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RESEARCH ARTICLE

APHIS CRACCIVORA CONTROL BY OCIMUM GRATISSIMUM OIL

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ABSTRACT

The pests control in agriculture are increasingly complex, the irrational use of products can cause environment pollution and the production cost increase. The aphids are insects and when they eat plant they can cause direct damages, that´s because sap sucking, and direct damages, by sick transmission by toxin injections. The essential oils of aromatic and medicinal plants whit insecticidal, fungicidal and bactericidal properties lead to promising ways and as result a "clean" agriculture, free of pesticides. For the purpose to contribute with the knowledge generation about the action of the essential oils in the pest insects was the objective of this work, study the essential alfacava (*Ocimum grtisssimum)* oil efficiency in the control of black aphid (*Aphis craccivora)*. The experimente was performed in the Entomologia e Apicultura Lab in the Instituto Federal de Educação, Ciência e Tecnologia da Paraíba, campus Sousa. The design was completely randomized and consisted in four treatments: T0 water + 0,5% of neutral detergent (control); T1 0,5% of essential oil + 0,5% of neutral detergent "diluted with water"; T2 1% of essential oil + 0,5% of neutral detergent; T3 2% of essential oil + 0,5% of neutral detergent. Ten repetitions were done for each treatment every repetitions had ten insects. The first insect mortality analysis was made twenty-four hours after the alfacava essential oil application and the second one with forty-eight hours. All the treatments presented significant insect mortality rates by Tukey test. At a concentration of 0,5% of alfacava oil essential it was noted be enough to cause an average aphids mortality of 90%, making it preferable to use since there was not significant changes by the F teste of ANAVA between this one and the higher concentration, therewith reducing product application costs with high efficiency.

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INTRODUCTION

Although the agriculture is practiced by humanity for over ten thousand years, the intense use of pesticides to control pests and crop diseases exist just over a century ago. It was originated after the great world wars, when the chemical industry of poisons so used as chemical weapons found in agriculture a new market for their products (LONDRES, 2011).

As the intense use of pesticides in Brazil from the 70's through the agricultural credit stimulus policy and the loan conditioning to the use of inputs in the crops, show up the increasing of domestic and wild animals mortality, ground and water contamination and a lot of others factors that affects, directly and indirectly, the health of developed communities in food production around the world (ROEL, 2001; LIMA, 2008).

According to the dossier published by Associação Brasileira de Saúde Coletiva Abrasco (2012), in the last three years the Brazil has been occupying the higher pesticides consumer place of the world. The impacts to the public health are wide because they reach vast territories and involve different population groups as workers in different types of activities, residents around factories and farms, besides all of us who eat contaminated food. These impacts are associated to our actual model of development, focused primarily to the production of primary goods for export.

According to the Agência Nacional de Vigilância Sanitária (ANVISA) while in the past ten years, the world pesticide Market grew 93%, the Brazilian Market grew 190%. In the last crop, that involves the second half of 2010 and the first half of 2011, the national Market of pesticides sales moved 936 thousand tons of products, being 833 thousand tons produced in the Country, and 246 thousand tons imported (ANVISA & UFPR, 2012).

To Boziki *et al*. (2011) the pesticides are the principal pollutants of the actual agriculture model. The poison are not limited to a local, in spite of they are applied in a given area. The contamination of natural resources by the improper use of pesticides became a serious problem of public health and environment pollution.

Ribas & Matsumura (2009), emphasizes that, the effects of pesticides in human health could be from two types: 1) acute effects, those resulting from exposure to concentrations of one or more toxic agents, capable of apparent effective damage within 24 hours; 2) chronic effects, or those resulting from a continued exposure to relatively low doses of one or more products.

The growing concern of society about the side effects of pesticides, such as applicator toxicity, environmental pollution and the presence of residues in foods, has encouraged researchers to develop studies with new ways of alternative pests control, such as the use of insecticides of plant origin (ALMEIDA *et al*. 2004; TAVARES & VENDRAMIM, 2005);

The persistent challenge of agriculture is the obtaining of high levels of crop productivity in response to the growing demand for agricultural products determined by the need for internal supply and foreign exchange generation through the export of these products. Among the obstacles of agricultural activity stands out the productivity loss of the crop caused by pest insects that, in the agroecosystem, find the favorable conditions to grow (CARVALHO, *et al*.,2011).

Knowing the impact of insects on crop growth and yield and the conditions that favor the increase of their populations are essential for proper pest management in the farming (EMBRAPA, 2006).

According to SANTOS (2012), the pests control in agriculture is every time more complex, the use of products in an irrational way can cause the intensification of the pests attacks; selection and the appearance of resistance; environmental pollution and elevation of production costs.

The aphids that attack plant are insects that when they eat can cause direct damages, because of sap suction, and indirect damages, by the sick transmission and by the toxin injection (SALVADORI, 1999). When it is about virus transmission, the simple presence of an aphid can be characterized as pest and deserve lots of attention because of the hard control and the wide potential for multiplication (LIRA, 2005).

The sucking action of aphids causes leaf curling; their edges turn downward and has deformation in the buds. Because their food is exclusively of sap, these insects eliminate large amounts of a sweet liquid from which ants feed that, in contrast, protect them from natural enemies. (EMBRAPA, 2003).

Many species of aphids (Hemiptera, Aphididade) are find in the cultures depending on the season, the year and the region (EMBRAPA, 2009). The aphids are distributed all over the world and attacks diverse cultivations how: corn (*Zea Mays*), sorghum (*Sorghum bicolor L.*), wheat (*Triticum aestivum,* L), sugar cane (*Saccharum officinarum*, L), citrus fruits, cotton (*Gossypim hirstum*, L), coconut (*Cocos nucifera*) e *Gliricideasepium* (WAQUIL, 1995).

The cowpea (*Vigna unguiculata*) which grains are of high food biological value and are cultivated by family farmers in the North and Northeast of Brazil is one of the principal cultivation that suffers with black aphids (*Aphis craccivora)* attacks (DANTAS *et al*., 2002).

One way to control the black aphids (*A. craccivora)* in the cowpea (*V. unquiculata)* is the use of botanical insecticides that are compounds resultants from the plants secondary metabolism, being accumulated in small proportion in various plant tissues (LUCCA, 2009).

According to Costa *et al*. (2009), the alfacava essential oil (*O. gratissimum)* have insecticides, repellent and antimicrobials properties. Your use in the biological control has been shown as a sustainable alternative for the use in behavior study and in the pest

insects' mortality, including predators and parasitoids.

The fix essential oils or even the aromatic and medicinal plants extract with antibiotic properties, lead to promising ways and as result a "clean" agriculture, free of pesticides. For the purpose to contribute with the knowledge generation about the action of the essential oils in the pest insects, was the objective of this work, study the essential alfacava (*Ocimum gratisssimum)* oil efficiency in the control of black aphid (*Aphis craccivora)* evaluating if it can be a sustainable alternative for rational control of this insect.

This study consists of five chapters. The first chapter addresses the introductory aspects of the work and its objectives. The second, theoretical reference about the botanical features of the Alfacava plant (*O. gratissimum)*, importance of the essential oils in the black aphids (*Aphis craccivora*) control, the cowpea (*Vigna unguiculata)* and host plants of this insect. The third one describes the methodology that was used for the work. The fourth presents the results and the discussions about the efficiency of the Alfacava essential oil (*O. gratissimum*) application in the mortality of black aphid. The fifth chapter is going to be presented the conclusions and the final considerations about the studied subject.

Brazilian flora is considered the richest in the world in biodiversity, containing about 23% of existing plant species on the planet. The Brazil has more than 55 thousands of plant species, which 10 thousand can be considered medicinal, aromatic or useful. In the medicinal plants national market, hundreds of them, the natives and exotics, are economically explored (CASTRO *et al*., 2009).

The Alfacava, (*Ocimum gratissimum)*, originating plant from the Asian continent, is very used in the home medicine in the form of baths and teas and very appreciated as condiment. The plant is an aromatic undergrowth that grows, without big problems, all over the Brazil. Can hit until 1 meter high, with oval leaves and jagged edges, varying from 4-8 centimeters high, and inflorescence with little flowers and purple in color. Its propagation is, mainly, by cuttings taken from the stem of the plant (JORGE, *et al*., 2006).

The specie (*O. gratissimum)* was bring to Brazil by the African slaves, with the purpose of preserve the traditional African medicine, and it became natural real fast in the Country. It is a plant that presents big number of essential oils, secondary metabolic with super antioxidant action, acting on lipid peroxidation inhibition and free radical neutralization (PEREIRA & MAIA, 2007).

The great interest in (*O. gratissimum*) is due to the constituents of its essential oil, presents in superficial glandular trichrome (GANG *et al*., 2001). SILVA *et al*., (2005) highlights that the majority component of the Alfacava essential oi is the eugenol that varies according to the growing conditions, plant development status and chemo type.

Ocimum gratissimum is a big producer of essential oils, presenting aromatic compounds that are widely used by pharmaceutical industry because contains eugenol (70-80%) and geraniol (80-90%). Plants extracts are used in traditional medicine in rheumatism treatments, paralysis and metal illnesses, besides contains active biological substances that are naturally used as insecticides, nematicide, fungicide and local antiseptic (EGGRAIM *et al*., 2001).

Alvarenga (2010) says that the vegetal development is influenced by nutrient availability, light, temperature and water in appropriate proportions. This group of factories allied to genetic of the cultivated plant will determine the productivity of a crop; so that changes occurred in them will contribute to the fall or increase of production.

The Alfacava (*O. gratissimum)* crop with temperatures between 20 e 30ºC provides higher leaf thickness and higher density of glandular trichrome, producers of essential oil. The quantity and quality of solar radiation can be modulated to obtain desirable anatomical characteristics directly associated to the essential oil production, influencing your medicinal potential and commercial value (MARTINS *et al*., 2009).

According to Minami *et al*., (2007), the lighter and looser soils with good fertility, high content of organic matter and good drainage favor the Alfacava cultivation. He points out that, any type of grounds can be used to cultivate the species mentioned, as long as you make a correction to hit a pH value between 6,2 and 6,6 and the incorporation of organic matter.

Costa Filho *et al*., (2006) studying the influence of different water regimes (0%, 50%, 75% e 100% of available water) about the growing and the developing of *O. gratissum* concluded that the plant is too influenced by water and thermal availability. With the water regime close to the field capacity of the soil, the plants have their growth and productivity accelerated. He points out that there is little information regarding the quantity of water absorbed by the plant daily.

Cuttings propagation is considered an important tool in the improvement of woody and herbaceous species, especially in the cultivation of medicinal plants (EHRLERT *et al*., 2004). In the Alfacava (*Ocimum gratissimum)* culture, Sousa *et al*., (2005) state that the basal stake is the best form of vegetative propagation of the species, and that the soil vegetable substrate provides better dry matter production and rooting of all studied stakes (apical, median and basal).

The use of insecticides in pests control in agriculture as, organophosphate, organochlorines, pyrethroids, fungicides, dithiocarbamates, phenoxyacetic herbicides, dipyridyls, fumigants methyl bromide e aluminum phosphide presents a series of problems, environmental contamination, presence of high levels of food waste, biological imbalance, because the elimination of natural enemies and the emergence of resistant insect population. All of these pesticides can and determine acute poisoning, chronic

adverse effects and diseases of various kind, many times lead the infected individual to death be abruptly (acute), or insidious (chronicles) (TRAPÉ, 2003).

The search for new alternatives of phytonematoids control is, currently, a worldwide concern, giving priority to the biologically active natural substances use (SILVA, 2006). The essential oils can be used as raw material in fine chemical industry, to direct application in products like perfumes, fragrances and cosmetics, or by transformation into structural derivative products for use in the drugs industry (phytopharmaceuticals) or veterinary and horticulture (insecticides, fungicides, bactericides, larvicide) (PEREIRA, 2012)

According to Minami & Barraca (1999), the essential oils are volatile, refrigent, odor-characteristic liquids. Accumulate in certain tissues within cells or reservoirs of essence, under the epidermis of the hair, the glands or in intracellular spaces. They are extracted from fresh or dried plant by steam distillation, pure and simple extraction or other techniques (by pressure, by fat absorption). They play an important role in attracting pollinating agents, defense against herbivores, as regulators of the rate of decomposition of organic matter in soil and as antimicrobial agents (PEREIRA& MOREIRA, 2011).

According to Wolffenbuttel (2007), the chemical composition of the essential oils depends on several factors, especially the plant origin, that is why each oil has a specific chemical composition. The essential oil is composed of over 300 different chemical components, which makes it such a valued product.

From the agro ecological agricultural production perspective, a viable alternative for pests control is the use of secondary metabolites present in some plants, which are called insecticide plants. Many substances from secondary metabolism products of these plants can be found in the roots, leaves and seeds, among them rotenoids, pyrethroids, alkaloids and terpenoids that can interfere in the metabolism of other organisms, causing variable impacts as repellency, food and oviposition deterrence, sterilization, metabolism block and developmental interference without necessarily cause death (MACHADO *et al*., 2007).

Linard (2008) points out that, the eugenol chemical constituent (4-allyl-2-methoxyphenol), found in Alfacava (*O. gratissimumI*) essential oil has been arousing the interest of scientists because your lip solubility, low toxicity and biological activities.

For Tangerino (2006) the eugenol is an important and recognized antimicrobial agent extracted from clove and from Alfacava that has analgesic properties and antibacterial qualities. Because it is a phenolic compound, the release of protons from its structure denatures the bacterial cell wall causing the death of the microorganism. He also points out that Brazil is nowadays a huge exporter of eugenol; however, the country does not use this bioactive principle in fine chemistry for the production of materials intended to the medical field. It is a recognized fact that the medicinal plant are the basis for the development of phytomedicines or obtaining products with high market potential and benefit.

The essential oils represents a viable alternative to plants protection and are potentially useful in crop disease management, especially in organic agriculture, because they are important in defending plants against microorganisms and predators (OKA *et al*., 2000; SALGADO *et al*., 2003).

According to Pereira (2005), the paraibana Caatinga is rich region in plant and inset biodiversity, varying its biological and physiological activities according to the season of the year. Studies about this plant biodiversity have been made and described occurrences of great biological value that can provide interesting resources for the national economy and for the local biodiversity preservation.

The Aphids are small insects (from 1 mm. to just over 5mm.), usually of damp, oval or piriform body, uniformly colored (green, yellow, orange, violet, brown or black), or presenting area of dark brown or black color. Generally, they are polymorphic, introducing itself, when completely developed, by three main forms: winged, provided with more or less developed teak and apteras (LIMA, 1942).

According to Salas *et al*. (2003), the aphids are important sucking insects as pests of plants grown in many regions of the world, particularly in the temperate zone, because of the large multiplication capacity and polyphagous feeding habit of many species. The main problems that these insects cause to crops can be divided into: a) direct damages because of their feeding on the host plant resulting in subsequent nutrient withdrawal and, b) indirect damages, involving the transmission of phytoviruses, toxicogenic action by substances introduced through the saliva and even the favoring of saprophytic fungi (fumagine) that grow on aphids sugary droppings (honeydew).

The aphids' reproduction is by parthenogenesis that are the type of reproduction from virgin females in which the eggs undergo full development, without being fertilized. It is called telitoca when it originates only females, like is the case of the aphids in regions of tropical climate, as occurs in the Northeast (GALLO *et al*., 2002). The reproductive capacity by parthenogenesis leads to aphids hit high population levels and, in the winged form migrate settling in other areas. The damages caused by them is due to its food form, because when they suck the sap of the plant inject saliva that has phytotoxic effect and transmit pathogens (ZANINI, 2004).

The aphid's life cycle lasts, around, 5 to 20 days, during this period each individual has the reproductive power of 100 to 120 descendants. The nymph period has four instars lasting one to three days totaling from 4 to 12 days its nymph stage (PAPA, 2006).

The aphid is a sucking insect of plant sap, found in large numbers of young shoots and leaves. When they suck the final part of the branches, they

cause their withering and death, which lead the plant to emit lateral shoots. It is common for aphids to attack flowers and fruits without formation (BARBOZA, *et al*., 1996).

According to Araújo (2007) the aphids are the most responsible for the virus transmission from one plant to another, being its main hosts the plants of the cucurbit and legume family.

The *Aphis craccivora* belongs to the Aphididae family, are small insects, around 2 mm long, blackish in color. Adult females have a bright black abdomen and are usually apeterous. The larvae are grayish and slightly powdery, live throughout the year, without producing sexual forms, this is the apteric and winged forms present, they are viviparous parthenogenetic females. They live in colonies, under the leaves, young shoots and flowers (SANTOS *et al*., 2001).

The black bean aphid (*Aphis craccivora*), Hemiptera: Aphididae is a cosmopolitan pest that feeds on several plant species, especially Fabaceae (RAKHSHANI *et al*., 2005). This pest sucks the sap of the plant from the terminal buds and leaf petioles and is still a vector of pot virus. When the attack happens on young plants, it causes intense leaf deformation, delay in plant development, and may cause its death (QUINTELA, *et al*., 1991). According to BLACKMANN & EASTOP (2007), this aphis attacks about 50 plants of 19 families and is a vector of approximately 30 viruses.

The cowpea (*Vigna unguiculata*) is legume belonging to the Dicotyledoneae class, Fabales order, Fabaceae family, Faboideae subfamily, Phaseoleae tribe, Phaseolinea subtribe, *Vigna* genus and (*Vigna unguiculata*) species. It is an herbaceous, autogamous and annual plant who is most likely source regions is western and central Africa. It is one of the best-adapted, versatile and nutritious legumes among cultivated, being an important food and key component of production systems in the dry regions of the tropics, covering part of Asia, the United States, the Middle East and Central and South America (SINGH *et al*., 2002).

The cultivation of cowpea (*V unguiculata*) also known as "string bean" occurs in the northern and northeastern regions of Brazil, predominantly of subsistence, by the rural population and, in a minor scale, by the urban, thus, a product of great socioeconomic expression for these regions (GALVÃO, *et al*., 2012).

The *Vigna unguiculata* is an excellent source of protein (about 23% - 25%) amino acids, carbohydrates (about 62%), vitamins and minerals, besides of having a large amount of dietary fiber, low fat (2% oil content) and contain no cholesterol. It represents staple food for low-income populations in Northeastern Brazil. It has a short cycle, low water requirement and rusticity to develop low fertility soils, and symbiosis with bacteria of the Rhizobium genus has the ability to fix nitrogen from the air (ANDRADE JÚNIOR *et al*., 2002).

Many factors may influence in the production of cowpea: cultivars, crop practices, soil type and especially the occurrence of pests and diseases (MORAIS & RAMALHO, 1980).

According to Lima *et al*. (2002), insects that cause damage to cowpea (*Vigna unguiculata*) crop occur according to the developmental stage of the plant until the dried and stored grains. Because of the big variety of insects, practically all plant structure are attacked causing estimated losses of between 33% and 86%.

The *Gliricidia sepium* is a specie of great commercial and economic interest for tropical regions because of its multiple use characteristics, being cultivated in several tropical countries. The *G. sepium* stands out for its fast growth, high regeneration capacity, drought resistance and facility in propagations sexually and asexually. In Brazil, *Gliricidia sepium* was introduced in the Northeastern Semiarid region in 1985 in the city of Petrolina Pernambuco, through stakes from the Comissão Executiva da Plano da Lavoura Cacaueira (CEPLA), (DRUMOND & CARVALHO FILHO, 1999).

For the conditions of the Brazilian semiarid, there are recommendations for the use of *Gliricidia sepium* in the form of protein banks, in consortium with palm, corn and beans, of forage hedges, as well as forage preserved in the form of hay and silage (CARVALHO FILHO *et al*., 1997).

The *G. sepium*, a forage legume used for animal feed. The use of this material may increase the productivity of rural establishments, especially family farms that have difficulties in purchasing materials to be used as protein sources, reducing the raised cost of soybean meal in the paraibana region (SOUZA *et al*., 2012).

In Brazil, there are no reports of pests and diseases that are limiting for *Gliricidea sepium*. When the foliage is attacked by aphids (*Aphis craccivora*) segregation of sweetened substances occurs that promotes the development of fungi, ants and causes the drying of the apex of the plant and their branches. It loses its apical dominance; the plants emit many shoots making it difficult to form upright cuttings, and are shorten. This attack occurs most frequently between December and February (rainy season), when plants presents many new shoots (FRANCO, 1988).

According to Boff (2008) from the perspective of sustainable agriculture, new forms of plant protection are sought, including the use of extracts and essential oils from medicinal plants, syrups, biological control (natural enemies), traps and bio fertilizers. Works with many plant species employing alternative forms of disease and pest control are realities within the practice of agro ecological production (LORENZETTI, 2012).

Costa *et al*. (2010) evaluating the effect of neem seed oil (*Azadiracta indica*) marketed as natuneem, on black aphid, on cowpea (*Vigna unguiculata)* found that the oil extracted from the seed, presented 81,15% effectiveness in *Aphis craccivora* mortality.

Santos *et al*. (2013) reports the effect of different concentrations of ethanoic extracts of *Annonana muricata* L. seeds (1, 2, 3, 4, 5%) on the control of black aphid (*Aphis craccivora*) in common bean and concluded that, *Annona muricata* L. at 2, 3, 4, 5% concentrations had mortality of 96,66% of *Aphis craccivora* nymphs, showing to be efficient in this pest control.

Pontes (2005) studying the insecticidal activity of alcoholic extracts of malvarisco (*Plectranthus amboinicius(*Lour.), basil (*Ocimum brasilicum*L.), celery (*Apium graveolens*L.) and leek (*Allium porrum*), and the effect of sunflower oils (*Helianthus annuus*), corn (*Zea mays*), soybean (*Glycine max*) and the Ypê® neutral detergent (emulsifying agent), on black aphids (*Aphis craccivora*Koch) nymphs under common bean (*Vigna unguiculata*L.) in the condition of the vegetation house, concluded that, leek (*Allium porrum*) and celery (*Apium graveolens*) showed better efficiency in combating aphids (*A. craccivora*).

MATERIALS AND METHODS

The experiment was accomplished at Laboratório de Entomologia e Apicultura no Instituto Federal de Educação, Ciência e Tecnologia da Paraíba, located at the irrigated perimeter of São Gonçalo, in Sousa – PB, situated in the Rio do Peixe sub-basin and the Rio Piranhas basin.Sousa city is located in the physiographic zone of the Sertão Paraibano, at 220 meters above sea level, with latitude geographical coordinates 6º45'33", with an average annual temperature of 28ºC, relative humidity of 60% and annual sunshine stroke of 3,058(Figure 1)(DNOCS, 2010).

The design was completely randomized composed of four treatments: T0 water + 0,5% of neutral detergent (control); T1 0,5% of essential oil + 0,5% of neutral detergent; T2 1% of essential oil + 0,5% of neutral detergent; T3 2% of essential oil + 0,5% of neutral detergent. Ten repetitions were done for each treatment every repetitions had ten insects, totalizing four hundred insects in the studied experiment. The Alfacava essential oil and the neutral detergent used for application on aphids were diluted in 100 ml of distilled water.

To test the efficacy of essential oil of Alfacava (*Ocimum gratissimum*) in pests' control, were used black aphids (*Aphis craccivoraI*) collected is several parts of the *Gliricidia sepium* plant (leaves, branches and apical buds). The aphids used in the experiment were collected at the seedling nursery at the Insituto Federal de Educação, Ciência e Tecnologia da Paraíba, Sousa campus (Figure 02).

Figure02: Parts of the *Gliricidia sepium* plant collected in the seedling nursery from IFPB – Sousa Campus full with *Aphis craccivora*.
Source: Personal archive Amorim, M. C. (2012).

For the test realization, the collected material from *Gliricidia sepium* plant was transported to the Laboratório de Entomologia e Apicultura do Instituto Federal de Educação, Ciência e Tecnologia da Paraíba, Sousa Campus.

The essential oil was extracted from aerial part of Alfacava (*O. gratissimum*) plant (leaves, inflorescences) with a puller adapted by Professor Paulo Wanderley by the steam drag method. To prevent the aphids from leaving the repetitions without being accounted for were used disposable plates with water and supernatant Styrofoam discs forming "islands".

To avoid the mortality of the insects by drowning with the excess of essential oil application was putted on the Styrofoam discs, absorbent paper (Figures 03 e 04).

Figure 03: Sample above de supernatant Styrofoam
Source: Personal archive AMORIM, M. C. (2012).

Figure 04: Demonstration of the experiment being analyzed.
Source: Personal archive Amorim, M. C. (2012).

The dead aphids count was made with twenty-four hours and with forty-eight hours after the installation of the experiment with the help from a magnifying glass and flashlight.

Data were subjected to the F-Test of Variance Analysis and the comparison of average was made by Tukey test at the 1% probability level for both the twenty-four hours and the forty-eight hours count. For statistical analysis was used the statistical software Assistência Estatística (ASSISTAT) version 7,6 beta (SILVA, 2013).

RESULTS AND DISCUSSIONS

The first mortality analyzes of the insects was made twenty-four hours after the Alfacava essential oil application and the second with forty-eight hours. All treatments resulted significant percentages of mortality of the insects by the Tukey test (Tables 01 e 02).

TABLE 01

Table of the statistical variance analysis of the experiment 24 hours after the application of Alfacava (*Ocimum gratissimum*) essential oil confirmed by the significant 1% F test., LOCAL, MONTH/YEAR.

FV	GL	SQ	QM	F
Treatments	3	87.30000	29.10000	10.4970 *
Leavings	36	99.80000	2.77222	
Total	39	187.10000		

* Significance at the 1% probability level ($p < .01$).

TABLE 02

Table of the statistical variance analysis of the experiment 48 hours after the application of Alfacava (*Ocimum gratissimum*) essential oil confirmed by the significant 1% F test., LOCAL, MONTH/YEAR.

FV	GL	SQ	QM	F
Treatments	3	21.80000	7.26667	9.9847 **
Leavings	36	26.20000	0.72778	
Total	39	48.00000		

** Significance at the 1% probability level ($p< .01$).

The analyzes made in twenty-four hours after the Alfacava essential oil on the black aphid shows the statistical comparison of the averages of the treatments (Table 03). The treatments T_1 0,5% of Alfacava essential oil + 0,5% of neutral detergent, T_2 1% of Alfacava essential oil + 0,5% of neutral detergent e T_3 1% of Alfacava essential oil + 0,5% of neutral detergent showed statistically significant in relation to the control, T_0 water + 0,5% of neutral detergent.

In concentration of 0,5% of Alfacava essential oil the mortality was 68%, in 1% concentration the mortality was 80%, however at 2% concentration the mortality was 93%. In the control (water + neutral detergent), the mortality was 53% (Graphic 01).

TABLE 03

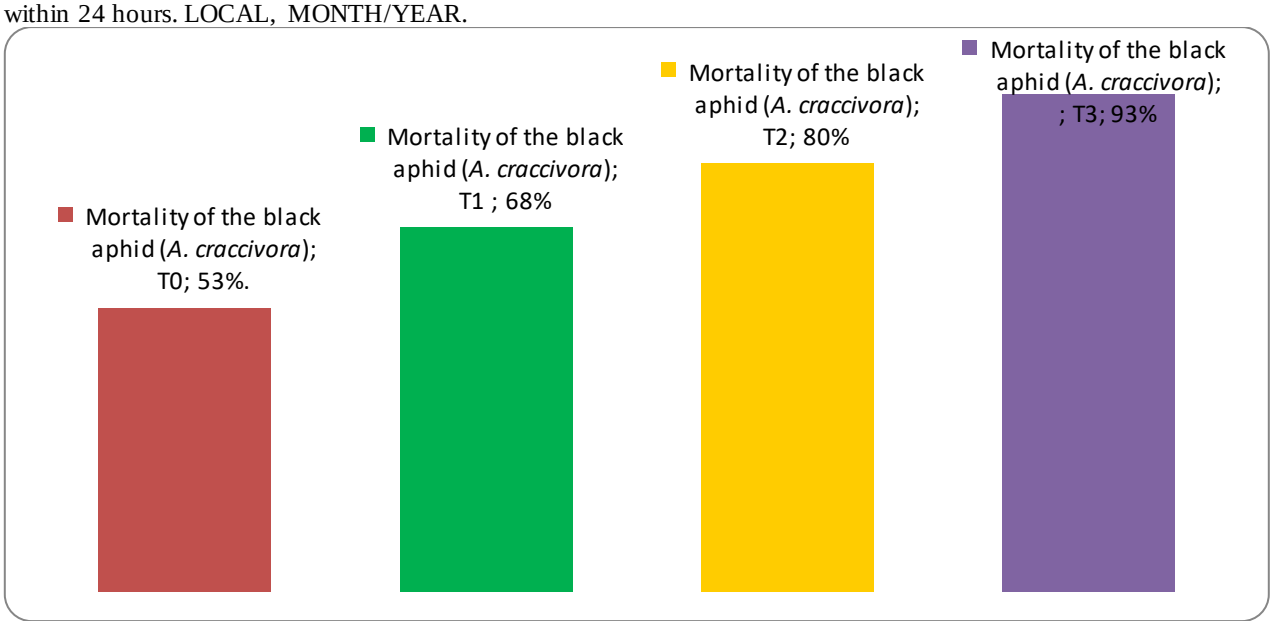
Average of the treatments after a period of 24 hours of Alfacava essential oil application in the black aphids (*Aphis craccivora*). LOCAL, MONTH/YEAR.

Treatments	Average of the treatments
T_0Control	5.30000 c
T_1: oil** 0,5% + ND* 0,5%	6.80000 bc
T_2: oil 1% + ND 0,5%	8.00000 ab
T_3: oil 2% + ND 0,5%	9.30000 a

The averages followed by the same letter does not differ statically from each other. * Neutral Detergent. ** Alfacava essential oil.

GRAPHIC 01

Percentage mortality rate of black aphid(*A. craccivoraI*) with Alfacava (*O. gratissimum*) essential oil application within 24 hours. LOCAL, MONTH/YEAR.



T0 – water + 0,5% of neutral detergent; T1 – 0,5% of Alfacava oil essential + 0,5% of neutral detergent; T1 – 1% of Alfacava oil essential + 0,5% of neutral detergent; T3 – 2% of Alfacava oil essential + 0,5 of neutral detergent.

The analyzes made forty-eight hours after the Alfacava essential oil application in the black aphis shows the statistical comparison of the treatments average (Table 04), which, T1, T2 e T3 were not statistically significant, but in relation to the controlT0 there was a significant difference.

With 0,5% concentration of Alfacava essential oil it was found to be enough to cause the aphids death in an average percentage of 90% (Graphic 02), becoming preferential its uses since it had not significant difference between this and the highest concentration, thereby reducing the costs of the product application with high efficacy

TABLE 04

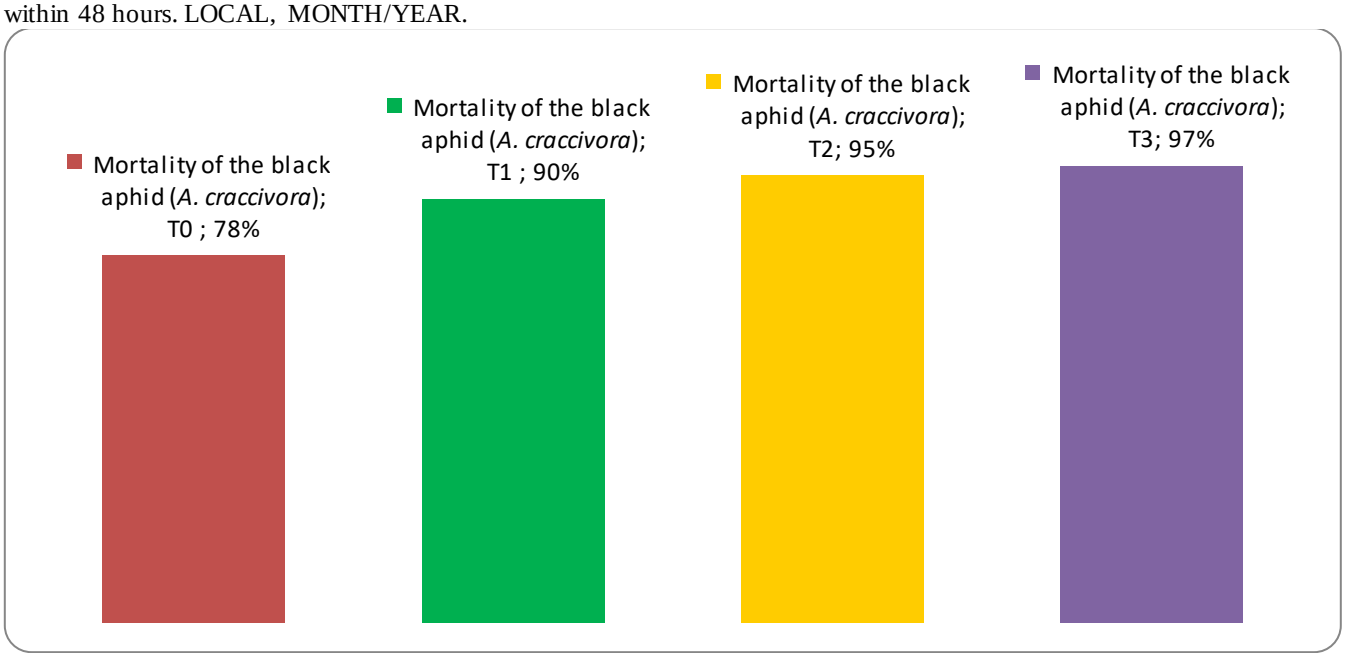
Average of the treatments after 48 hours of the Alfacava essential oil application in the black aphid (*Aphis craccivora*).

Treatments	Average of the treatments
T_0control	7.80000 b
T_1: oil** 0,5% + ND* 0,5%	9.00000 a
T_2: oil 1% + ND 0,5%	9.50000 a
T_3: oil 2% + ND 0,5%	9.70000 a

The averages followed by the same letter does not differ statically from each other. * Neutral Detergent. ****** Alfacava essential oil.

GRAPHIC 02

Percentage mortality rate of blach aphis (*A. craccivoraI*) with Alfacava (*O. gratissimum*) essential oil application within 48 hours. LOCAL, MONTH/YEAR.



T0 – water + 0,5% of neutral detergent; T1 – 0,5% of Alfacava essential oil + 0,5% of neutral detergent; T1 – 1% of Alfacava essential oil + 0,5% of neutral detergent; T3 – 2% of Alfacava essential oil + 0,5% of neutral detergent.

One of the resons that can explain the high mortality rate of the black aphid (*A. craccivora*) with the Alfacava (*O. gratissimum*) essential oil application is that the presence of various plant secondary substances, standing out the Eugenol chemical component which contains bioinsecticidal properties, making it a viable alternative for pest control.

This information corroborates the study of the content, yield and chemical composition of Alfacava (*O. gratissimum*) essential oil by Fernandes (2012), he points out that the results obtained identified eight chemical components, highlighting eugenol as the major component, with an average content of 91% of the essential oil contituents (Table 05).

TABLE 05
Relative percentage of essential oil constituents in *Ocimum gratissimum* plants grown in different photosynthetically active radiation (PAR).

Compounds	PAR (mol m^{-2} d^{-1}				
	KI*	4	7,4	11	20
		Relative percentage (%)			
cis-ocimeno	1034	1,47	3,86	4,13	3,49
trans-4-tujanolou cis-sabineno hydrate	1073	0,52	0,63	0,53	0,54
terpin-4-ol	1185	-	-	0,43	0,64
Eugenol	1358	91,97	91,66	89,76	90,70
β-bourboneno	1388	-	-	0,43	0,43
E-caryophyllene	1429	1,37	1,29	1,41	1,49
germancreno D	1486	3,92	2,56	2,83	2,22
Caryophyllene oxide	1589	-	-	0,41	0,49
Total identified (%)		99,25	100	99,93	100

KI*= Kovats index. Source: FERNANDES, 2012.

Gomes & Favero (2011) evaluating the insecticide action of the Alfacava (*O. gratissimum*) essential oil in nymphs of third and fourth development stakes of *Triatoma infestants*, concluded that, the Alfacava (*O. gratissimum*) essential oil presents a toxic effect on the insect causing its mortality.

Studies desenvolved by Franca *et al*. (2010) with the objective of test different essential oils in the repellency of the *Callosobruchus maculatus* insect in cowpea (*Vigna unguiculata*) cv. Curujinha pointed out that, independent of the concentration used (0,5% or 2%) the Alfacava essential oil promoted less attraction of the insect into the cowpea in relation to the others oils studied, anise (*Foeniculum vulgare*) and Citronela (*Cymbopogon winterianus*). They also points out that the *O. gratissimum* essential oil promotes the contact mortality of the insect and presents it like a promisor alternative in the *C. maculatus* control.

CONCLUSIONS

The Alfacava essential oil has an insecticide action in concentrations from 0,5% in the submitted test conditions, actuating significantly in the index mortality of black aphid.

The 0,5% concentration presents positive index in insects mortality, enabling less costs of application when it is compared with the highest dose tested in the experiment.

For agro ecological agriculture Alfacava (*O. gratissimum*) essential oil, emerge as promising tool in pest insect control. From the knowledge of these factors it is possible to conclude that, the botanical insecticides are less likely to develop resistant pests, are biodegradable and do not harm the environment.

CONSIDERATIONS

It is important to point out the relevance of new fields studies, to have answers about the efficacy of the Alfacava (*O. gratissimum*) essential oil application in the black aphid (*A. craccivora*).

Find natural products that can substitute the emulsifying agent (neutral detergent) is another parameter that should be evaluated, because it has chemical properties that may harm the environment.

REFERÊNCIAS BIBLIOGRÁFICAS

ABRASCO. **An alert about the pesticides affects in the health.** (**Um alerta sobre os impactos dos Agrotóxicos na Saúde**.) Rio de Janeiro: ABRASCO, 2012.:

ALMEIDA, S.A.; ALMEIDA, F.A.C.; SANTOS, N.R.; ARAÚJO, M.E.R.; RODRIGUES, J.P. Insecticide activity of vegetal extracts about *Callosobruchus maculatus* (Coleoptera: Bruchidade). (Atividade inseticida de extratos vegetais sobre *Callosobruchus maculatus* (Coleoptera: Bruchidae)). **Brazilian Jornal of AgroSciences. (Revista Brasileira de Agrociência)**. Pelotas: v. 10, n. 1, p. 67-70, 2004.

ALVARENGA, I. C. A. **Hydric stress in Rosemary – pepper (*Lippia Sidoides Cham*.): physiological and productive aspects. (Estresse Hídrico em Alecrim-**

pimenta (*Lippia Sidoides* Cham.): aspectos fisiológicos e produtivos). Dissertation (Master´s degree in Agrarian Sciences, concentration área in Agroecology) - Universidade Federal de Minas Gerais, 2010.

ANDRADE JÚNIOR, A. S.; SANTOS, A. A.; SOBRINHO, C. A; BASTOS, E. A.; MELO, F. B.; VIANA, F. M. P.; FREIRE FILHO, F. R.; CARNEIRO, J. S.; ROCHA, M. M.; CARDOSO, J. M.; SILVA, P. H. S.; RIBEIRO, V. Q. **Cowpea (*Vigna unguiculata* (L.) Walp cultivation. (Cultivo do feijão caupi (*Vigna unguiculata* (L.) Walp)).**Teresina: Embrapa Meio-Norte, 2002.108 p. (production systems, 2).

ANVISA; UFPR. **Agrochemical and regulatory market seminar. (Seminário de mercado de agrotóxico e regulação).** Brasília: ANVISA, 2012.

ARAÚJO, E. C. D. **Biological control of anthracnose in papaya, using *Colletrotichumgloeosporioides* antagonista yeasts. (Controle biológico da antracnose no mamão, utilizando-se leveduras antagonistas ao *Colletrotrichum gloeosporioides*).** 34p. Monography (Specialization in Environmental and Industrial Microbiology) - Universidade Federal de Minas Gerais, 2007.

BARBOZA, S. B. S. C.; TAVARES, E. D.; MELO, M. B. **Acerola cultivation instructions. (Instruções para o cultivo da acerola)**. Aracaju: EMBRAPA-CPATC, 1996, p.42. (Circular Técnica, 6).

ACKMANN, R. L.; EASTOP, V. F. Taxonomic issues. In: EMDEN, H. F.; HARRINGTON, R. **Aphids as crop pests**. London: Cabi, U.K. Nosworthy Way, Wallingford, Oxfordshire, 2007. 171p.

BOFF P (coord). 2008. *Agropecuária saudável: da prevenção de doenças, pragas e parasitas à terapêutica não residual*. Lages: Epagri; Udesc 80p.

BOZIKI, D.; SILVA, L. B.; PRINTES, R. C. **Current situation of pesticides use and packaging destination in the rota sol State environmental protection area, Rio Grande do Sul, Brazil. (Situação atual da utilização de agrotóxicos e destinação de embalagens na área de proteção ambiental Estadual rota sol, Rio Grande de Sul, Brasil).** Niterói: Revista VITAS – Visões Transdisciplinares sobre Ambiente e Sociedade, 2011.

CARVALHO FILHO, O. M.; DRUMOND, M. A.; LANGUIDEY, P. H. ***Gliricidia sepium*: promising legume for semiarid regions. (*Gliricidia sepium*: leguminosa promissora para regiões semiáridas).** Petrolina: EMBRAPA CPATSA, 1997. 17 p. (Circular Técnica, 35).

CARVALHO, N. L.; PERLIN, R. S.; COSTA, E. C. Thiamentoxam in seed treatment. (Thiametoxam em tratamento de sementes). Cascavel: Revista Eletrônica do PPGEAmb--CCR/UFSM, v.2, n.2, p. 158 – 175, 2011.

CASTRO, A. R. R.; JORGE, M. H. A.; ALMEIDA, W. B.; BORSATO, A. V. **Development of Alfacava (*Ocimum gratissimum L.*) cuttings in different substrates. (Desenvolvimento de estacas de Alfavaca (*Ocimum gratissimum* L.) em diferentes substratos).** Corumbá: Embrapa Pantanal, 2009. (Comunicado Técnico, 75).

COSTA FILHO, L. O; ENCARNAÇÃO, C. R. F.; OLIVEIRA, A. F. M. **Hydric and thermal influence and development of *Ocimum gratissimum* L.(Influência hídrica e térmica e desenvolvimento de *Ocimum gratissimum* L.).** Revista Brasileira de Plantas Medicinais, Botucatu, v.8, n.2, p. 8-13, 2006.

COSTA, C. M. G. R.; SANTOS, M. S.; BARROS, H. M. M.; AGRA, P. F. M.; FARIAS, M. A. A. **Inhibitory effect of brazil essential oil on vitro of *Erwinia carotovora.* (Efeito inibitório do óleo essencial de manjericão sobre o crescimento in vitro de *Erwinia carotovora*).**Tecnol. & Ciên. Agropec., João Pessoa, v.3, nº3, p.35-38, set. 2009.

COSTA, J. V. T. A.; BLEICHER, E.; CYSNE, A. Q.; GOMES, F. H. T. **Oil and aqueous extract of neem, azadiractin and Acephate seed in the control of black aphid of cowpea. (Óleo e extrato aquoso de sementes de nim, azadiractina e Acefato no controle do pulgão-preto do feijão-de-corda).** Goiânia: Pesquisa Agropecuária Tropical, v. 40, n. 2, p. 238-241, 2010.

DANTAS, J.P. *et al*. **Evaluation of cowpea genotypes under salinity. (Avaliação de genótipos de caupi sob salinidade)**. Revista Brasileira de Engenharia Agrícola e Ambiental, v.6, n.3, p.425-430, 2002.

DEPARTAMENTO NACIONAL DE OBRAS CONTRAS AS SECAS (DNOCS). **Irrigated Perimeter São Gonçalo. (Perímetro Irrigado São Gonçalo)**. 2010.

DRUMOND, M. A.; CARVALHO FILHO, O. M. **Introduction and evaluation of *Gliricidia sepium* in the semiarid region of brazilian northeastern. (Introdução e avaliação da *Gliricidia sepium* na região semiárida do**

Nordeste Brasileiro). In: QUEIRÓZ, M. A. de; GOEDERT, C. O.; RAMOS, S.R.R. Genetic resources and improvement of plants for the Braziliannowtheastern. (Recursos Genéticos e Melhoramento de Plantas para o Nordeste brasileiro). Petrolina-PE: Embrapa Semiárido / Brasília-DF: Embrapa Recursos Genéticos e Biotecnologia, 1999.

EFFRAIM, K.D.; JACKS, T.W. & SODIPO, O.A. **Histopathological studies on the toxicity of *Ocimum gratissimum* leave extract on some organs of rabbit**. Nigéria: African. Journal Biomedical Research. Borno State, v.6, p. 21-25, 2001.

EHLERT, P.A.D., LUZ, J.M.Q., INNECCO, R. **Vegetative propagation of carnation using different types of Alfacava-cravo and substrates. (Propagação vegetativa da alfavaca-cravo utilizando diferentes tipos de estacas e substratos)**. Brasília: Horticultura Brasileira, v.22, n.1, p. 10-13, 2004.

EMBRAPA. **Cowpea (*Vigna unguiculata*) cultivation. (Cultivo de feijão caupi (*Vigna unguiculata*)).** Teresina: Embrapa Meio Norte, 2003.

EMBRAPA. **Highland Rice Cultivation in the Mato Grosso State. (Cultivo do Arroz de Terras Altas no Estado de Mato Grosso)**. Santo Antônio de Goiás: Embrapa Arroz e Feijão, 2006.

EMBRAPA. **Wheat Cultivation. (Cultivo do Trigo)**. Passo Fundo: Embrapa Trigo, 2009.

FERNANDES, V. F. **Growth, production of essential oil and leaf anatomy of *Ocimum gratissimum* L. (Lamiaceae) at diferente light radiation levels. (Crescimento, produção do óleo essencial e anatomia foliar de *Ocimum gratissimum* L. (Lamiaceae) em diferentes níveis de radiação luminosa).** 2012. 78 f. Dissertation (Master's degree in vegetables production) – Universidade Estadual de Santa Cruz, 2012

FRANCA, D. A. M.; SILVA, T. M. B.;SOUZA, L. S.; WANDERLEY, M. J. A.; ROCHA, R. B.;ARRUDA, J. D. **Attractiveness of *callosobruchus maculatus* in cowpea *vigna unguiculata* grains, corujinha cultivar, treated with essential oils. (Atratividade de *callosobruchus maculatus* em grãos de caupi *vigna unguiculata,* cultivar curujinha, tratado com óleos essenciais)**. In: CONGRESSO CEARENSE DE AGROECOLOGIA, 2, 2010, Juazeiro do Norte. *Anais...* Juazeiro do Norte, 2010.

FRANCO, A. A. **Use of *Gliricidia sepium* as live moirão. (Uso de *Gliricidia sepium* como moirão vivo)**. Rio de Janeiro: EMBRAPA-UAPNPBS, 1988. 5p. (Comunicado Técnico, 3).

GALLO, D.; NAKANO, O.; SILVEIRA NETO, S.; CARVALHO, R.P.L.; BAPTISTA, G.C.; BERTI FILHO, E.; PARRA, J.R.P.; ZUCCHI, R.A.; ALVES, S.B.; VENDRAMIN, J.D. ; MARCHINI, L.C.; LOPES, J.R.S.; OMOTO, C. **Agricultural Entomology Manual. (Manual de Entomologia agrícola)**. Piracicaba: FEALQ, 2002. p. 920.

GALVÃO, A. R. A.; SILVA, F. S. N; BARBOSA, R. R. N.; BEZERRA, F. A. X.; PINHEIRO, D. C.; OLIVEIRA NETO, C. F**. Influence of potassium fertilization on the occurrence of black aphis (*Aphis craccivora)*(hemiptera: aphididae) on cowpea *(Vigna unguiculata)*culture (l) Walp. (Influência da adubação potássica na ocorrência de pulgão preto (*Aphis craccivora)* (hemiptera: aphididae) na cultura do feijão-caupi *(Vigna unguiculata)* (l) Walp).** In: Reunião Anual do SBPC, 64, São Luís, 2012. *Resumos...* São Luís, 2012.

GANG, D. R; WANG, J; DUDAREVA, N; NAM, K. H; SIMON, J. E; LEWINSOHN, E; PICHERSKY, E. **An investigation about the storage and biosynthesis of phenylpropenes in sweet basil. (Uma investigação do armazenamento e biossíntese de phenylpropenes em sweet basil)**, 2001.

GOMES, S. P.; FAVERO, S**. Evaluation of the essential oils of aromatic plants with insecticidal activity in *Triatoma infestants* (Klug, 1834) (Hemiptera: Reduviidaade). (Avaliação de óleos essenciais de plantas aromáticas com atividade inseticida em *Triatoma infestans* (Klug, 1834) (Hemiptera: Reduviidae)).**Maringá: Acta Scientiarum, v. 33, n. 2, p. 147-151, 2011

GURJÃO, K.C.O. **Development, storage and drying of Tamarind (*Tamarindus indica L.*).(Desenvolvimento, armazenamento e secagem de tamarindo (*Tamarindus indica* L.))**. 2006. 145 f. Thesis (Doctorate in Agronomy) - Centro de Ciências Agrárias, Universidade Federal da Paraíba, 2006.

JORGE M. H. A; EMERY, F. H; MORAES E SILVA, A. **Rooting of Alfacava (*Ocimumgratissimum* L.) cuttings. (Enraizamento de Estacas de Alfavaca (*Ocimumgratissimum* L.)).** Corumbá: Embrapa Pantanal, 2006. 3 p. (Embrapa Pantanal. Comunicado Técnico, 56).

LIMA, A. C. **Brazil insects. (Insetos do Brasil)**. Rio de Janeiro: Escola Nacional de Agronomia, série didática n. 4, 1942. p. 324.

LIMA, P. J. P. **Possible physical and mental illnessess related to the handling of pesticides in rural activities, in the Atibaia, Sp/Brazil region. (Possíveis doenças físicas e mentais relacionadas ao manuseio de agrotóxicos em atividades rurais, na região de Atibaia, SP/Brasil)**. 2008. 158 f. Dissertation (Master's degree) - Universidade de São Paulo, São Paulo, 2008.

LIMA, R. O.; OLIVEIRA, A. V. S.; FERREIRA, A. N.; ARAUJO, C. C. PEREIRA, T. P. B.; PERIN, L. DANTAS, J **. The alternative control of cowpea pests: preliminar results. (O. Controle alternativo das pragas do feijão caupi: resultados preliminares).** In: Semana Nacional de Ciência e Tecnologia, Sergipe, 2012. *Anais...* Sergipe: NEA, 2012.

LINARD, C. F. B. M. **Study of the antinociceptive effect of eugenol. (Estudo do efeito antinociceptivo do eugenol)**. Dissertation (Master's degreen in Physiological Sciences) – Universidade Federal do Ceará, 2008

LIRA, R. S**. Biological Aspects of *Chrysoperla externa* fed with anise aphids. (Aspectos biológicos de *Chrysoperla externa* alimentados com pulgões da erva-doce)**. Dissertation (Master's degree in Plant Production) Centro de Ciências Agrárias, Universidade Federal da Paraíba, 2005.

LONDRES, F**. Pesticides in Brazil: a guide to action in defense of life. (Agrotóxicos no Brasil: um guia para ação em defesa da vida).** Rio de Janeiro: AS-PTA – Assessoria e Serviços a Projetos em Agricultura Alternativa, 190 p. 2011.

LORENZETTI, E. R. **Control of strawberry diseases with essential oils and *Trichoderma* spp. (Controle de doenças do morangueiro com óleos essenciais e *Trichoderma* spp).**2012. Thesis (Doctorate in Phytophathology) – Universidade Federal de Lavras, 2012.

LUCCA, P. S. R. **Insecticide potential of extracts of fennel, anise, clove and homeopathic preparation for kale aphid control. (Potencial inseticida de extratos de funcho, erva-doce, cravo da índia e do preparado homeopático para o controle de pulgão em couve).** 2009. 60f. Dissertation (master's degree) – Universidade Estadual do Oeste do Paraná. Cascavel: UNIOESTE, 2009.

MACHADO, L. A.; SILVA, V. B.; OLIVEIRA, M. M. **Use of plant extracts for pests control in horticulture. (Uso de extratos vegetais no controle de pragas em horticultura)**. Biológico, São Paulo, v. 69, n. 2, p. 103-106, 2007.

MARTINS, J. R. ALVARENGA, A. A.; CASTRO, E. M.; SILVA, A. P. O.; OLIVEIRA, O. C.; ALVES, E. **Leaf anatomy of Alfacava-cravo grown under colored meshes. (Anatomia foliar de plantas de alfavaca-cravo cultivadas sob malhas coloridas)**. Santa Maria: Ciência. Rural, v.39, n.1, p. 82-87, 2009.

MINAMI, K.; BARRACA, S. A. **Management and production of medicinal and aromatic plants. (Manejo e produção de plantas medicinais e aromáticas)**. Supervised Plant Production Internship Report-II. São Paulo: Universidade de São Paulo, 1999.

MINAMI, K.; SUGUINO, E.; MELLO, S. C.; WATANABE, A. T. **The Basil cultivation. (A cultura do Manjericão)**. Piracicaba: Escola Superior de Agricultura "Luiz de Queirós" (ESALQ) – Divisão de Biblioteca e Documentação, 2007. p. 25. (Série Produtor Rural, 36).

MORAES, G.J.; RAMALHO, F.S. **Some insects associated to the *Vigna unguiculata* Walp in Northeast. (Alguns insetos associados a *Vigna unguiculata* Walp no Nordeste).** Petrolina: EMBRAPA-CPATSA, 1980. 10p. (Boletim de Pesquisa, 1.).

OKA, Y. NACAR, S.; PUTIEVSKY, E. RAVID, U.; YANIV, Z.; SPIEGEL, Y. **Nematicidal activity of essential oils and their components against the root-knot nematode**. Nematology, v. 90, n. 07, p. 710-715, 2000.

PAPA, G. **Current situation and future perspectives in the management of cotton pests' resistance to insecticides. (Situação atual e perspectivas futuras no manejo de resistência de pragas do algodoeiro a inseticidas)**. In: CONGRESSO BRASILEIRO DE ALGODÃO, 3, Dourados, 2006, *Resumos das palestras...*, Campo Grande: Embrapa/UFMS, 2006. 286-288p.

PEREIRA, C. A. M; MAIA, J. F. **Study of antioxidant activity of the extract and essential oil obtained from alfacava (*Ocimum***

***gratissimum* L.). (Estudo da atividade antioxidante do extrato e do óleo essencial obtidos das folhas de alfavaca (*Ocimum gratissimum* L.)).** Campinas: Ciência e Tecnologia de Alimentos, 2007.

PEREIRA, D. D. **Prose plant ah Poetry in the Semiarid. (Plantas Prosa e Poesia no Semiárido)**. Campina Grande-PB: EDUFCG. 2005. 217p.

PEREIRA, I. C. **Phytochemistry and morphophysiological aspects of *Aniba parviflora* (Lauraceae) cultivaded in Santarém – PA City. (Fitoquímica e aspectos morfofisiológicos de *Aniba parviflora* (Lauraceae) cultivada no município de Santarém – PA).**Dissertation (Master's degree) – Universidade Federal do Oeste do Pará, Programa de Pós-Graduação em Recursos Naturais da Amazônia. Santarém, 2012.

PEREIRA, R. C. A.; MOREIRA, A. L. M. **Basil: cultivation and use. (Manjericão: cultivo e utilização)**. Fortaleza: Embrapa Agroindústria Tropical, 2011. (Documento, 136).

PINHEIRO, A. L.; LOPES, D. A. G. **Essential oils production. (Produção de óleos essenciais)**. Viçosa: CPT, 188p, 2008.

PONTES, F. S. S. **Insecticidal activity of plant extracts and oils on bean black aphids (*Aphis craccivora* Koch) nymphs. (Atividade inseticida de extratos e óleos vegetais sobre ninfas de pulgão-preto-do-feijoeiro (*Aphis craccivora* Koch)**. 2005. 47 f. Monography (Agronomy graduation) – Universidade Federal do Ceará, 2005.

QUINTELA, E. D.; NEVES, B. P.; QUINDERÉ, M. A. W.; ROBERTS, D. W.**Main cowpea pests in Brazil. (Principais pragas do caupi no Brasil)**. Goiânia: EMBRAPA-CNPAF, 1991. 37 p. (Documentos, 35).

RAKHSHANI, E.; TALEBI, A.A.; KAVALLIERATOS, N.G.; REZWANI, A.; MANZARI, S.; TOMANOVIĆ, Ž. **Parasitoid complex (Hymenoptera, Braconidae, Aphidiinae) of *Aphiscraccivora* Koch (Hemiptera: Aphidoidea) in Iran**. Journal of Pest Science, v.78, p.193-198, 2005.

RIBAS, P. P., MATSUMURA, A. T. S. **The chemistry of pesticides: impact in health and environment. (A química dos agrotóxicos: impacto sobre a saúde e meio ambiente).**Novo Hamburgo: Revista Liberato, v. 10, n. 14, p. 149-158, 2009

ROEL, A. R. **Use of plants with insecticidal properties: a contribution for the Sustainable Rural Development. (Utilização de plantas com propriedades inseticidas: uma contribuição para o Desenvolvimento Rural Sustentável)**. Revista Internacional de Desenvolvimento Local. Vol. 1, N. 2, p. 43-50, 2001.

SALAS, F. J. S.; FERERES, A.; LOPES, J. R. S. **Resistence of comercial potato varieties to Myzus persicae and Y vírus. (Resistência de variedades comerciais de batata ao pulgão Myzus persicae e ao vírus Y).**Itapetininga: Revista Batata Show, n.6, 2003.

SALGADO, S. M. CAMPUS, V. P.; CARDOSO, M. G.; SALGADO A. P. S. **Outbreak and mortality of second stage juveniles of Meloidogyne exígua in essential oils. (Eclosão e mortalidade de juvenis de segundo estádio de Meloidogyne exígua em óleos essenciais).**Nematologia Brasileira, v. 27, n. 01, p. 17-22, 2003.

SALVADORI, J. R. **Biological control of wheat aphids: success that lasts. (Controle biológico de pulgões de trigo: o sucesso que perdura).** Passo Fundo: Embrapa Trigo, 1999. (Comunicado Técnico, 27).

SANTOS, A. A.; MACIEL, A. G. S.; NASCIMENTO, J. P. M.; TRINDADE, R. C. P.; BROGLIO-MICHELTTI, S. M. F.; FERREIRA, E. S.; SABINO, A. S. **Insecticide activitie of the *Annona muricata* L. extract in the control of *Aphis craccivora* koch (Hemiptera: Aphididae). (Atividade inseticida do extrato de *Annona muricata* L. no controle de *Aphis craccivora* koch (Hemiptera: Aphididae)).** In: Congresso Brasileiro de Defensivos Agrícolas Naturais, 6, 2013, João Pessoa. *Anais...* Universidade Federal de Alagoas, 2013.

SANTOS, C. A. B.; SILVA, A. P. M.; SCHER, F. A.; ROCHA, A. G.; SILVA, J, A.; MOREIRA, J. O. T. **Insecticide activitie of vegetal extracts against the cowpea (*Vigna unguiculata*) aphid (*Aphis craccivora* Koch). (Atividade inseticida de extratos vegetais contra o pulgão (*Aphis craccivora* Koch) do feijão caupi (*Vigna unguiculata*)).**In: Congresso Brasileiro de Agroecologia, 7, Fortaleza, 2011. *Resumos...* UNEB/DTCS, 2011.

SANTOS, F. **Warning station and phytosanitary situation of apple orchards in Friburgo – SC. (Estação de avisos, e situação**

fitossanitária dos pomares de macieiras em Fraiburgo-SC). Monography (Postgraduate Degree in Plant Protection) – Universidade Federal de Viçosa, 2012.

SILVA, F. A. S. **Statistical Assistance Software (ASSISTAT). (Assistência estatística software (ASSISTAT)).**Campina Grande: DEAG – CTRN – UFCG, 2013.

SILVA, F; SANTOS, R. H. S; ANDRADE, N. J; BARBOSA, L. C. A;CASALI, V. H. D; LIMA, R. R; PASSARINHO, R. V. M. **Basil conservation affected by cropping season, harvest time and storage period**. Brasília: Pesquisa agropecuária brasileira, v.40, n.4, 2005.

SILVA, G. S. **Natural substances: na alternative for disease control. (Substancias naturais: uma alternativa para o controle de doenças)**. In: CONGRESSO BRASILEIRO DE FITOPATOLOGIA, 39., 2006, Salvador. Palestra... Salvador, 2006.

SINGH, B.B.; EHLERS J.D.; SHARMA B.; FREIRE FILHO, F.R. **Recent progress in cowpea breeding.**In: FATOKUN C.A.; TARAWALI, S.A; SINGH B.B.; KORMAWA, P. M.; TAMO, M. (eds.). Challengens and opportunities for enchancing sustainable cowpea production. Ibadan: IITA. 2002. p. 22-40.

SOUSA, P. B .L.; AYALA-OSUNA, J. T.; GOMES, J. E. **Vegetative propagation of *Ocimum gratissimum* L. in different substrates. (Propagação vegetativa de *Ocimum gratissimum* L. em diferentes substratos)**. Botucatu: Revista Brasileira de Plantas Medicinais, v.8, n.1, p.39-44, 2005.

SOUZA, E. Y. B.; MUNIZ, E. N.; SANTOS FILHO, P. F. RANGEL, J. H. A.; GALATI, R. L.; SANTANA NETO, J. A.; SANTOS, D. O._; **Evaluation of nutritional quality of corn silage add with different proportions of *gliricidia.* (Avaliação da qualidade nutricional da silagem de milho confeccionada com diferentes proporções de *gliricídia*).** In: CONGRESSO NORDESTINO DE PRODUÇÃO ANIMAL, 7.; SIMPÓSIO NORDESTINO DE ALIMENTAÇÃO DE RUMINANTES, 13., 2012, Maceió. *Anais...* Maceió: Sociedade Nordestina de Produção Animal, 2012.

TANGERINO, L. M. B. **Study of antimicrobial properties of eugenol derived copolymers**. (**Estudo das propriedades antimicrobianas de copolímeros derivados do eugenol).**Dissertation (Master's Degree in Engineering Materials) - Universidade Federal de Itajubá, 2006.

TAVARES, M. A. G. C.; VENDRAMIM, J. D. **Bioactivity of Santa Maria herb, *Chenopodium ambrosioides L.,* on *Sitophilus zeamais* Mots. (Coleoptera: Curculionidae)**. (**Bioatividade da Erva-de-Santa-Maria, *Chenopodium ambrosioides* L., sobre *Sitophilus zeamais* Mots. (Coleoptera: Curculionidae).** Londrina: Neotropical Entomologyv. 34, n. 2, p. 319-323, 2005.

TRAPÉ, A. Z. **Use of pesticides and the human health. (Uso de agrotóxicos e a saúde humana)**. In: Workshop tomate na UNICAMP: Perspectivas e Pesquisas, 2003, Campinas. *Workshop...* Campinas: UNICAMP, 2003.

WALQUIL, J. M. **Leafhoppers, aphids and diabrotic in corn crop**. **(Cigarrinhas, pulgões e diabrótica na cultura do milho)**. In: SEMINÁRIO SOBRE A CULTURA DO MILHO SAFRINHA, 2., 1995, Assis, SP. *Resumos*... Campinas: Instituto Agronômico, 1995. p. 29-38.

WOLFFENBUTTEL, A. N. **Essential oils. (Óleos essenciais)**. Informativo CRQ-V, ano XI, n.105, 2007.

ZANINI, A. **Biological control of the wheat *sitobion avenae* (FABRICIUS 1775) aphid by the *aphidius colemani* viereck parasitoid, 1912 in Medianeira, PR, Brazil.(Controle biológico do pulgão de trigo *SITOBION AVENAE* (FABRICIUS 1775) pelo parasitoide *APHIDIUS COLEMANI* VIERECK, 1912 Em Medianeira, PR, BRASIL).** 86 p. Dissertation (Master's degree in Agronomy) – Universidade Estadual do Oeste do Paraná, 2004.