a mean of 1.06 g/ cm^3. The highest so far was obtained from the control plots with a mean of 1.13 g/cm^3. It was noted that the bulk density of soils at a range of 1.06 to 1.08 decreased from the initial value of 1.65 g/cm^3. This indicates that application of the formulated organic liquid fertilizers and the presence of crop improves the soil bulk density. Plaster (1997) stated that tillage temporarily loosens the surface soil and that roots penetrate the soil by pushing their way into pores.

Table 8. Bulk density (D_b) of the soil after harvest as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	D_b OF THE SOIL g/cm^3
Control	1.13^a
60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB)	1.06^a
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	1.09^a
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	1.08^a
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	1.08^a
Initial	1.65

Means with the same letter/s are not significantly different by DMRT

Soil pH as Influenced by Rates of Formulated Organic Liquid Fertilizers

The soil pH was not significantly affected by the application of formulated organic liquid fertilizers (Table 9). Plots applied with the rate of 60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB) however, registered the highest soil pH of 5.86. The lowest was obtained from the control plots. Further, the pH of the soil as compared to the initial of 5.10 increased with the application of organic liquid fertilizers. Therefore, it is implied that organic liquid fertilizers improves the soil pH as the plants were provided with nutrients through their foliage which minimizes the removal of basic ions from the soil.

Table 9. Soil pH after harvest as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	SOIL pH
Control	5.83[a]
60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB)	5.86[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	5.78[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	5.83[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	5.78[a]
Initial	5.10

Means with the same letter/s are not significantly different by DMRT

<u>Organic Matter Content of the Soil as Influenced by Rates of Formulated Organic Liquid Fertilizers</u>

Application of different rates of formulated organic liquid fertilizers significantly affected the organic matter content of the soil (Figure 11). The highest soil organic matter was obtained from the plots applied with 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) with a mean of 3.67% followed by plots applied with 60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB) (3.65%). Further, the organic matter content of plots applied with formulated organic liquid fertilizer increased when compared to the initial of 2.24%. This could be attributed to the basal application of 5 tons/ha organic fertilizers in the plots prior to planting. Organic fertilizers are likely to contain all the essential plant nutrient elements but are released slowly as they decay. Brady and Weil (2008) reported that the plant nutrients and organic matter are recycled and returned to the soil.

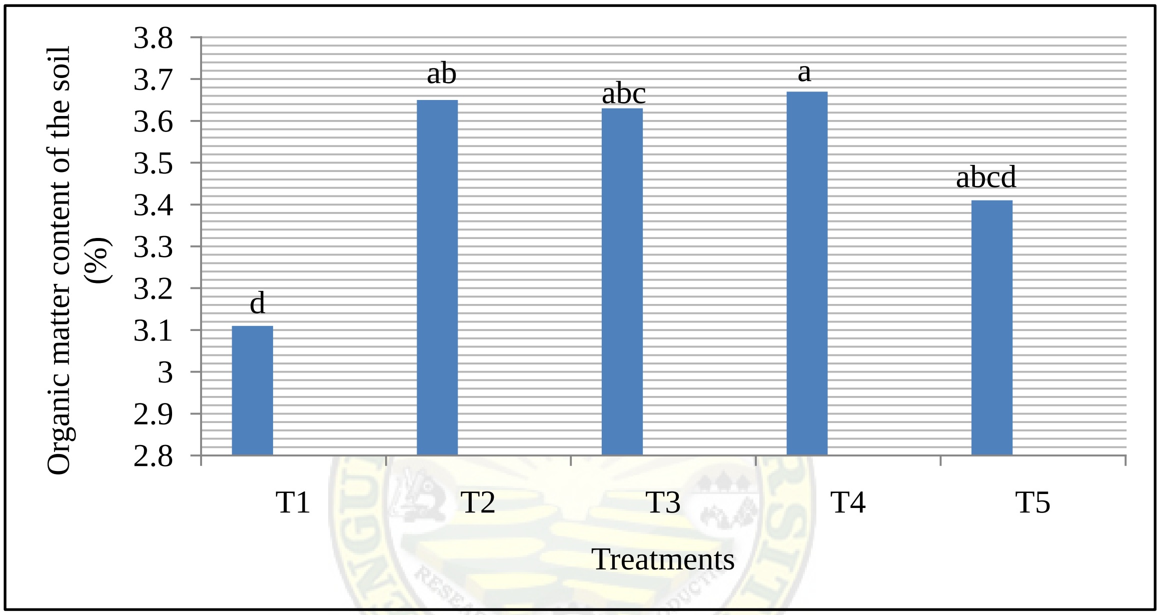

Figure 11. Organic matter content of the soil as influenced by rates of formulated organic liquid fertilizers
Means with the same letter/s are not significantly different by 5% DMRT

Total Nitrogen Content of the Soil as Influenced by Rates of Formulated Organic Liquid Fertilizers

The total nitrogen content of the soil as affected by the rates of formulated organic liquid fertilizers is presented in Table 10. Results showed significant differences on the total nitrogen content of the soil as affected by the application of different rates of organic liquid fertilizers. The rate 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) has the highest nitrogen content. This could be due to the higher organic matter content of the soil. Organic matter is usually used as an index of soil fertility, and by itself, is a source of other major and secondary nutrient elements. Organic matter is a source of other major and secondary nutrient elements (PCARRD, 2006).

About 92-94 % of soil nitrogen and 15-18 % of total phosphorus are released from organic matter.

Table 10. Total nitrogen content of the soil after harvest as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	TOTAL N (%)
Control	0.1553[d]
60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB)	0.1827[ab]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	0.1815[abc]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	0.1835[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	0.1707[abcd]
Initial	0.1120

Means with the same letter/s are not significantly different by 5% DMRT

Available Phosphorus Content of the Soil as Influenced by Rates of Formulated Organic Liquid Fertilizers

Available phosphorus content of the soil did not differ significantly as affected by the application of formulated organic liquid fertilizers as shown in Table 11. The application of 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB) however, registered the highest mean of 511.24 ppm and the lowest was from plots applied with 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB). Further, the available phosphorus content of the soil compared to the initial of 488.49 ppm increased with the application of organic liquid fertilizers. It is implied therefore that, organic liquid fertilizers and the presence of a crop improves the available phosphorus content of the soil as the case with the control plots.

Table 11. Available phosphorus content of the soil after harvest as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	AVAILABLE P (ppm)
Control	499.03[a]
60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB)	491.70[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	495.30[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	511.24[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	506.36[a]
Initial	488.49

Means with the same letter/s are not significantly different by DMRT

<u>Exchangeable Potassium Content of the Soil as Influenced by Rates of Formulated Organic Liquid Fertilizers</u>

The different rates of formulated organic liquid fertilizers applied did not differ significantly on the potassium content of the soil. Table 12 shows however that the potassium content of the soil increased considerably as compared from the initial of 220 ppm. Furthermore, the plots applied with the rate 60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB) registered the highest potassium content, while plots applied with the rate 90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB) registered the lowest potassium content.

Table 12. Exchangeable potassium content of the soil after harvest as influenced by rates of formulated organic liquid fertilizers

TREATMENTS	K CONTENT (ppm)
Control	353.11[a]
60:30:10 (SS)/30:60:10 (VS)/ 10:30:60 (RB)	530.66[a]
70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB)	504.00[a]
80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB)	395.56[a]
90:5:5 (SS)/ 5:90:5 (VS)/ 5:5:90 (RB)	352.89[a]
Initial	220.00

Means with the same letter/s are not significantly different by DMRT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

<u>Summary</u>

The study was conducted at the Balili Experimental Area from December 2010 to March 2011 to determine the: 1) effects of formulated organic liquid fertilizers on the growth and yield of carrot, 2) the best rate of the formulated organic liquid fertilizers for the production of carrot, and (3) the effects of the formulated organic liquid fertilizers on some physical and chemical properties of the soil.

Results showed that the application of formulated organic liquid fertilizers differed significantly on the total and marketable yield of carrot. Results showed that the control plots has the lowest total and marketable yield mean which is 20.5 tons/ha and 15 tons/ha, respectively.

Meanwhile, the plots applied with a rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) registered the highest total and marketable yield mean of 24.09 and 20.17.

Application of formulated organic liquid fertilizers at the rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) had the highest return on cash expense.

Similarly, the application of formulated organic liquid fertilizers at different rates differed significantly effect on the soil organic matter and total nitrogen content of the soil. Results revealed that the highest organic matter and total nitrogen content of the soil were obtained from plots applied with the rate of 80:10:10 (SS)/ 10:80:10 (VS)/ 10:10:80 (RB).

Conclusions

The following conclusions were drawn from the results and findings:

1. The application of formulated organic liquid fertilizers enhanced better growth and development of carrot. Higher marketable yield of carrot was obtained from application of formulated organic liquid fertilizers at the rate 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB).

2. The organic matter and total nitrogen content of the soil were improved by the application of formulated organic liquid fertilizers.

3. Application of formulated organic liquid fertilizers at the rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) had the highest return on cash expense.

Recommendations

It is therefore recommended that the application of formulated organic liquid fertilizers at the rate of 70:20:10 (SS)/ 20:70:10 (VS)/ 10:20:70 (RB) can be applied to improve soil properties and gain higher yield of carrot. A follow-up study using the formulated organic liquid fertilizers at different rates is recommended to verify results and findings.

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APPENDECIS

Appendix Table 2. Plant height 38 DAP (cm)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	11.02	9.59	12.12	32.73	10.91
T_2	11.35	11.36	11.41	34.12	11.37
T_3	11.16	11.30	9.97	32.43	10.81
T_4	10.49	11.05	10.58	32.12	10.71
T_5	11.18	11.57	10.83	33.58	11.19
TOTAL	55.20	54.87	54.91	164.98	
MEAN					11.00

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.01	0.003		4.46	8.65
Treatment	4	0.92	0.230	0.390^{ns}	3.84	7.01
Error	8	4.73	0.590			
TOTAL	14	5.66				

^{ns} = Not significant CV = 6.98%

Appendix Table 3. Plant height 59 DAP (cm)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	24.39	22.52	25.59	72.50	24.17
T_2	23.17	26.02	26.31	75.50	25.17
T_3	22.73	24.07	22.47	69.27	23.09
T_4	22.88	24.46	24.36	71.70	23.90
T_5	23.72	23.93	23.88	71.53	23.84
TOTAL	116.89	121.00	122.61	360.50	
MEAN					24.03

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	3.48	1.74		4.46	8.65
Treatment	4	6.73	1.68	1.29^{ns}	3.84	7.01
Error	8	10.40	1.30			
TOTAL	14	20.61				

^{ns} = Not significant

CV = 4.74%

Appendix Table 4. Final plant height 87 DAP (cm)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	35.05	38.00	41.38	114.43	38.14
T_2	34.58	38.75	39.50	112.83	37.61
T_3	37.65	40.00	35.00	112.65	37.55
T_4	33.90	35.00	37.70	106.60	35.53
T_5	38.35	36.00	42.25	117.40	39.13
TOTAL	179.53	188.55	195.83	563.91	
MEAN					37.59

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	26.67	13.34		4.46	8.65
Treatment	4	20.76	5.19	0.96^{ns}	3.84	7.01
Error	8	43.38	5.43			
TOTAL	14	90.81				

^{ns} = Not significant CV = 6.20%

Appendix Table 5. Computed total yield of carrot (tons/ha)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	20.00	19.50	22.00	61.50	20.50
T_2	23.76	21.76	23.76	69.28	23.09
T_3	23.00	23.76	25.50	72.26	24.09
T_4	23.50	21.00	21.76	66.26	22.09
T_5	22.00	21.26	22.00	65.26	21.75
TOTAL	112.26	107.28	115.02	334.56	
MEAN					22.31

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	6.1551	3.0775		4.46	8.65
Treatment	4	22.2175	5.5544	6.3961*	3.84	7.01
Error	8	6.9468	0.8684			
TOTAL	14	35.3194				

* = Significant CV = 4.18%

Appendix Table 6. Computed marketable yield of carrot (tons/ha)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	14.00	14.50	16.50	45.00	15.00
T_2	19.50	15.26	16.00	50.76	16.92
T_3	20.00	18.50	22.00	60.50	20.17
T_4	19.00	15.50	18.26	52.76	17.59
T_5	17.00	16.00	18.00	51.00	17.00
TOTAL	89.50	79.76	90.76	260.02	
MEAN					17.33

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	14.50	7.25		4.46	8.65
Treatment	4	41.46	10.37	5.82*	3.84	7.01
Error	8	14.23	1.78			
TOTAL	14	70.19				

* = Significant

CV = 7.70 %

Appendix Table 7. Cutworm infestation 40 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.1	1.0	1.0	3.1	1.033
T_2	1.0	1.2	1.0	3.2	1.067
T_3	1.04	1.0	1.0	3.4	1.133
T_4	1.1	1.0	1.0	3.1	1.033
T_5	1.1	1.0	1.0	3.1	1.033
TOTAL	5.7	5.2	5.0	15.9	
MEAN					1.06

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.052	0.02600		4.46	8.65
Treatment	4	0.023	0.00575	0.45^{ns}	3.84	7.01
Error	8	0.102	0.01275			
TOTAL	14	0.177				

^{ns} = Not Significant cv = 10.65 %

Appendix Table 8. Cutworm infestation 50 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.1	1.1	1.1	3.3	1.100
T_2	1.0	1.1	1.0	3.1	1.033
T_3	1.0	1.0	1.1	3.1	1.033
T_4	1.1	1.0	1.0	3.1	1.033
T_5	1.0	1.1	1.0	3.1	1.033
TOTAL	5.2	5.3	5.2	15.7	
MEAN					1.047

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.0010	0.0005		4.46	8.65
Treatment	4	0.0103	0.0026	0.8^{ns}	3.84	7.01
Error	8	0.0257	0.0032			
TOTAL	14	0.0370				

^{ns} = Not Significant CV = 5.41%

Appendix Table 9. Looper infestation 50 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.1	1.0	1.1	3.2	1.067
T_2	1.1	1.0	1.1	3.2	1.067
T_3	1.0	1.0	1.0	3.0	1.000
T_4	1.1	1.1	1.0	3.2	1.067
T_5	1.0	1.0	1.0	3.0	1.000
TOTAL	5.3	5.1	5.2	15.6	
MEAN					1.04

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.004	0.002		4.46	8.65
Treatment	4	0.016	0.004	2.0^{ns}	3.84	7.01
Error	8	0.016	0.002			
TOTAL	14	0.036				

^{ns} = Not Significant CV = 4.30%

Appendix Table 10. Looper infestation 60 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.5	1.2	1.5	4.2	1.40
T_2	1.5	1.2	1.5	4.2	1.40
T_3	1.1	1.5	1.1	3.7	1.23
T_4	1.4	1.4	1.4	4.2	1.40
T_5	1.4	1.3	1.4	4.1	1.37
TOTAL	6.9	6.6	6.9	20.4	
MEAN					1.36

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.0120	0.0060		4.46	8.65
Treatment	4	0.0627	0.0157	0.565^{ns}	3.84	7.01
Error	8	0.2213	0.0277			
TOTAL	14	0.2960				

^{ns} = Not Significant CV = 12.24 %

Appendix Table 11. Semi-looper infestation 50 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.1	1.1	1.1	3.3	1.100
T_2	1.0	1.1	1.0	3.1	1.033
T_3	1.0	1.0	1.0	3.0	1.000
T_4	1.3	1.1	1.0	3.4	1.133
T_5	1.0	1.0	1.0	3.0	1.000
TOTAL	5.4	5.3	5.1	15.8	
MEAN					1.053

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.0090	0.0045		4.46	8.65
Treatment	4	0.0437	0.0109	1.98^{ns}	3.84	7.01
Error	8	0.0443	0.0055			
TOTAL	14	0.0970				

^{ns} = Not Significant CV = 7.04 %

Appendix Table 12. Semi-looper infestation 60 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.1	1.6	1.1	3.8	1.267
T_2	1.2	1.4	1.3	3.9	1.300
T_3	1.3	1.1	1.2	3.6	1.200
T_4	1.2	1.2	1.2	3.6	1.200
T_5	1.3	1.6	1.3	4.2	1.400
TOTAL	6.1	6.9	6.1	19.1	
MEAN					1.273

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.086	0.04300		4.46	8.65
Treatment	4	0.083	0.02080	1.0^{ns}	3.84	7.01
Error	8	0.181	0.02263			
TOTAL	14	0.350				

^{ns} = Not Significant CV = 11.82 %

Appendix Table 13. Powdery mildew infection 80 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.8	2.0	1.8	5.6	1.87
T_2	1.6	1.8	1.6	5.0	1.67
T_3	2.2	1.8	1.7	5.7	1.90
T_4	1.4	1.7	1.8	4.9	1.63
T_5	1.9	1.9	1.7	5.5	1.83
TOTAL	8.9	9.2	8.6	26.7	
MEAN					1.78

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.03	0.02		4.46	8.65
Treatment	4	0.17	0.04	1.0^{ns}	3.84	7.01
Error	8	0.28	0.04			
TOTAL	14	0.48				

^{ns} = Not significant CV =11.24 %

Appendix Table 14. Powdery mildew infection 87 DAP

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	2.0	2.8	2.0	6.8	2.27
T_2	1.8	2.0	1.8	5.6	1.87
T_3	2.4	1.5	1.8	5.7	1.90
T_4	1.5	2.0	1.9	5.4	1.80
T_5	2.1	1.9	1.7	5.7	1.90
TOTAL	9.8	10.2	9.2	29.2	
MEAN					1.95

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.10	0.05		4.46	8.65
Treatment	4	0.41	0.10	0.83^{ns}	3.84	7.01
Error	8	0.99	0.12			
TOTAL	14	1.5				

^{ns} = Not significant CV = 17.7%

Appendix Table 15. Return on cash expenses (%)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	91.85	98.70	126.10	316.65	105.55
T_2	140.82	88.45	97.59	326.86	108.95
T_3	146.99	128.47	171.69	447.15	149.05
T_4	134.64	91.42	125.50	351.56	117.19
T_5	109.94	97.59	122.29	329.82	109.94
TOTAL	624.24	504.63	643.17	1772.04	
MEAN					118.136

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	2257.21	1128.61		4.46	8.65
Treatment	4	3799.44	949.86	3.398^{ns}	3.84	7.01
Error	8	2247.74	280.97			
TOTAL	14	8304.39				

^{ns} = Not Significant CV = 14.19 %

Appendix Table 16. Bulk density of the soil after harvest (g/cm^3)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	1.16	1.09	1.15	3.40	1.13
T_2	1.00	1.18	0.99	3.17	1.06
T_3	1.10	1.17	1.01	3.28	1.09
T_4	1.14	1.14	0.96	3.24	1.08
T_5	1.19	1.05	0.99	3.23	1.08
TOTAL	5.59	5.63	5.1	16.32	
MEAN					1.09

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.030	0.020		4.46	8.65
Treatment	4	0.006	0.002	0.29^{ns}	3.84	7.01
Error	8	0.054	0.007			
TOTAL	14	0.090				

^{ns} = Not significant CV = 7.68%

Appendix Table 17. Soil pH

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	5.79	5.84	5.87	17.50	5.83
T_2	5.76	5.92	5.89	17.57	5.86
T_3	5.66	5.71	5.98	17.35	5.78
T_4	5.75	5.81	5.93	17.49	5.83
T_5	5.76	5.71	5.88	17.35	5.78
TOTAL	28.72	28.99	29.55	87.26	
MEAN					5.82

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.07	0.04		4.46	8.65
Treatment	4	0.01	0.003	0.60^{ns}	3.84	7.01
Error	8	0.04	0.005			
TOTAL	14	0.12				

^{ns} = Not significant CV = 1.1 7%

Appendix Table 18. Organic matter content of the soil after harvest (%)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	3.07	2.88	3.37	9.32	3.11
T_2	3.56	3.73	3.67	10.96	3.65
T_3	3.79	3.52	3.58	10.89	3.63
T_4	3.78	3.57	3.66	11.01	3.67
T_5	3.09	3.45	3.70	10.24	3.41
TOTAL	17.29	17.15	17.98	52.42	
MEAN					3.49

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.08	0.04		4.46	8.65
Treatment	4	0.69	0.17	4.31*	3.84	7.01
Error	8	0.31	0.04			
TOTAL	14	1.08				

* = Significant CV = 5.64%

Appendix Table 19. Total nitrogen content of the soil after harvest (%)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	0.1535	0.1440	0.1685	0.4660	0.1553
T_2	0.1780	0.1865	0.1835	0.5480	0.1827
T_3	0.1895	0.1760	0.1790	0.5445	0.1815
T_4	0.1890	0.1785	0.1830	0.5505	0.1835
T_5	0.1545	0.1725	0.1850	0.5120	0.1707
TOTAL	0.8645	0.8575	0.8990	2.6210	
MEAN					0.1747

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	0.00017	0.000087		4.46	8.65
Treatment	4	0.00171	0.000430	4.28*	3.84	7.01
Error	8	0.00080	0.000100			
TOTAL	14	0.00268				

* = Significant CV = 5.72 %

Appendix Table 20. Available phosphorus content of the soil after harvest (ppm)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	485.02	493.50	518.56	1497.08	499.03
T_2	454.18	458.03	562.72	1475.11	491.70
T_3	465.74	500.44	519.72	1485.90	495.30
T_4	501.22	507.00	525.50	1533.72	511.24
T_5	468.44	499.29	551.34	1519.07	506.36
TOTAL	2374.6	2458.26	2678.02	7510.88	
MEAN					500.73

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	9823.81	4911.91		4.46	8.65
Treatment	4	767.96	191.99	0.41^{ns}	3.84	7.01
Error	8	3724.72	465.59			
TOTAL	14	14316.49				

^{ns} = Not significant CV = 4.31%

Appendix Table 21. Exchangeable potassium content of the soil after harvest (ppm)

TREATMENTS	REPLICATION I	II	III	TOTAL	MEAN
T_1	377.33	374.67	307.33	1059.33	353.11
T_2	825.33	397.33	369.33	1591.99	530.66
T_3	837.33	333.33	341.33	1511.99	504.00
T_4	536.00	348.00	302.67	1186.67	395.56
T_5	378.67	333.33	346.67	1058.67	352.89
TOTAL	2954.66	1786.66	1667.33	6408.65	
MEAN					427.24

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARE	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
Block	2	202378.81	101189.41		4.46	8.65
Treatment	4	85844.95	21461.24	1.32^{ns}	3.84	7.01
Error	8	129801.57	16225.20			
TOTAL	14	418025.33				

^{ns} = Not significant CV = 29.81 %

Appendix Table 22. Production cost (PhP)

PARTICULAR	TREATMENT				
	T_1	T_2	T_3	T_4	T_5
Production Cost					
Seeds	20.76	20.76	20.76	20.76	20.76
Fertilizer (Basal)	12.50	12.50	12.50	12.50	12.50
Fertilizer (Foliar)	0	81.00	81.00	81.00	81.00
Garden Tools					
Grub hoe	6.43	6.43	6.43	6.43	6.43
Hose	20.00	20.00	20.00	20.00	20.00
Tractor	29.00	29.00	29.00	29.00	29.00
Labor					
Land preparation	50.00	50.00	50.00	50.00	50.00
Fertilizer application (Basal)	5.00	5.00	5.00	5.00	5.00
Sowing	20.00	20.00	20.00	20.00	20.00
Thinning	20.00	20.00	20.00	20.00	20.00
Hilling-up	20.00	20.00	20.00	20.00	20.00
Irrigation	500.00	500.00	500.00	500.00	500.00
Weeding	40.00	40.00	40.00	40.00	40.00
Fertilizer application (Foliar)	70.00	80.00	80.00	80.00	80.00
Harvesting	50.00	50.00	50.00	50.00	50.00
TOTAL	875.69	971.69	971.69	971.69	971.69
Gross Income	1800.00	2030.40	2420.00	2110.40	2040.00
Net Income	924.31	1058.71	1448.31	1128.31	1068.31
ROCE (%)	105.55	108.95	149.05	116.12	109.94
Rank	5	4	1	2	3