بسم الله الرحمن الرحيم

Sudan University of Science and technology

College of Agricultural Studies

Department of plant protection

The Effect of garlic (*Allium sativum*) extract and fungicide (fulldazin on the growth (*penicillum digitatum*)

تاثير المستخلص المائي لنبات الثوم والمبيد الفطري فولدازين على نمؤ فطر بنسيليوم ديجيتاتم

B.Sc (Honours) Graduation Research Project in Plant Protection

BY:

Manahil Abaker Jeberel Jebero

Supervisor:

Dr:Ibrahim Saeed Mohammed

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الايــة

﴿ لَا يُكَلِّفُ اللَّهُ نَفْسًا إِلَّا وُسْعَهَا ۚ لَهَا مَا كَسَبَتْ وَعَلَيْهَا مَا اكْتَسَبَتْ ۗ رَبَّنَا لَا تُؤَاخِذْنَا إِنْ نَسِينَا أَوْ أَخْطَأْنَا ۚ رَبَّنَا وَلَا تَحْمِلْ عَلَيْنَا إِصْرًا كَمَا حَمَلْتَهُ عَلَى الَّذِينَ مِنْ قَبْلِنَا ۚ رَبَّنَا وَلَا تُحَمِّلْنَا مَا لَا طَاقَةَ لَنَا بِهِ ۖ وَاعْفُ عَنَّا وَاغْفِرْ لَنَا وَارْحَمْنَا ۚ أَنْتَ مَوْلَانَا فَانْصُرْنَا عَلَى الْقَوْمِ الْكَافِرِينَ﴿٢٨٦﴾.

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Dedication

To my parents

To my friends and to everyone who helped me in this research

With Love

ACKNOWLEDGEMENTS

I would like very much to render His Almighty Allah who gives me the power and health to complete this work.

I would also like to express my sincere gratitude to my supervisor Dr. Ibrahim Saeed Mohammedfor his keen interest, constant guidance, help and encouragement throughout the course of this study to bring this work to reality. It has been a privilege and a pleasure to work with him.

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Abstract

This experiment was conducted in plant pathology lab to test the effectiveness of the garlic aquatic extraction on the growth of the penicillium sp as alternative pesticide as the result obtained from this experiment has been shown that the aquatic extract has latterly effectiveness of the growth of the fungi and the result shows that the more we add highest concentration from the extract the more we found the growth of the fungi has been reduced and the less concentration had been used the more we found the growth increase which indicate to the effectiveness of the highest concentrations on inhibiting the growth of the fungi hence the less inhibit has been found in the less concentration (25%) compering with the control which had the huge amount of growing compering with the samples that has been used the different concentrations on them.

مـــلـــخـــص الـبـحـــث

أجريت هذه التجربة في معمل امراض النبات قسم وقاية النبات – كلية الدراسات الزراعية (شمبات) جامعة السودان للعلوم والتكنولوجيا لاختبار فعالية مستخلص الثوم المائي في تثبيط نمو الفطر بنسيليوم كبديل للمبيدات الكيميائية ، واظهرت النتائج المتحصل عليها من التجربة ان للمستخلص المائي فعالية نسبية في تثبيط نمو الفطر حيث كانت النتائج المتحصل عليهل تدل علي ان نمو الفطر له علاقة عكسية مع ذيادة تركيز المستخلص في الاطباق، كلما زاد تركيز المستخلص قل النمو الفطري في الطبق، واقل نسبة تثبيط في اقل تركيز مستخدم (25%)، مقارنتآ مع الشاهد اللذي كانت نسبة نمو الفطر عالية جداً مقارنتآ بالاطباق المستخدم فيها تراكيز مختلفة من المستخلص.

CHAPTER ONE

Introduction:

The famous French chef, X. Marcel Boulestin (1878-1943), is reputed to have said, "It is not really an exaggeration to say that peace and happiness begin, geographically, where garlic is used in cooking." (Agricultural Outlook, 2000).

Garlic is a crop widely grown for fresh market by many producers on a small scale for local markets and, particularly in the U.S., by a few large-scale producers for processing and fresh sales. About one million hectares (2.5 million acres) of garlic produce about 10 million metric tons of garlic globally each year, according to the United Nations Food and Agriculture Organization (FAO). Garlic is one of the most popular spices in the world. It is reported that in ancient Egypt, the workers who had to build the great pyramids were fed garlic daily, and the Bible mentions that the Hebrews enjoyed their food with garlic. In the first world war, garlic was widely used as an antiseptic to prevent gangrene and today people use garlic to help prevent atherosclerosis and improve high blood pressure (Hedrick, 1972). Although widely cultivated, it is only since routine seed production became possible in the 1980's that garlic can be called a domesticated crop, since a strict definition of domestication is the process of selective breeding of a plant or animal to better meet human needs. Clones held by growers today have been maintained as separate entities, but a system to confirm or refute the identity of a given clone has not been established. Only with several seasons of careful field observation can garlic clones be identified, and even then ambiguities often remain. For example, virus infection can dramatically reduce plant size and vigor, and alter leaf color and shape (USDA, 2006).

There are about 300 varieties of garlic cultivated worldwide, particularly in hot, dry places. Today, garlic is one of the twenty most important vegetables in the world, with an annual production of about three million metric tons. Major growing areas are USA,

China, Egypt, Korea, Russia and India (Innvista, 2005) Garlic has been used as both food and medicine in many cultures for thousands of years, dating as far back as the time that the Egyptian pyramids were built. Later, gravediggers in early eighteenth-century France drank a concoction of crushed garlic in wine which they believed would protect them from getting the plague that killed many people in Europe. More recently, during both World Wars I and II, soldiers were given garlic to prevent gangrene, and today people use garlic to help prevent atherosclerosis (plaque buildup in the arteries causing blockage and possibly leading to heart attack or stroke), improve high blood pressure, and reduce colds, coughs, and bronchitis (UMM, 2004).

Potato (*Solanum tuberosum* L.) is the most important non-grain food crop in the world, ranking 3rd in terms of total production with over 365 million tons per year (FAOSTAT, 2013), after rice and wheat. It is grown in around 150 countries spread across both temperate and tropical regions and at elevations from sea level to 4,000 m (Paul et al. 2012). More than half of the potato production takes place in developing countries including India, and over one billion people have potato as their staple diet. It has steadily expanded globally, with 35% increase in overall production since 1960. The increase in production is still higher in developing countries of Asia and Africa indicating its growing importance as a staple food source.

Nutritionally, potatoes are second only to soybean for amount of protein/ha, with the major storage protein being patatin, one of the most nutritionally balanced plant proteins known (Liedl et al. 1987). A single 150g tuber provides up to 45% of recommended daily allowance (RDA) for vitamin C, 10% vitamin B6, 8% niacin, 6% folate as well as significant amounts of other essential mineral nutrients required; however it lacks many other essential nutrients like vitamin B12, Biotin, Thiamin, Riboflavin, Alfa carotene, Lycopene, Retinol and Alfa to copherol and important minerals like copper, iodine and molybdenum (Meredith, 2012) required for human consumption.

The objective of this investigation was to study the effect of garlic extract on the growth of *penicillum sp* (fungi) as alternative pesticide

CHAPTER TWO

LITEREATURE REVIEW

2.1. Potato (*Solanum tuberosum* L.)

The potato plant which belongs to the family *Solanaceae* includes, among 2000 other species, tomato *(Lycopersicum esculentum*), sweet pepper (*Capsicum annuum*), eggplant (*S. Melongena var. esculentum*), tobacco *(Nicotiana tabacum*), and petunia (*Petunia hybrida*) (Fernald, 1970).

2.2. Scientific classification

Kingdom: Plantae (unranked):

Order: Solanales

Family: Solanaceae

Genus: Solanum

Species: *S. tuberosum*

(Binomial name: *Solanum tuberosum* L.)

The genus *Solanum* is a polymorphous and largely tropical and subtropical genus containing more than 1000 species. The origin agreed to be the high elevation of South America and the area of first domestication was reasoned to be the area where wild diploids are still found and where the greatest diversity of cultivated forms can still be found, and is identified as the high plateau of Bolivia and Peru, in the general region of Lake Titicaca (Hoopes and Plaisted, 1987).

Potato is one of the major vegetable crops grown worldwide following wheat, maize, and rice, with a production estimates of 368 million tons (FAOSTAT, 2015). It is the staple food of many cultures and civilizations past and present. The term Potato is used to refer both to the plant, and the vegetable itself (Howard, 1970; Simmonds, 1976; De Jong, 1984 and Burton, 1989).

In Sudan, the potato is grown mainly as winter crop and the main area of production are along the Nile bank in both Khartoum and Northern Estates. Although potato cultivation in Sudan depends mainly on exotic advanced cultivars

but an old introduced material is still produced in Jebel Marra in the far west and it is locally known as Zalingei potato (Abdelgadir, 2003).

Potatoes in Sudan are an important cash crop for small-scale growers, and have the potential to increase incomes in periurban areas, improve living standards and create employment opportunities. Potato production is steadily increasing in Khartoum; the acreage devoted to this crop has more than tripled in the last ten years (Ahmed, 1985).

The total acreage under potato cultivation in the Khartoum region amounts to about 6,500 hectares, with yields of 17 to 25 ton/ha. However, production costs of potatoes are high in comparison with those of other crops; seed potatoes have to be imported and account for more than half of the total production cost of potatoes (Elsir, 2005). This is a major constraint to further expansion of potato production (Elrasheed et al., 2009). The estimated total potatoes production in Sudan is about 616,000 tons in a cultivated area of about 88,000 feddans (Hind et al., 2010).

Potatoes are pruned to attack by a number of fungal species such as: *phytophtora infestans, Alternaria solani, Virtacillium oleuliaeklobed, Virtacillium alboatrum, Fusarium sp., Penicillin sp., Helminthosporium solani, Pythium ultimam. Phytophthora erythorsptic, Pythium spp. Colletotricam acpccodes, Spongospore subterranean, sterptomces scabies* (?)

One of the major constraints facing the quantity, quality and availability of healthy crop worldwide are the losses and contamination caused by post-harvest diseases. The major groups of postharvest diseases are those which arise from infections initiated during and after harvest.

The threat to potatoes from fungal infections has now reached a level that outstrips that posed by bacterial and viral diseases (Berger, 1977).

2.2. Garlic:

2.2.1 Taxonomy

Garlic belongs to the family *Liliaceae*. Common garlic is classified as *Allium sativum*, British wild garlic as *Allium oleraceum*, and American wild garlic as *Allium candense*. The field garlic of Europe and the Americas is classified as *Allium vineale*. False garlic is classified as *Nothoscordum bivalve*(MEOE, 2001).

The origin of garlic as recalled in an Indian legend (from a Sanskrit manuscript dated to AD 350-375): The King of the Asuras, Rahu, stole the elixir of life from

Vishnu and drank it. Vishnu's act of revenge was to cut Rahu's head off. Garlic sprang from the blood that was spilled.

Kingdom Plantae

Subkingdom: Tracheobionta

Division: Magnoliophyta

Class: Liliopsida

Subclass: Liliidae

Order: Liliales

Family: Liliaceae

Genus: Allium

Species: *Allium sativum* L.

(The plants database, 2000).

2.2.2 Origin

Garlic is among the oldest known horticultural crops. In the old world , egyptian and Indian cultures referred to garlic 5000 years ago and there is clear historical evidence for its use by the Babylonians 4500 years ago and by the chinese 2000 years ago. some writings suggest that garlic was grown in China as far back as 4000 years ago. garlic grows wild only in central Asia (centered in kyrgyzstan , Tajikistan , Turkmenistan , and uzbekistan) today. Earlier in history garlic grew wild over a much larger region and, in fact, wild garlic may have occurred in an area from china to India to Egypt to the ukraine . This region where garlic has grown in the wild is referred to as its "center of origin" since this is the geographic region where the crop originated and the only place where it flourished in the wild. In fact, although we sometimes hear about "wild garlic" elsewhere in the world, this is the only region where true garlic routinely grows in the wild without the assistance of human propagation. There are other plants locally referred to as "wild garlic", but these are invariably other species of the garlic genus (*Allium*), not garlic itself (*Allium sativum*). For example, *Allium vineale* is a wild relative of garlic that occurs in North America and is commonly called "wild garlic" (USDA, 2006).

The "center of origin" for a plant or animal species is also referred to as its "center of diversity" since it is here that the broadest range of genetic variation can be expected. That is why those who have sought to find new genetic variation in garlic have collected wild garlic in Central Asia.

Once cultivated by the first garlic farmers outside of its "center of origin", what types of garlic did early afficianados grow? In fact, we know almost nothing about the early types of garlic produced. No designation of garlic varieties was made in the early writings discovered to date, be it hardneck or softneck, red or white, early or late, local or exotic. Throughout its earlier history some have speculated that softneck garlic was the predominant type cultivated although evidence of what would be interpreted as a hardneck type was found interred in Egyptian tombs. It was not until garlic was cultivated in southern Europe within the last 1000 years that the distinction between hardneck and softneck was routinely noted. Until more ancient writings which describe garlic are found, or old, well-preserved samples are unearthed, we can only speculate about the early types of garlic grown.

Garlic producers and consumers have come through 5000 years of history growing and eating their crop with little need to specify type or variety. In fact it is a rather modern habit of only the last few hundred years whereby more detailed descriptions of varieties have come to be developed for any crop plant (USDA, 2006).

2.2.3 Botanical description

Garlic is a perennial that can grow two feet high or more. The most important part of this plant for medicinal purposes is the compound bulb. Each bulb is made up of 4 to 20 cloves, and each clove weighs about 1 gram. The parts of the plant used medicinally include fresh bulbs, dried bulbs, and oil extracted from the garlic. (UMM, 2004). The Bulb, 12 inches to 18 inches tall (30-45 cm), 9 inches to 12 inches in spread (22.5-30 cm)

2.2.3.1 Root

The roots are trimmed and the stems snipped or braided. Depending on where they are grown, the size, shape, colour, and flavour will differ. Colours can range from white to red to purple or pink (Innvista, 2005).

2.2.3.2 Leaf

Garlic's straplike leaves are 1-2 feet long, surrounding a central flower stalk or scape, which develops a globular cluster of tiny white blossoms (The Rodales Herb book,1987). The leaves are flat, linear, gray-green, and longitudinally folded, with a keel on the lower surface. Six to twelve of them grow, widely spaced, along the central stalk of the plant. The bases of non-topsetting types form a semi-stiff pseudostem, which remains upright until bulb maturity, when it bends over near ground level (Garlic and friends, 1996).

A head of garlic is composed of a dozen or more discrete cloves, each of which is a botanical bulb, an underground structure comprised of thickened leaf bases. A garlic bulb is generally four to eight centimeters in diameter, white to pinkish or purple, and is composed of numerous (8-25) discrete cloves. The foliage comprises a central stem 25-100 cm tall, with flat or keeled (but not tubular) leaves30-60 cm long and 2-3 cm broad. The flowersare produced in a small cluster at the top of the stem, often together with several bulblets, and surrounded by a papery basal spathe; each flower is white, pink or purple, with six petals3-5 millimetres long. The flowers are commonly abortive and rarely produce any seeds(Wikipedia, 2006).

A garlic bulb develops from the bud primordia (2 or 3) of the cloves that are planted. Each bud primordia forms between two and six growing points, each of which develops a lateral bud which later develop into a clove. Temperatures during growth determine the rate of leaf growth, clove, and flower stalk development. Clove formation in non-bolting types differs slightly in that lateral-bud primordia (which form the cloves), form in the axil of the youngest 6-8 foliage leaves, beginning with the oldest one. At maturity, these develop into cloves. The growing point may then either form a clove and go dormant, or form an incomplete leaf that degenerates (OSU, 2005).

2.2.3.3 Flowers

The scape or flower stem usually emerges coiled, then later straightens to vertical as it grows and develops. A papery spathe covers the umbel at the top of this scape (also called a capsule). This spathe splits along one side to reveal the umbel, which consists of many bulbils that vary greatly in size between cultivars. The small, greenish-white, purple, or pink flowers vary in number, or may be absent. In many cultivars, these flowers wither as buds, without opening. Even those that open and

occasionally produce black withered seeds are sterile, however (Garlic and friends, 1996).

The scape of topsetting types remains rigid and fully upright, even after full senescence. The "true stem" is below ground and almost flat as a pancake, a small disc upon which the cloves rest within the bulb (Growing Great Garlic, 1991).

Unlike onion, garlic produces a compound bulb, made up of 4-15 cloves. They are called cloves from the word cleave, which means both "to cling together" and "to divide along natural lines". Individual cloves are made up of two modified leaves, one which forms the protective papery outer skin, and the other which thickens to form a storage structure (Garlicand friends, 1996). Each clove is inside a protective sheath, and the whole compound group is covered with a thin, papery skin, which is tan colored to pinkish. Flowers are very small, white to pinkish, with six segments and six stamens. These are sterile, borne in a terminal globe-shaped umbel (Rodale's Illustrated Encyclopedia of Herbs, 1987).

2.2.3.4 Pollen and pollination

Garlic presents no pollination problem and when flowers do appear on garlic they are sterile so seeds are unknown. Both are propagated by bulblets or cloves (Mann, 1952).

2.2.4 Cultivars:

M.R. Pooler and P.W. Simon, of the University of Wisconsin, madison, have made an effort to classify a confusing array of garlic varieties into a botanically organized and logical order. Filaree Farm in okanogan , Washington offers organic planting stock of an exhaustive collection of garlic varieties, using the taxonomic system of Pooler and Simon to organize a catalog of amazing diversity. More than just a sales brochure, this publication can be a valuable reference tool for the would-be garlic grower. All garlics are divided into two common subspecies, based on whether or not they form a hard flower stalk (scape) or not. *Allium sativum* ophioscorodon, or the hardneck garlic, is considered the more primitive type, producing a tall stalk with a cluster of bulbils and undeveloped flowers at the top. These bulbil stalks emerge curled and

looped in a variety of ways. How the stalk is produced and emerges is one of the classification descriptors of the different varieties within the general "hardneck" type. All hardneck varieties are sometimes lumped under the designation "rocambole," though this system uses that name for a specific sub-group of the ophioscorodon subspecies. These "ophio" varieties are generally considered the "gourmet" types, with better, more complex flavor than their softneck kin. In general, though, they do not store as well as softneck types. Over millennia of selection, softneck garlics, A. sativum sativum, were developed. These produce no hard central stalk or aboveground clusters of bulbils. All energy storage is in clove form within the bulbs produced underground. These bulbs typically have many more cloves than the hardneck types, some of them small central ones, thought to be converted remnants from what once would have been a bulbil stalk. The leaves form a pseudostem above the ground, which softens and falls over as the garlic matures, very much like the tops of an onion. These are the garlics of the mainstream marketplace, because they yield more, store better, and require less maintenance in the field than the hardnecks the soft, pliable stems also make them the garlics of choice for braiding. Softneck cultivars may be less hardy than hardnecks in cold winter areas (Botanical purists, such as Rexford Talbert, insist on a third subspecies, *A. sativum* pekinense, although popular literature seldom if ever mentions this type, or describes how it is set apart from the hardneck, *Allium sativum* ophioscorodon, variety (Heirloom Vegetables, 1998)

2.2.5 Growth habit:

Planting garlic beside rose bushes helps control the greenfly. It is also a good companion to lettuce, beetroot, summer savoy, chard, and strawberries; but should not be planted near peas and beans. Single garlic cloves are planted annually late in the fall and are referred to as seeds. In the spring, the plant produces long pointed leaves known as garlic shoots which can be used in salads

and stir fries. Garlic does not develop its full flavour until the bulbs have dried and the outer layer appears papery. The garlic bulb is formed at the base of the perennial plant and is surrounded by several dry, white, red, or purple layers of skin. It is usually composed of up to twelve bulblets called cloves, which in turn are surrounded by papery layers of skin. When garlic sprouts, diallyl disulfide, the sulfur compound that gives it its distinctive taste and odour, goes into the new growth, causing the garlic itself to become milder. Garlic requires plenty of sunshine and does particularly well in Mediterranean countries where the big, juicy cloves have an excellent flavour. However, these do not keep well (Innvista, 2005).

Garlic likes full sun and well-drained soil. Garlic is quite tolerant when it comes to soil types and textures, but it definitely appreciates sandy-clay-loam that is friable (easily crumbled in the hand) and has a high organic content. It does best when the pH is in the 6.2 to 6.8 range. You can get your soil tested at the local university extension office or use one of the soil test kits on the market. Make sure you take samples from several spots in your garden and mix them together to obtain a representative reading. The garden or field should drain easily - standing water just won't cut it as the bulbs could rot in the ground. To increase the tilth of the soil, add organic matter such as well-composted manure. You can also green mulch, that is plant cover crops such as clover or buckwheat and then till them into the ground (Figure 8)(The garlic store, 2003).

2.2.6 Cultural practices

Like all Alliums, garlic is a fairly heavy feeder that appreciates fairly high levels of fertility. Planting beds should be well amended with compost or other well-rotted organic matter, fertilized, and thoroughly worked before planting a high phosphorus and potassium fertilizer should be incorporated before or at planting. Nitrogen will probably not be stable in the soil over the winter, so application should be delayed until the soil warms in the spring. Abundant organic matter in

the soil enhances garlic's performance. Raised beds might be advisable to prevent waterlogged soil over the winter. After the ground crusts over with frost in early winter, a mulch of some sort will help prevent winter damage from frost heaving, and growth starting and stopping. During early season growth, plants should be watered whenever necessary to prevent the soil from drying out. In much of temperate North America, garlic grows in the part of the year with the most dependable rainfall (Voigt, 2004).

As garlic reaches maturity, the leaves will brown then die away. This is the cue that it is time to harvest your garlic crop. If you harvest too early the cloves will be very small, too late and the bulb will have split. Once picked, it is essential that garlic is dried properly, otherwise it will rot. The bulbs are often hung up in a cool, dry place. After a week or so, take them down and brush the dirt off gently - don't wash the bulbs at this stage (Garlic-Central, 2004). Garlic should be dug while there are still at least 4 live, green leaves on the plants, since these leaves are attached to the papery wrappers on the bulbs, which quickly deteriorate in moist soil once the leaves die. Under humid summer conditions, bulbs left too long in the soil rapidly lose quality and storability. Wrapperless bulbs do not keep well. Bulbs with 4 or 5 layers of intact wrappings can be rubbed clean of dirt when they have cured and dried, leaving the cloves well covered and protected by the remaining wrappers. Garlic must be undercut or dug since it will not readily pull up out of the ground, even at full maturity (Voigt,2004) Curing and Storing: Whole plants should be moved from the field into a dark, dry, wellventilated area for drying and curing of the bulbs. Bulbs should be moved out of the sunshine as quickly as possible after digging. Do not dry by laying the plants in the sunshine. Tops and roots are allowed to remain on the drying bulbs After several weeks, drying and curing should be complete, and the unique flavors fully developed within the bulbs (Most garlics will taste fairly similar, fresh from the ground). Tops and roots can be removed once drying and

curing are complete. Depending on variety, the bulbs should store for 4-12 months, once they are properly cured. Best flavor also develops during curing. If garlic is planted fairly early in the fall, a cover crop of oats can be sown at planting time to try to provide some winter cover for the young garlic plants. In cold-season, low snow cover areas, a layer of organic mulch, applied after the ground freezes, is usually recommended for fall-planted garlic. Materials such as shredded leaves or straw can be used as mulching materials. This should stabilize the young plants, preventing frost heaving, cold injury, or premature growth in the late winter (Voigt, 2004).

2.2.7 Planting

2.2.7.1 Planting and Preliminary Actions

Although the bulbils produced at the top of the hardneck stalk can be used to produce bulbs, the process usually takes two years. In general, the size and weight of the clove planted will affect the ultimate size of the bulb formed. In a given planting of a single cultivar, bigger cloves almost always make bigger bulbs. Bulbils can be used in cooking, though they are difficult and tedious to peel. Unless these tiny bulblets are desired for faster reproduction of a garlic strain, it is usually recommended that the topsets be removed as the stalk is fully emerged and begins to uncoil. The development of the bulbils saps strength that will be transferred to the developing underground bulb if the topset is removed. Tender topsets and stems can be used in cooking, if desired. Wholesale removal of topsets is a tedious and smelly job, but will result in the production of much larger bulbs. Green garlic can be produced in much the same way that scallions are produced from onion sets. This can be a way to turn bulblets and undersized cloves left over from planting stock into a deliciously different crop. To grow garlic this way, small cloves or bulbils are planted thickly in rows, in mid to late fall, whenever garlic for mature bulbs is sown. These germinate and root well in late fall, go into dormancy through the coldest part of the winter, and start

growing and are usable very early in the spring. Plants are dug, washed, and bunched much like scallions. The whole plant, leaves and all, is then chopped for use in recipes calling for garlic. The flavor is usually more subtle and less pungent than from mature bulbs, which can be a definite plus in some dishes. When these plants start to bulb, the tops begin to toughen, so harvest should be completed before the daylength reaches the critical level, which cues the bulbing response. Garlic strains can be as unique and different as fine wines. Cooks using garlic in recipes need to become familiar with some of the more obvious differences in texture, taste, and aftertaste among all the various varieties. Just as Riesling is not an acceptable substitute for Merlot, neither is California White always a workable alternative to Spanish Roja for the garlic purist. As with chili peppers, some recipes work best when specific varieties are used. Some are hotter, some are nuttier, some are crunchier, and some hit the diner on different parts of the palate. Part of the wonder of the Filaree catalog is the detailed flavor information included in the variety descriptions. Where possible, try to match specific garlic strains to specific tastes. Like other fine edibles, certain garlics may be "in season" for only part of each year. Throughout much of North America , garlic is best planted in fall, like many other hardy bulbs, such as tulips and daffodils. If planted about 6-8 weeks before the ground can be expected to freeze (where the ground freezes), the cloves have a chance to root and grow a shoot to the soil surface in the fall. Then, in the spring, growth commences immediately, when the frost goes out of the soil, allowing lush growth before conditions would allow spring planting of garlic. In frost-free areas, plant garlic when hardy bulbs normally go into the ground (except in the extreme south where flowering bulbs are planted after a winter in the refrigerator for chilling). Garlic needs no chilling to begin growing. Except in rare early springs, garlic from spring plantings never comes close to making up the difference with fall plantings, and has to mature in the hotter, dryer conditions of

mid-summer, as well. Just prior to planting, bulbs are broken apart into individual, unpeeled cloves which should be planted 3-4 inches deep, in 36 inch rows, about 4 inches apart in the row. Care may be taken to align the cloves within the row to keep foliage uniformly arranged in the rows to facilitate cultivation. If cloves are planted with the flattened sides perpendicular to the axis of the row, the leaves will all develop in the plane of the row. This makes mechanical cultivation much easier. In situations where hand cultivation is to be used in dense plantings, the angled sides of the clove should be planted parallel to the plane of the row so that the leaves will emerge perpendicular (crosswise) in the row, allowing plants to be spaced closer without leaf interference (Voigt, 2004).

2.2.7.2 Propagation

Garlic is propagated vegetatively from the cloves in each bulb. The size of both the clove and the bulb is an important consideration when selecting planting stock. Grade your garlic for both size and quality. Discard anything that is diseased, small, soft, damaged, or discolored. This is time-consuming, but important. Crack the bulb into individual cloves. Plant cloves basal plate-side down; where winters are mild, plant cloves 1 inch deep; where winters are severe, put them 2-4 inches deep. Mulch will help improve winter survival, suppress weeds, conserve soil moisture, and prevent soil erosion. It will also increase yields by keeping the soil cooler. Garlic quits growing when the soil temperature increases above 90°F. Garlic can also be mulched with clean straw or other organic material immediately after planting. The garlic will have no trouble pushing through an inch or more of mulch. However, mulch will make harvesting by machine difficult or impossible. Garlic is often planted in raised beds for ease of digging, good soil drainage, and reduction of soil compaction In-bed spacing of 6 inches by 12 inches is best, except for the variety 'Music,' which requires a spacing of 12 by 12 inches to produce the largest bulbs. Hardneck

varieties put up a tall, woody flowering stalk or scape that grows bulbils at the top. If the plant is allowed to put its energy into these bulbils, the bulb forming below the ground will be 1/3 smaller than if the scape is cut (ATTRA, 2001)

2.2.7.3 Irrigation

Irrigation is not always required. As maturity nears, water should be withheld in areas where this is possible. In spring, two side-dress applications of nitrogen fertilizer should be made, the first about the time the soil warms enough to begin planting field corn (about 50-55° F at a 4 in depth), and the second about three to four weeks later. This will help the garlic plants to grow large and robust before they receive the daylength cue to begin bulbing in late spring.

The bigger the plants when this signal is received, the bigger the resulting bulbs will be (Figure 9). About 40-50 pounds of actual N per acre, applied alongside the rows, is recommended for each of these side-dress applications. In smaller plantings, this works out to about 1 pound of N per 1,000 square feet of garlic. If conditions become dry in the spring while the garlic is actively growing, irrigation is recommended. The plants need to make as much growth at this stage as possible. All this energy will later be transferred into the bulbs. As the plants begin to bulb and mature, added water should be avoided, to allow better rot control. Varieties that produce topsets should have these scapes removed after they emerge. This forces all the energy of the plant into the bulbs, making them significantly larger. Bulbs will usually begin to be ready to harvest from late June through much of July, depending on garlic variety and where you are, geographically (Voigt, 2004).

Most of the time garlic really likes moist (not soggy) soil. Watering regularly in the fall during germination is essential. In dry climates, watering in winter is also important. Do not let the upper several inches of soil turn to dust. When do you need to water? Try the old farmer's test of clumping a bit of soil in your fist. If the clump stays together upon releasing your fingers, it is wet enough. If not,

water. Keep on watering into the spring when the maximum green shoots are forming. Then about mid- to late June, or when the scapes (on hardnecks) are standing high, STOP. During the last four weeks, when the bulbs are finishing off, and the wrappers are drying out, too much water is not good. You can create a mold or fungus problem. Wet soil also makes for dirty and unappealing wrappers. In drier climates some people like to heavily irrigate at the pre-planting phase to help build a winter deep soil moisture reserve (The garlic store, 2003).

2.2.7.4 Fertilization:

Five cultural practice considerations or recommendations are as follows: Weeds are frequently the worst problem; garlic is a poor competitor; the crop is in the ground a long time. Avoid, prevent and control them. Garlic is a moderate user of nitrogen; it may or may not require phosphorus, depending on the soil and previous management. It rarely responds to potassium fertilizer and rarely requires micronutrients. A good compost and/or organic matter management program will satisfy most garlic nutrition needs. Up to half of the nitrogen needs should be available at planting or early in the season; another major need will occur in late winter, after rain caused leaching, and when the garlic begins its strong re-growth. No nitrogen should be applied during the last 60 days before harvest; the garlic should run out of nitrogen late in the season. Garlic can grow in a wide range of soil textures and soil pH. Fertilization, irrigation, and harvest practices may be different for each combination of situations (SFC, 2006).

2.2.8 Economic and social impact of the garlic crop

One niche market that has grown tremendously is garlic. From the eleven acres of garlic reported by the national Agriculture Statistics in 1992, New York's Garlic crop has grown to 240 garlic farms and 265 acres in 2002. Hard-neck garlic harvested in New York as a prized specialty crop must be harvested by hand. As new crops like garlic gain popularity among residents, farmers quickly adapt to meet this attraction (Noble, 2005).

U.S. garlic use has soared, hitting a record-high 3.1 pounds per person in 1999, three times the level in 1989. Despite impressive growth for vegetables such as broccoli, bell peppers, and carrots, no other vegetable has experienced stronger growth in demand over the past 10 years. The strong surge in use during the 1990's likely reflects: rising popularity of ethnic foods and restaurants, persistent publicity

about the health benefits of garlic, and demand from the health supplements industry. Vigorous demand has resulted in a doubling of U.S. garlic production over each of the last two decades. Output was record high in 1999, and wholesale garlic prices this spring are a third lower than a year earlier. Farm value of the U.S. garlic crop is about $200 million.

The trend in garlic use is unique among vegetables in that demand has not only increased steadily over many decades but has grown at an increasing rate. Also, despite impressive growth for vegetables such as broccoli, bell peppers, and carrots, no vegetable has experienced stronger growth in demand over the past 10 years. The strong surge in use during the 1990's likely reflects several factors:

- rising popularity of ethnic foods and restaurants;
- persistent health messages circulating in the press about garlic;
- demand from the health supplements industry; and
- The never-ending quest by consumers for new taste experiences.

These demand factors reflect a broadening view of garlic as a "functional food"--one that imparts both the usual taste and nutritional attributes of food, plus certain perceived healthenhancing benefits (broccoli is another example of such a food). Used primarily in cooking to flavor a wide variety of foods, garlic provides vitamin C, potassium, phosphorous, selenium, several amino acids, and a variety of sulfur compounds, including allicin--a naturally occurring compound whose promising health effects are now being studied at several major universities. Garlic has proven itself as a popular food and nutrition item, and is gaining scientific credibility as a significant contributor to good health. Garlic and its benefits are solidly launched, and U.S. production and consumption are likely to continue to grow in the next few years (Agricultural outlook, 2000).

2.2.9 Medicinal uses

Garlic is taken orally to reduce high blood pressure, prevent heart disease and artherosclerosis, treat earaches, stimulate both the immune and circulatory systems and prevent cancer. Other applications include treating diabetes, arthritis, colds and flu, fighting stress and fatigue and maintaining healthy liver function.

Various official monographs list garlic as being both antibacterial and antimycotic

(Suppresses the growth of certain fungi. Consequently garlic is administered to treat *Helicobacter pylori* infections, and to inhibit the growth of *Candida albicans*, particularly in cases of recurrent yeast infections.

Parasitic worms are also apparently susceptible to garlic. The World Health Organisation ―Monographs on Selected Medicinal Plants‖ reports garlic has having been used to treat roundworm (*Ascaris strongyloides*) and hookworm (*Ancylostoma caninum* and *Necator americanus*) infestations, listing allicin as the active anthelmintic constituent.

The United States Department of Agriculture lists garlic as being a viricide on its Medicinal Plant Database.

The garlic bulb contains an amino acid derivative called alliin which is in fact odourless and contains no antibacterial properties. However when the garlic bulb is crushed or ground, alliin comes into contact with an enzyme (alliinase) that converts the alliin into allicin.

Allicin is the reason for garlic's distinctive odour, and is a potent antibacterial agent

The use of garlic in history goes back thousands of years, with Hippocrates, Galen, Pliny the Elder, and Dioscorides all reporting its use for various conditions, including parasites, low energy, and respiratory and digestive disorders. Garlic's reputation in Western medicine was established in 1858 when Louis Pasteur confirmed its antibacterial properties.

Traditional Chinese medicine has used garlic since at least A.D. 510, and is still using it for amoebic and bacterial dysentery, tuberculosis, scalp ringworm and vaginal trichomoniasis. Other folk medicine cultures have traditionally used garlic for treating colds and flu, fever, coughs, headache, hemorrhoids asthma, arterioscelrosis, low blood pressure, both hypoglycemia and hyperglycemia, cancer and as an aphrodisiac (amongst other things), Garlic has also been used to treat pinworms ,the antiparasitic nature of garlic is demonstrated in the uses to which it has been applied in folk medicines around the world. For example, it has been traditionally used to treat parasitic worms in such diverse cultures as East Asia , India , Italy , North America , Peru , Saudi Arabia , Tunisia and the West Indies . Traditional practitioners in Greece have long used garlic extracts to protect against amoebic infections Laboratory tests (both in test tubes and in animals) have demonstrated that fresh garlic has antimicrobial activities (including antibacterial, antiviral, antifungal, antiprotozoal, and antiparasitic).

Particular activity against *B. subtilis, E. coli, P. mirabilis, Salmonella typhi,* methicillinresistant *Staphylococcus aureus, Staphylococcus faecalis, Salmonella enteritidis,* and *Vibrio cholerae* have been noted,Bacteria shown to be susceptible to garlic in the test tube include species from *Staphylococcus, Escherichia,*

Proteus, Salmonella, Providencia, Citrobacter, Klebsiella, Hafnia, Aeromonas, Vibrio and *Bacillus* genera . Human trials as well as in vitro studies have shown that garlic consumption is active against *Mycobacterium tuberculosis*.

An epidemiological study in China among 214 people from the Shandong province suggested that garlic consumption may have a protective effect against H. pylori infection and the development and progression of precancerous gastric lesions .

Fungi demonstrated to be susceptible to garlic in lab tests include the genera *Microsporum, Epidermophyton, Trichophyton, Rhodotorula, Torulopsis, Trichosporon, Cryptococcus neoformans,* and *Candida,* including *Candida albicans*. It is reported that garlic is more effective against pathogenic yeasts than nystatin, especially *Candida albicans*.

Essential garlic oils were active on *Entamoeba histolytica* in clinical trials, confirming its potential for antiamoebic activity.

Antiprotozoan activity has also been demonstrated in lab tests against *Paramecium caudatum*. Garlic has also shown itself in lab tests to have several immune-enhancing effects. Fresh garlic, garlic extracts, oil and oleoresin have been generally recognized as safe when consumed in amounts commonly found in food. Garlic has been used for medicinal purposes in clinical studies lasting up to 4 years without reports of significant toxicity. It is possibly unsafe when consumed in large amounts, with the American Herbal Products Association Botanical Safety Handbook claiming that high doses could be dangerous or even fatal for children. There are, however, no reported cases of significant adverse reactions or mortality in children associated with the ingestion of garlic.

There are no published reports of garlic adversely affecting pregnancy, although it would be wise to avoid consuming large amounts during these times (Theoretically large amounts of garlic might act as an abortifacient causing uterine contractions). There is a lack of reliable information dealing with the use of garlic while breastfeeding, but it has been generally accepted that consuming it in amounts commonly found in food would be safe. By- products

The sulfur compounds that give garlic its trademark odor are probably also responsible for its benefits. Crush a garlic clove and you start a chemical reaction that produces allicin, an antibacterial compound that has killed nasty stomach bugs in laboratory tests. Allicin and its byproducts might help protect the heart by lowering cholesterol levels and thinning the blood (Healthyme, 2006).

2.2.10 Effect of Garlic plant on tuber rots fungi

The treated potato tubers and carrots when inoculated with the respective test fungi and treated with the plants extracts, the degree of reduction or protection of the tubers from rot by the plant extracts varied and was highly significant ($p<0.05$) after incubation the highest rot reduction in potato was seen with P. guineense which showed 91.70% reduction on G. candidum than A. Sativum (81.76%) on F. solani. A combination of P.guineense and A. Sativum also reduced potato tuber rot (84.47%) while A. flavus was the least susceptible to the extracts. However, there was no significant difference on the activities of all the extracts on A. flavus. The present result is similar with the findings of Okigbo et al. (2009) who recorded high rot reduction (62.80%) with A. sativum and also Udo et al (2001) reduced the growth and sporulation of fungal pathogens on sweet potato and yam with garlic (Allium sativum). (Amaeze, et al., 2013).

The highest rot reduction in carrot (87.06%) was observed with the combination of P. guineense and A. sativum on F. oxysporium than A. sativum on F. solani (85.61%). However all the extracts reduced rot of Carrot caused by R. carotae greatly with no significant difference and also A. sativum with a combination of P. guineense and A. sativum reduced rot of Carrot with no significant difference. However the lowest rot reduction was observed with P.guineense on F. oxysporum while the control recorded highly significant unlimited rot development. Studies by (Ilondu and Iloh 2007) and also (Eruteya and Odunfa ,2009) have also confirmed that extracts of P. guineense prevented the growth of the fungi such as A. Niger, Rhizopus stolonifer, Fusarium solani, Colletritichium sp., Pythium sp. and Cladosporium herbarium.

The present study showed that A. sativum and P. guineense both have fungitoxic substance and potential to protect Potato and Carrot against rot fungi especially rot caused by G. candidum with a synergetic effect on F. oxysporum of Carrot by combining the two extracts. Several other works have confirmed the antimicrobial activity of garlic against a broad spectrum of fungal and bacterial organisms (Shashikanth et al., 1981; Gond we et al., 1996; Shenge, 2002; Amodu, 2006). The antimicrobial properties of garlic have been attributed to the presence of an essential oil that contains allyl disulphide (C6H2 S2) diallyl disulphide (C6 H10S2) and two or more sulphur-containing compounds (Shenge 2002; Obagwu, 2003).

The use of synthetic fungicides can be harmful to both farmers and the environment. This problem can be prevented by the use of biological methods

which can provide an alternative way of reducing and controlling rot of tubers as it is less expensive, economically safe, non-phytotoxic and easy to prepare. (Amaeze, et al., 2013)

2.2.11 Garlic as a pesticide

Effective pesticides have been developed from garlic extracts. Field trials carried out on mosquito breeding sites at Bombay (now Mumbai, India) have shown that garlic oil is very effective on several species of mosquitoes. Amonkar & Reeves (1970) studied the toxic effect of crude methanolic extract and garlic oil against 3rd stage of larvae of *Culex peus*, *C. tarsalis*, *Aedes aegypti*, *A. trisoriatus*, *A. sirensis* and 3rd and 4th stage larvae of highly insecticide resistant strains of *A. nigromaculis*. They reported that partially purified oil fraction was more toxic than the crude extract. Later, the larvicidal principles of garlic oil have been isolated and identified as diallyl disulfide and diallyl trisulfide (Amonkar & Banerji, 1971). Allicin inhibited malaria infection by inhibiting cysteine protease, which processed circumsporozoite protein (CSP) of *Plasmodium sporozoites* for invasion of host cells (Coppi *et al.*, 2006). These compounds were fatal to *Culex pipiens quinquefasciatus*. Nakagawa *et al.* (1980) reported that raw garlic juice at a dose 5 ml/kg body weight caused death of rats due to stomach injury. Gupta & Sharma (1993) have observed that root-dip treatment for tomato seedlings in 25 ppm allicin for 5 min is effective against nematode *Meloidogyne incognita*. Concentration of 200 and 100 ppm allicin as bareroot dips for 30 min killed 83% and 87% of *M. incognita* of tomato seedlings, respectively. Gareth *et al.* (2006) reported that the insecticidal activity of garlic juice in two dipterian pests *Delia radicum* (LC_{50} - 0.4%) and *Musca domestica* (LC_{50}- 2.2%). They reported that garlic juice is effective against all the life stages of both insects.

Ajoene, the major bioactive compound derived from garlic, showed a potent leishmanicidal activity in *in vitro* against *Leishmania mexicana* and *L. donovani* (Ledezma *et al.*, 2002). The 50% inhibitory concentration (IC_{50}) for lysis was about 2 μM. They reported that leishmanicidal activity of ajoene is due to the morphological alteration of the mitochondrial membrane and nuclear envelope, as well as the formation of large autophagic vacuoles. Gamboa-Leon *et al.* (2006) suggest that garlic extract has mild protective effect against *Leishmania donovani*. This might be due to unspecific enhancement of interferon-gamma secretions. The homopteran sucking insect *Lipaphis erysimi* (mustard aphid) causes severe damage to various crops. This pest not only affects plants but it also transmits single-stranded RNA luteoviruses while feeding, which cause disease and damage in the

crop. The mannose-binding garlic leaf lectin has been found to be a potent control agent of *L. erysimi* on one hand and on the other symbionin mediated luteovirus transmission (Banerjee *et al.*,2004).

Singh & Singh (1993) reported that the water extract of garlic bulb is a potential source of molluscicide against *Lymnaea acuminata* and *Indoplanorbis exustus*. These snails are the intermediate host of liver fluke *Fasciola hepatica* and *F. gigantica*, which causes 94% fascioliasis in the buffalo's population of northern India (Singh & Agarwal, 1981; Singh & Agarwal, 1983). Singh & Singh (1995) characterized that allicin is the main molluscicidal component of garlic. The toxicity of allicin (LC_{50} 3.64 mg/l) at 96 h exposure is 4.1, 4.2 and 2.5 times higher with respect to synthetic molluscicides (phorate, carbaryl and formothion, respectively) (Singh & Agarwal, 1983). There was a progressive increase in the toxicity (8.67 fold) of garlic bulb extract against *Lymnaea acuminata* in the pre-harvest (2 to 5 months) period while in the post-harvest period (5 to 11 months) it was 5.5 fold (Singh & Singh, 1996a). Significant increase in toxicity of pre-harvest garlic is due to increase in level of alliin. Increase in molluscicidal activity of garlic in post-harvest period is due to some changes in the chemical composition of garlic bulb (Lawson *et al.*, 1991b). Singh & Singh (1996b) demonstrated that the treatment of snail with sublethal concentrations of allicin caused a significant inhibition of acetylcholinesterase (AChE), lactic dehydrogenase (LDH) and alkaline phosphatase (ALP) activity in the nervous tissue of *Lymnaea acuminata*. Kinetic studies demonstrated that the inhibition of AChE by allicin was uncompetitive whereas inhibition of LDH and ALP was competitive (Singh & Singh, 1996b). Inhibition of this enzyme by allicin in the nervous tissue of snail *L.acuminata* may be the cause of the molluscicidal action of garlic Singh & Singh (1997), Singh *et al.* (1998), Singh & Singh (2000a,b), Singh & Singh (2001a,b) and Tripathi & Singh (2001) have reported that combinations of garlic bulb powder with *Cedrus deodara* oil, *Annona squamosa* seed, *Lawsonia inermis* seed, *Punica granatum* bark, *Canna indica* root powder, piperonyl butoxide and MGK-264 are very effective molluscicide. These combinations were effective in reducing the fecundity, hatchability and survival of young snails (Singh & Singh, 2004). Singh &Singh (2000b) have clearly demonstrated that these effects of garlic powder were due to inhibition of certain enzymes and alteration in brain biogenic amine levels in the nervous tissue of *L. acuminata*. Mantawy & Mahmoud (2002) observed that glucose and glycogen levels and phenol oxidase activity in snail *Biomphalaria alexandrina* were significantly decreased after 2 and 7 day of feeding on garlic, which ultimately reduced the fecundity of snails. Spraying of garlic powder (24h

LC_{50} - 7.24%) singly and in combination with *Cedrus deodara* (24h LC_{50}- 4.18%) were toxic, as well as effective in controlling the reproductive capacity of the giant African snail *Achatina fulica* (Rao & Singh, 2000, 2002; Rao *et al.*, 2003). Allicin, the active molluscicidal component of garlic (Singh & Singh, 1995), is effective in killing snails as well as making them sterile (Singh & Singh, 2000a).

2.3 Penicillium App:

Scientific classification:

Kingdom: fungi

Class: Deuteromycetes

Order: Eurotiles

Family: Ascomycota

Genus: penicillium (Link, 1809)

Penicillium as well is a large genus containing 150 recognized species, of which 500 or more occur commonly many species of penicillium are isolated from foods causing spoilage in addition, some may produce bioactive compounds, important mycotoxin produced by penicillium include ochratoxin A patulin, citruin and penitrem A , some of the most important toxigenic species in foods are *penicillium curstosum*, *penicillium expansum*, *penicillium citrinum*, and *penicillium verrucosum*, a much larger number of *penicillium aurantiogriseum penicillium chrysognum*, *penicillium digitatum*, *penicillium griscofulrum*, *penicillium italicum*, *penicillium oxalicum* and *penicillium viridicatum*, some of those produce mycotoxins however penicillium species are associated more with cool temperate and temperate crops, mainly cereals since most species do not grow very well above 23-30 C (Pitt,2006)

CHAPTER THREE

Materials and Methods

3.1 Site of Study

This study was conducted in the laboratory of plant pathology, Department of Plant Protection, College of Agricultural Studies, Sudan University of Science and Technology during October, 2017.

3.2 Preparation of garlic

Garlic was brought to the laboratoryof plant pathology. After complete samples were crushed separately to obtain fine extract for extraction.

3.3. Aqueous extract preparation.

The obtained fine powder garlic form each plant was weighted (1kg) and placed in 100 ml conical flask each and completed to 500 ml sterilized distilled water to obtain the three concentrations and it was placed in a shaker for 4 hrs. The extracts were filtered over night to obtain 25 % 50% and 100% concentrations.

3-4: Statistic analysis:

The obtained data was statistically analyses by mustatc microcomputer program according to analysis of variance (ANOVA); -Duncan's Multiple Range Test was used for mean separation.

Plate (1): Laboratory Equipment's:

Plate (A): Autoclave

plate (B): Sensitive balance

Plate(C): cylinder

plate (D): Flask

Plate (E): distil water

plate (F): Petri dish

Plate (G): Aluminum foil

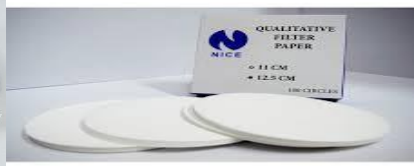

plate (H):Filter paper

Plate (2) Experiment Materials:

Plate (I): The Petri dish of the experiment

CHAPTER FOUR

RESULTS

4.1. The effect of garlic aquatic extraction on the growth of (*penicilliumsp*):

The result obtained by this experiment indicate the effectiveness of the different concentrations of the garlic extract on the *penicilliumsp* shows that the extraction has a higher effectiveness of the reducing the germination of the fungi.

The highest inhibit rate of the fungi has been founded in the concentration (100%), and it was (1.17), therefore the second reduction was in the concentration (50%), hence the last reduction rate founded within the within the concentration (25%), compering all the previous concentrations with the control it had the highest growth between them and compering them with the pesticide (Fulldazin) which has been used with them the inhibition percentage was (100%).

Table (1): The effect of garlic aquatic extraction on the growth of (*penicilliumsp*):

Concentrations	Mean
25%	2.16
50%	1.88
100%	1.17
Pesticide	0.00
Control	2.94
C.V%	65.20%
S.T.D	1.06

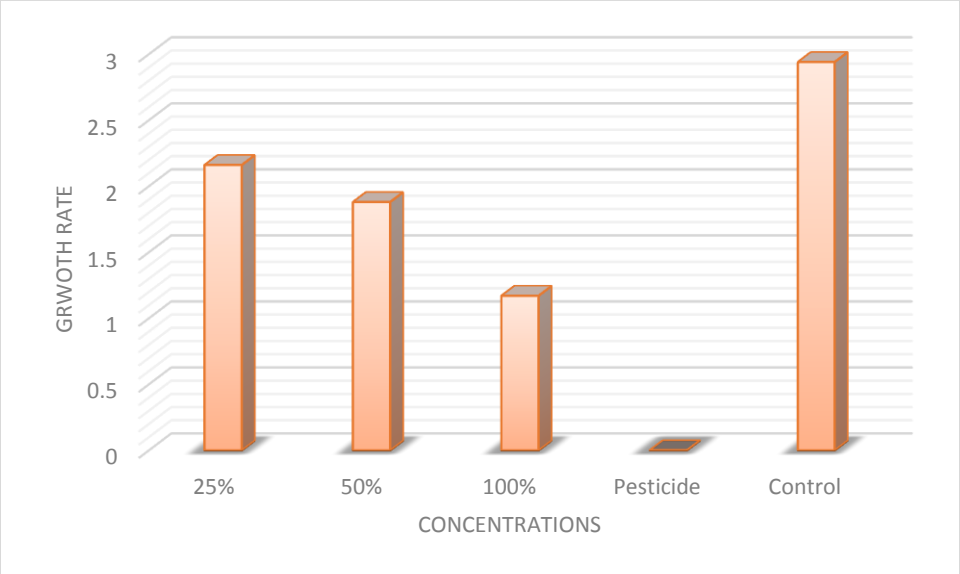

Figure (1): The effect of garlic aquatic extraction on the growth of (*penicilliumsp*)

CHAPTER FIVE

DISCUSSION

Comparing between the aquatic extractions of the garlic it has been founded that the outperform to reduce the growth rate was (1.17) and the other highest inhibit was founded in the less concentration (1.88), therefore the less inhibit within the less concentration (2.16), so as we can noticed that the effectiveness of reducing the growth of the fungi going gradually according to the concentrations that has been used.

Taken the pesticide in the consideration it has the absolute mortality rate on the growth of the fungi and the control lastly compering with them it has the highest growth among them of inhibiting the growth of the fungi.

Therefore the more we use the highest concentration of the extraction, the more we find the growth of the fungi has been inhibit.

Conclusion:

Garlic extraction obtained an effectiveness of reducing the growth of the *penicillium sp***.**

The highest concentration (100%) that has been used of garlic extraction

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