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AGRONOMIC EFFECTIVENESS AND PRACTICABILITY OF INSECTICIDES IN Lyriomyza *huidobrensis* CONTROL (*Diptera: agromyzidae*) OF POTATO[1]

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ABSTRACT - The test was carried out in the experimental area at the School of Agronomy / UFG, Goiânia - GO, for the control of *L. huidobrensis* with contact insecticide and ingestion sprayed on potato variety Agate. The experiment was conducted during the period from January to May. The experimental design used was one random complete blocks with six treatments and four replications. Each plot consisted of three lines of 10 meters - length. The treatments used was control treatment ie without any chemical product, Vertimec 84 in the SC doses of 25, 50, 100, and 200 ml of c.p. / ha and Vertimec EC 18, in the dose of 1000 c.p. ml / ha. Three weekly sprays were performed, which began at stage BBCH 21, 23 and 24. Since the tests were conducted on 50 leaflets from each plot in advance, seven days after the second application and at seven and fourteen days after the third application. According to the observed results it is concluded that Vertimec 84 SC in the doses of 100 pc and 200 ml / ha and Vertimec 18 EC in the dose of 1000 ml cp / ha showed efficient above 80% in weekly applications, and this efficiency extended up to fourteen days after the third and final application in the control of Liriomyza huidobrensis in potato cultivation.

Key words: Chemical control, Leafminer, *Solanum tuberosum*

EFFICÁCIA E PRATICABILDADE AGRONÔMICA DE INSETICIDAS NO CONTROLE DE ly*riomyza huidobrensis* (*Diptera: agromyzidae*) NA CULTURA DA BATATA

RESUMO - O teste foi realizado na área experimental da Universidade Federal de Goiás / UFG – Goiânia – GO para controle da *L. huidobrensis* com inseticida de contato e ingestão aplicado na variedade de batata Agata. O experimento foi desenvolvido durante o período de janeiro à maio. Utilizou-se delineamento experimental em blocos completos ao acaso com seis tratamentos e quatro repetições. Cada parcela constituiu-se de três linhas de 10 metros de comprimento. Os tratamentos utilizados foram testemunha ou seja sem nenhum produto químico aplicado, Vertimec 84 SC, nas doses de 25, 50, 100, e 200 ml de p.c./ha e Vertimec 18 EC, na dose de 1000 ml de p.c./ha. Foram realizadas três pulverizações semanais, que se iniciaram no estágio BBCH 21, 23 e 24. Para as avaliações foram coletados 50 folíolos de cada parcela previamente, aos sete dias após a segunda aplicação, e aos sete e quatorze dias após a terceira aplicação. Concluiu-se que Vertimec 84 SC, nas doses de 100 e 200 ml de p.c./ha e Vertimec 18 EC, na dose de 1000 ml de p.c./ha apresentaram eficiências acima de 80% nas aplicações semanais se estendendo até quatorze dias após a terceira e última aplicação no controle de *Lyriomyza huidobrensis* na cultura da batata.

Palavras chaves: Controle químico, Larva minadora, *Solanum tuberosum*

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INTRODUCTION

The potato is the fourth most consumed food in the world after rice, wheat and corn. According to Coelho et al. (1999) the potato is one of the most consumed foods in the world because of their agronomic and technological versatility, composition, besides the low marketing of tubers. According to FAO (2013) the world production of potatoes in 2011 was 374.4 million tons in an area of approximately 19.2 million hectares. Noteworthy is the northern countries, in particular China, Russia, India, and the United States, Asians accounting for approximately 41% of the total produced tubers (NAKANO et al., 2006). In Brazil, until the month of June this year, approximately 3,306,806 tons in 120,123 hectares were collected, mainly in the Minas Gerais (28%), Paraná (21%), São Paulo (19%), Rio Grande do Sul (15%), Bahia (6%) and Goiás (5%) states (IBGE, 2013).

In many countries of the Americas to leafminer *Lyriomyza huidobrensis* (Figure 1) is serious and limiting problem for potato crop. Its appearance on potato crop gradually has been increasing year after year, causing significant damage to the crop. Its occurrence is associated, especially prolonged periods of drought. In addition, constant use of insecticides has made this pest population reached high levels, reaching derail the crop cultivation in some cases.

Figure 1 - Leafminer fly on oviposition in potato leaf.

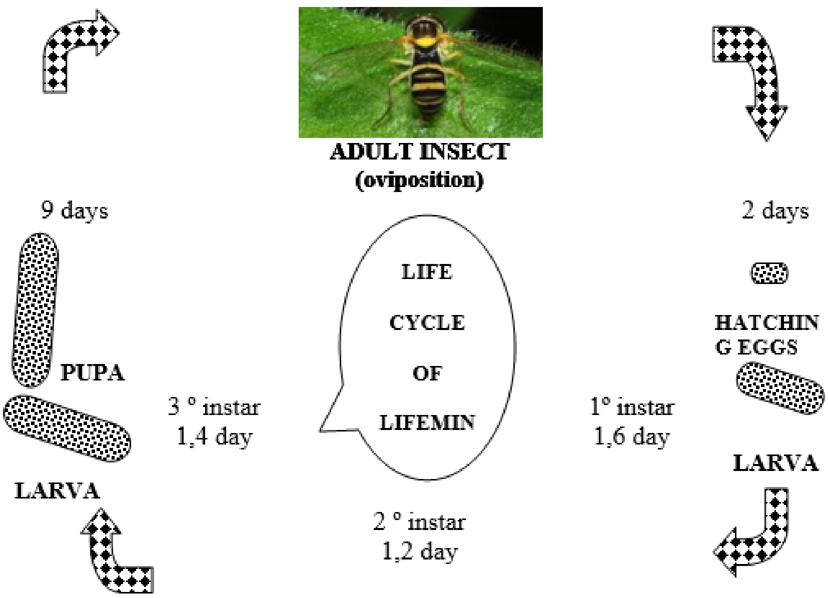

Figure 2: Life cycle of *Liriomyza huidobrensis*.Source: Adapted from Nakano (1993)

The life cycle is about 40 days in the fall and about 30 days in spring, however, can be completed in only 19 days in hot periods. This pest can develop several generations per year, about 4 to 5 in each growing cycle (Figure 2) of potato, why is biggest problem in summer plantings. One reason for the occurrence of pest outbreaks is attributed to the elimination of natural enemies of larvae and pupae of the leafminer due to the indiscriminate use of insecticides. As result, the control possibilities through cultural methods are limited. Only through conjunct actions between the various control methods, the pest population can be reduced to non-injurious levels (SCHMITT, 1980). The damage is caused by both the adult and the larva. In the larval stage, this pest causes mines in the leaves, which are usually associated with the ribs and can be serpentine, fashion galleries, or expanded. The main damage of the plague is caused at this time as to feed the leaf mesophyll, can result in drying of the leaves, galleries in mesophyll (Figure 3), reducing the leaf area and photosynthetic capacity and can cause wilting and drought of the sheets, especially when high population density. According to Souza & Kings (1999). and Souza et al.(1998) larvae to undermine and leaves can compromise the qualitative and quantitative production of tubers.

Figure 3 - Galleries representing caused by larvae of *Lyriomyza spp* action in watermelon leaf. Photo: Halfeld-Vieira cited by Michereff Filho et al. 2013.

The adults, in the form of female flies are two types of punctures or bites on potato leaflets. These punctures can be both oviposition, as for food, and have been used as indicative of the presence and fly control, where the finding of these becomes important tool in monitoring the leafminer. Females have endophytic posture predator laying in the mesophyll, directly on the leaf parenchyma. In addition to direct damage, there may be indirect. The attack of the leafminer may be associated with increased incidence of *Alternaria spp*. in bean crop, cucumber, tomato and potato. The low pest efficiency control is attributed the polyphagous specie that contributes favoring the pest survival alternative to different food sources (BARBOSA & FRANCE, 1980).

Its control can be done during the ridging using systemic insecticides granules, or by applying foliar insecticides. According to the portal Agrofit for chemical control of *Lyriomyza huidobrensis* in potato crop there are currently 29 products registered by the Ministry of Agriculture Livestock and Supply, with eight different chemical groups. The options on the market today focus on insecticide base triazinamine 4.67%, spinosyns 4.67%, 4.67% chlorfenapyr, organophosphates 4.67%, 4.67% milbemycins, pyrazole analog 4.67% pyrethroids 31%, 41% avermectin (AGROFIT, 2013). According to Mujica et al. (2000), abamectin molecule, the chemical group of avermectins, widely used in chemical control of this pest has translaminar action, and acts only on the larval stage of the leaf miner. This also has selectivity to natural enemies and pollinators, and low residual period in the field, requiring frequent reapplications. The spray method should be recommended when the adult populations are still in control stage or when damages are found in monitored crop fields generally caused by larvae, especially in new plants.

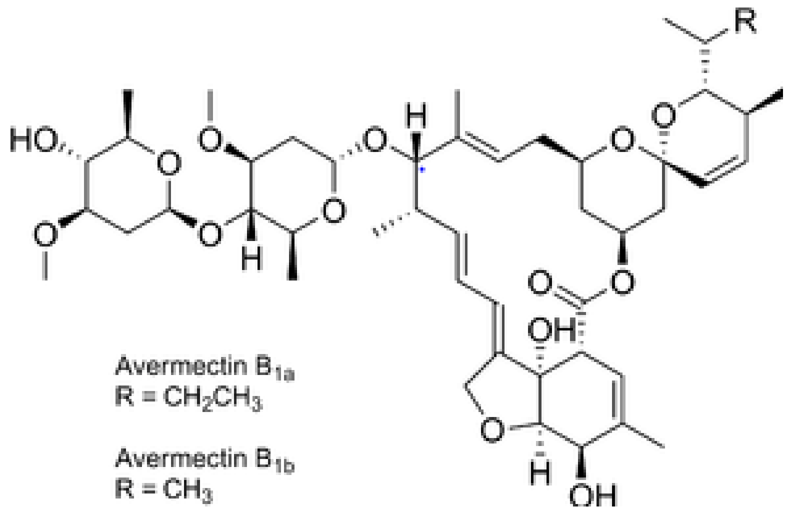

Figure 4. Basic structure of abamectin (avermectin B1a and B1b). Source: Teixeira (2015).

In doctoral thesis, Oliveira (2008) worked in controlling leafminer melon, points out that the mines affect the development of plants, especially in those young populations by removing the leaf parenchyma and the reduction of the plant photosynthetic capacity and were likely favor the entry of pathogenic organisms in plant tissue.

Many studies conducted to know the toxicological property of abamectin (Figure 4) bring synonymous nomenclatures and often seek the same goals. Abamectin constui a mixture of avermectins containing more than 80% of avermectin B1a and avermectin B1b rest. Any B1a and B1b present toxicological properties similar. The avermectin derivative is a compound obtained by bacterium *Streptomyces avermitilis* found in soil fermentation in the laboratory. The avermectins (AVMs) are macrocyclic lactones derived from fermentation of the fungus *Streptomyces avermitilis*. This group includes abamectin, ivermectin, eprinomectin, doramectin, selamectin, emamectin and drugs chemically related and used in veterinary and human medicine, as antiparasitic and in agriculture.

Currently there are among the antiparasitic drugs most used worldwide mainly due to its broad spectrum of action and good safety margin. They presents as main physico-chemical characteristics, high molecular weight and high lipophilicity, which reduce the possibility of crossing the blood brain barrier of animals, while minimizing toxic effects and also increase the persistence in the body, especially tangible in fats (TEIXEIRA, 2015).

At the same time, abamectin is a translaminar action insecticide and is considerate as substance of wide spectrum action. It works by stimulating the presynaptic release of the inhibitory neurotransmitter γ-aminobutiric acid from the terminal nerves enhancing the fixation of this acid to post sinaptics receptors, among them is the glutamate receptor. In arthropods prevents signal transmission in neuromuscular connections to the same amplification mechanism of the γ-aminobutyric acid, abamectin increase membrane permeability to calcium. The insects remain paralyzed and die irretrievably. Unlike most insecticides does not affect the cholinergic system and the observation tests; the control strains of mite resistant has been shown to insecticides and popular miticides. Considering its chemical composition way of action is not anticipated cross-resistance to other pesticides.

And knowing that the pest control occurs almost exclusively on the use of pesticides, and without a previous population survey (RODRIGUES et al., 2005; BUENO and FERNANDES, 2004), this study aimed to verify the efficiency and agronomic feasibility of different doses of commercial insecticide abamectin based on the control *Lyriomyza huidobrensis* in potato cultivation.

MATERIAL AND METHODS

The experiment was conducted at the School of Experimental Agronomy and Food Engineering / UFG, Goiânia / GO with potato cultivar Agata. The planting was made on january and led until May. The experimental site was under an altitude of 610 meters above sea level, the geographical position of longitude (S) 22 ° 64'708 " and latitude (W) 47 ° 08'504 ". The area was made up of a soil Oxisol type. The planting fertilizer was 600 kg / ha N, 200 kg / ha of P_2O_5 and 150 kg / ha K_2O. The experimental design was in randomized blocks, with six treatments and four replications, each plot was constituted by three lines ten meters long. Three sprays were carried out weekly on 02/04, 08/04 and 15/04, being initiated in the stage BBCH 21, 23 and 24, corresponding to the vegetative phase indicated the formation of side sprouting according to Meier (2001). A pressurized backpack sprayer were used fitted CO_2 with six spray nozzles TeeJet XR 11004 and VS spray volume of 400l / ha. The treatments were: control and Vertimec 84 SC at doses of 25, 50, 100 and 200 ml of p.c./ha and Vertimec 18 EC, at doses of 1000 ml p.c./ha. Evaluations were made on 50 leaflets of each portion before the first application, the seven days after the second, and the seven and fourteen days after the third application, relying on each sheet the number of mines with live larvae present at the middle third of each plant.

The data on the number of attacked leaves were transformed into percentages, which were submitted to analysis of variance as proposed design, and the averages compared by Tukey test at 5% probability. The percent efficiency of different treatments was calculated by the formula according to Abbott (1925). Therefore, the mortality data (%) of the treatments and control plot was used to calculate the effectiveness of the insecticides by Abbott Ma = fórmula (Mt - MC) / (100 - MC) x 100 wherein Ma = mortality corrected for the control treatment; Mt = mortality observed in the treatment with insecticide and MC = mortality observed in the control treatment.

RESULTS AND DISCUSSION

Food products in general, with emphasis in the case of plant products comprising fruits, vegetables, roots and tubers are perishable products, since not retained for long periods, and in many cases kept for only a few days or maximum weeks. That is why the main cause of loss is endogenous and even external factors may be of great importance, are characterized by a relatively high moisture content, are metabolically active after harvest and hence, deteriorates inevitably in any way (FREIRE JUNIOR 2015).

The advancement of technology has contributed to the knowledge and the creation and management techniques as a means to extend the retention period, however there is a maintenance limit, when the product becomes wrinkled or damaged or, still, is so changed by his own metabolism, which becomes unacceptable for food. Has - been much concerned with the agro-climatic conditions, temperature, relative humidity, level of damage by fungi, the presence of other disease-causing microorganisms, storage conditions, care during handling and transportation are factors that determine the degree of post losses -harvest vegetables thereof, which often depend on the nature of the product.

Economically quantitative losses due to the reduction in weight of food by loss of water or of dry matter must be included in the category of losses through inadequate handling and accidental losses, since they can make the product high undesirable cost for human consumption .

Both quantitative losses as the quality has great significance for the preference of the product on the market yet the quantitative are more noticeable and is more likely to be avoided. Both should be monitored because of what is expected of a healthy product. A food resuçta in healthy diet is one that meets all the requirements of the body, ie, is not below or above the needs of our body. Besides being a source of nutrients, diet involves different aspects, such as cultural, social, emotional and sensory values. People differently from other living beings to feed themselves seek not only meet their organic nutrient requirements. To have a food accepted by the consumer should take care in choosing techniques and care in production, transport and display. No feeds on nutrients but palpable food, with smell, color, texture and flavor. Therefore, food as a source of pleasure and cultural and family identity is also an important approach to promote health and satisfaction (DUTRA et al., 2009).

In bulbs and tubers, in which the breakage occurred dormancy, there is a marked increase in susceptibility to phytopathological attack. They become softer, more susceptible to mechanical injury and develop aroma and flavor characteristics which make them unsuitable for consumption. Therefore, some losses will always occur in perishable products, due to their natural physiological activity, which leads to the end of its shelf life. The causes of the plant post-harvest losses may occur separately or interactively, but may also, in some cases produce a synergistic effect. For example, if the product was collected contaminated, the contaminant associated with storage locations and management not scattered conveniently can accelerate the physiological changes of the product. In the previous evaluation is commum to find a population of leafminer of evenly distributed between the potato portions of the experiment. There was no statistical difference between the treatment and control, and between treatments and each other (Table 1).

Table 1 - Percentages average attacked leaflets (AL) in 50 collected / share and percentage efficiency (% E) of the insecticides tested to the leafminer (*L. huidobrensis*), the potato crop. Goiânia / GO, 2009.

TREATAMENT	DOSE ml of p.c./ha	PREVIOUS	DAYS AFTER APPLICATION					
			07 DA 2ªA		07 DA3ªA		14 DA3ªA	
			AL**	%E	AL**	%E	AL**	%E
Control	-	6,12a	18,00a	-	26,50a	-	34,00a	-
Vertimec 84 SC	25	7,50a	12,25ab	31,90	15,00ab	43,40	19,50ab	42,60
Vertimec 84 SC	50	6,50a	7,25b	59,70	8,25b	68,80	9,50b	72,00
Vertimec 84 SC	100	7,00a	3,25c	81,90	2,75c	89,60	5,75bc	83,00
Vertimec 84 SC	200	6,25a	0,75c	95,80	0,50c	98,10	0,50c	96,50
Vertimec 18 EC	1000	6,50a	0,50c	97,20	0,75c	97,10	1,25c	96,30
CV%	-	36,4	19,4	-	24,2	-		-

** Means followed by the same letter in the same column do not differ statistically by Tukey test at 5%; % E = percent efficiency calculated using Abbott's formula.

In any respect should consider that Brazil present a great potential country in the production of grains, vegetables and fruits, since different species can adapt to various ecosystems, due to the physiological aspects of plants to establish well with the tropical climate. Despite the climatic factors favor a good establishment of the different crops, the production of some of them is not within desired levels. Several factors contribute to this production does not reach more satisfactory levels, highlighting the use of little or no technology, due to the low level of capitalization of small producers that account for approximately 60% of national production. Another factor is the attack of insect pests that cause damage variable according to the environmental and cultural conditions which are subject, such as the establishment of monocultures, the occurrence of long periods of drought, off-season cultivation, etc. Among the control methods used are: cultural control, chemical control and biological control.

Placing the various types of controls at similar conditions technology, the choice of them depends on the knowledge and user ability. Any one of them can control pests that affect crop yields. Should be taken into account that the choice of the best method is one that results in the control of the pest, does not affect the health of human beings to consumer, the product do not leaves no residual effect on the production of consumer and soil for long time periods . Currently one product when the dynamics of production is known can be achieved by chemical or biological methods.

In agriculture, chemical control is currently the most common method for both small, medium and large producers, and is the use of chemicals such as insecticides, fungicides, bactericides, herbicides, etc. to control pests and diseases (SILVA & BATISTA, 2017) .

Despite its fast action and effectiveness, the use of chemicals has been reduced because, in most cases, cause the development of insect resistant populations the appearance of new pests or upwelling other, occurrence of biological imbalance effects harmful to man and other animals, beyond their high cost, making it therefore necessary to search for alternatives which minimize the adverse effects of synthetic insecticides to the environment.

Chemical control should only be used when the pest population reaches critical levels or achieve damage to justify the cost of treatment and the risks to humans and the environment. Therefore, in these conditions, this king of control is recommended when there is possibility of economic return.

The biological control is a natural process that is in control of populations through the use of natural enemies. Currently, biological control is approached with an intra and inter-specific view, where its use contributes to increase the sustainability of agro-ecosystems and the preservation of natural resources.

Biological control is one of the mainstays of the Integrated Pest Management (IPM), and is characterized by the maintenance of existing natural enemies, or the creation and release of predators, pathogens and parasites, and the maintenance of natural enemies made, preferably by applying selective products, for their preservation in order to avoid possible imbalances, with the increase in the outbreak of insect pests (QUINTELA, 2001).

The Biological Control stands out for being a safe, permanent, economical. It is safe, since many natural enemies are specific, thereby avoiding attack of species that are not targets. Permanent provided that suffers no interference because the natural enemies continue to act effectively for many years, without human interference is required. It is a relatively economical method because, when implemented, the natural enemies are little and gifts need to be done, but to avoid practices that affect it.

Among the disadvantages is that biological control can take a long time to be put in place as a result of research and other processes involved in its implementation, and that the results of the use of biological control practices are not as fast as those of pesticide use, and most of the natural enemies attack only specific types of animals, as opposed to broad spectrum insecticides. Silva and Batista (2017) conclude that the ideal would be to use biological control in combination with selective insecticides without bringing harm to the environment, human health and beneficial fauna. Making up this association, joins technical production technology, and thus can achieve promising results.

There are qualitative losses if not observed can take a product essential to human health from the market due to lack of observations on product quality and usually described by comparison with quality standards, accepted locally. Among these is, if the loss in flavor and aroma, deterioration in texture and appearance and are difficult to evaluate because they are made subjectively.

This fact is explained by the establishment of the migrant population in the area, and still have not been applications of insecticides for pest control. One week after the second application noted that all insecticides tested abamectin base active ingredient obtained by fermentation soil fungus from the group of actinomycetes, *Streptomyces avermitilis* Burg (Fisher & Mrozik 1989 cited by MUJICA et al., 2000) had significantly lower attack percentage compared to those observed in the control.

As for efficiency, Vertimec 84 SC treatments, doses of 100 and 200 ml p.c. / ha and Vertimec 18 EC, doses of 1000 ml p.c./ha were the only ones to provide acceptable control efficiency, ie above 80% (Table 1). The results concerning the average percentage of infested leaf also remained the same in the assessment one week after the third application and extended likewise in the evaluation fourteen days. The same was observed for efficiency, except for the doses of 25 and 50 ml of p.c./ha pesticide Vertimec 84 SC. As Bull et al. (1984) abamectin degrades rapidly on the surface of the sheet, so the residual activity depends on insect feeding areas of the plant absorbed the insecticide (DYBAS 1989). Such explanation corroborated by explaining the inefficiency of smaller doses, and the factors related to the amount of product deposited on the leaves needed in insect control. Other treatments and doses tested showed control levels above 80%. Chavarria and Carballo (1993) and Van Der Staay (1992) observed that in both field and laboratory, the high larvicidal effect of avermectin, confirming the results obtained in this study.

CONCLUSION

Therefore, to control the leafminer *L. huidobrensis* in potato crop can be said that the Vertimec 84 SC Insecticide in doses of 100 and 200 ml c.p. / ha and Vertimec 18 EC at a dose of 1000 ml pc / ha showed over 80% efficiency in weekly applications and this efficiency was extended up to fourteen days after the third and final application.

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