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THE EFFECT OF VARIOUS TYPES BIOPESTICIDES ON THRIPS POPULATION DEVELOPMENT IN CHRYSANTEMUM PLANTS (*Dendrathema grandiflora* Tzvelev)

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Abstract

Chrysanthemum (Dendrathema grandiflora Tzvelev) is an Asteraceae family, very popular ornamental plant in the family, generally characterized by aromatic, deeply lobed, alternate leaves and often large and showy flowers. The main problems in chrysanthemum business is Thrips sp. This pest can attack chrysanthemum plants in all plant growth stadia, but the most harmful attacks occur in early formation phase. Thrips pest control recommendations on chrysanthemums have been provided by various authorized agencies, including through the use of resistant varieties. This study aimed to determine the effectiveness of various bio-pesticides and microbial pesticides. The study was conducted using a randomized block design with 5 replications. The experimental unit consists of 1 m² land-plot, and each plot is planted with 100 stool with 10 x 10 cm space. Results indicated that the Neem seed, Annona muricata, and Tinospora crispa extract as biopesticides, effectively controlled the total population of Thrips nympa and adult, but has no significant different on the extracts level between three plant species on Thrips population density. The microbial pesticide (Beuveria sp.,) Jatropha curca leaf extract, Mentha cordifolia leaves, were less effective in controlling the Thrips population, although it was better than the Thrips population in control.

Key words: *Dendrathema grandiflora Tzvelev, Thrips, bio-pesticides agents, microbial pesticides*

INTRODUCTION

Chrysanthemum (*Dendrathema grandiflora* Tzvelev) is the main national floriculture industry development program commodity, as export and local commodity in line with the increasing of income and society lifestyle changing. Chrysanthemum flowers are needed for many purposes (birthday, marriages parties and other ceremonies). Domestic market demand for Chrysanthemum flowers is estimated to increase 15 - 27% per year, in 2012 the area is 9,852,612 m^2 increased to 10,914,154 m^2 by 2016, and the production also develop from 397,651,571 stalks (2012) to 404,185,586 stalks (2016). The export of Chrysantemum also rise from 57,049 kg (2013) to 60,549 kg (2016).

One of the main problems in Chrysanthemum business is Thrips sp., that attacked in all development stadia, but the most harmful are in early interest formation phase. The direct impact of Thrips attacks is the formation of a shiny silvery color on the underside of the leaves that turns brownish in an advanced attack. The most severe attack on plants is characterized by the appearance of metabolic process disorders, so the leaves malformation becomes curly and wrinkled. In severe attacks, leaves, shoots and plant buds roll inward and bumps arise like tumors followed by inhibition of plant growth. Thrips attacks often cause dwarf plants followed by the shoots. The impact of indirect attacks, in the form of transmission of viral diseases considering Thrips is a vector of mosaic virus disease and effective curly virus.

Symptoms of the attack are found in the dry season, if the insect attack is not immediately overcome, then the new buds formed will die so the plant cannot produce well. Usually Thrips pest attacks are followed by falling flower symptoms. This plant pest is very easy to see in the flowering plant, its small body extends like ants and these pests can move quickly and skip.

Thrips pest control recommendations on chrysanthemums have been provided by various authorized agencies, including through the use of resistant varieties of thrips attacks. Integrated thrips pest control measures, plant pest organism population are managed at a non-adverse level on an ongoing basis. On the other hand, to assemble the control component in an integrated manner, it is necessary information about epidemiology and bioecology to be able to give maximum effect of pest incidence without disturbing the balance of plant production ecosystem and increasing efficiency of production process by reducing the use of synthetic pesticide [11]. Based on this, it is necessary to carry out research on the effectiveness of various biopesticides on the Thrips pest population on Chrysanthemum spp.

The growing usage of chemical synthetic pesticides, is considered practical by plant lovers to control major pests and diseases. The use of biological pesticides has a positive impact on the environment even for its own users. According to World Health Organization (WHO), worldwide pesticide poisoning occurs annually between 44,000 - 2,000,000 people and of the highest number in developing countries. Pest and disease control can be done mechanically, technically and chemically. Mechanically is by catching pests that attack the plants or dispose of diseases parts of plants that are attacked by pests, or control of the technical culture between the air humidity regulation, the protective arrangement and the intensity of sunlight. The chemical control, are using insecticides and fungicides. Recommendation usage of insecticides and fungicides in the cultivation of medicinal plants are avoided, because the chemical residues can affect the medicinal compounds in the plant, so it is necessary to use biopesticide than chemical insecticides and fungicides. In general, biopesticides are defined as a pesticide whose base material is derived from plants and microbes. With advances in the field of chemistry and the development of analytical tools, many chemical compounds derived from plants have been isolated and identified even synthesized. The content of plant compounds can show various kinds of biological activity on insects such as inhibition/rejection of feeding, spanking rejection activities, growth and development inhibitory activities, and death effect, therefore the bioactive can be used to control of plant pest organism (PPO).

This study aimed to determine the effectiveness of various biological agents, consisting of biological and microbial pesticides as biopesticide.

MATERIALS AND METHODS

The solution method of biopesticide making is as follows: (1) Neems solution: one kg small cuts Neems leaves was extracted with five liters of distillated water, and soaked overnight. Then the extract was filtered and added with 1 cc of soap solution for one liter of extract as adhesive. (2) Jatropha curcas seeds, that contains a toxic active ingredient are mixed with coconut oil as bait for mice (3) *Mentha cordifolia* leaves solution: 20 grams of mint leaves boiled in water then filtered and sprayed on Chrysanthemum plants. Thrips do not like the smell so they will dodge. (4) *Tinospora crispa* solution, mixed with lime and sulfur then pounded until smooth and stirred until blended. Furthermore, the material is inserted in a vat containing water and stirred well until submerged and flattened, then remained for one week, then stirring again and filtered. The precipitate can be used as organic fertilizer while the extract as aqueous solutions with a ratio of 1:3, is used to control the Thrips. The microbiology pesticides are, the Bacillus sp., Trichoderma sp., and Beuveria sp. obtained from Entomology laboratory, Ornamental Plant Research Center Segunung, West Java, Indonesia. Other materials are soil, chrysanthemum seedlings (shoots tops), husks, fertilizers, nets, bamboo pieces, plastic straps, lamps, alcohol, paper label, root up fungicides, knives, scissors, jars, loops, microscopes, brushes, camera hoes and stationery.

The experiments using Randomized Block Design (RBD) with five replications. The experimental unit consists of one m^2 land-plot, which planted 100 cuttings with 10 x 10 cm space. Ten percent of total plant, was sampling from each plot, were taken by a random diagonal. Nine treatments, consisting of six vegetables and three microbial pesticides. The *Kulo* chrysanthemum seed, was obtained from the Department of Agriculture Tomohon City. Harvested Chrysanthemum seedlings are shoots five cm long, from the lateral buds of the parent plant. Shoot cuttings are rooted on burned husk medium and lighted. Firing is formed from 8^{th} days and is ready for use as propagation material when the rooting system has grown as intensive plants.

The treated land–plot, size 1 x 1 m^2 beds with five sub-plots for planting each varieties. Soil processing are according to the manner and habits of local farmers, each bed was given 30 ton/ha manure and liming with one ton/ha, after the manure and lime are mixed very well and let stand for one week. Urea was giving in two stages, when the plants aged 30 days and 60 days after planting, while SP36 and KCL given at the early planting time, and the weed control is done mechanically.

Thrips pest population observation was conducted on all plots by taking ten Chrysanthemum samples from each plot, in the bunch of the flower strings to observe whether or not Thrips pest was found. The Thrips, both nymph and imago found on the strands of Chrysanthemums are collected in a collection bottle containing 70% alcohol then counted. Sampling is done four times with interval once a week, from eighth weeks after planting until eleventh week, and then to calculate the average population of Thrips spp., using the formula:

(1) Average of Thrips population =
Number of Nymph or Imago found
Numbers of observation

(2) Percentage of flower attacked =
Number of flower attacks x 100%
Number of observed flower

Symptoms observation of the attacked Chrysantemum is done by taking the affected flowers and then observed the shape, color and other changes due to Thrips spp attacks. The percentage of infected flowers was done on 11-week-old plants by counting the number of flowers infected on a plurality of plant plots of each 100 plants. Criterion of flower attacked by the presence of symptoms of attack pest Thrips spp. and or the presence of nymph or imago in the flower of the sample plants.

RESULTS AND DISCUSSIONS

Number of Individual Thrips insects

Table 1. Effects of Various Control Agents on Total Number of Individuals Thrips Insects

Treatments	Total individual Thrips for each stool						
	7	21	35	49	63	74	90
1. Neems	1.82 f*)	2.79 f	3.81 f	4.17 c	4.28 e	5.41 g	5.84 fg
2. *Jatropha curcas*	29.74 ab	42.69 a	45.61 ab	48.37 a	55.31 b	60.44 ab	64.18 b
3. *Annona muricata*	5.37 ef	8.64 ef	9.23 f	10.49 c	11.73 e	13.72 f	14.29 f
4. *Mentha cordifolia*	27.38 bc	30.41 c	35.62 cd	40.16 a	40.28 c	43.01 d	45.80 d
5. *Tinospora crispa*	12.59 de	18.36 de	20.35 e	22.54 b	23.75 d	25.48 e	26.18 e
6. Bacillus sp.	17.90 cd	28.47 cd	30.52 de	42.41 a	43.83 c	50.63 bc	59.82 bc
7. Trichoderma sp.	20.42 bcd	33.16 bc	37.56 bc	45.39 a	46.82 bc	47.39 cd	49.02 cd
8. Beuveria sp.	1.42 f	2.15 f	2.31 f	2.95 c	3.01 e	3.56 g	3.99 g
9. Distilled water as control	39.35 a	38.26 ab	47.52 a	50.72 a	64.39 a	70.36 a	72.85 a

*) The average number followed by the same letter in each column is non-significant different according to Duncan's multiple range test at a real 95%
Source: Own calculation

Data on the influence of various control agents on the total number of Thrips individuals can be seen in Table 1.

In Table 1, shows that the number of individual Thrips treated with the formula Beuveria sp., is the lowest on weekly observations compared to other treatments. However, when compared with the Thrips population in Neems-treated plants, the number of individuals in the plant was not significantly difference. The *Annona muricata* seed extract is more effective to suppress the number of individual Thrips than the effect of *Tinospora crispa*, *Mentha cordifolia* and *Jatropa curcas* as the bio-pesticide, and *Tinospora crispa* plant extract is more effective in suppressing Thrips when compared with *Mentha cordifolia* leaf extract and *Jatropa curcas* but *Jatropa curcas* extract has no significant effect compared to *Mentha cordifolia* extract to Thrips population.

Among the three microbial pesticide formulas tested, the Beuveria sp formula is most effective against the thrips population density. This is because Beuveria sp. can directly colonize the Thrips body, so killed the Thrips insects. Bacillus spp., and Trichoderma spp., has no different effect on all observations when it is compared to control.

Number of Nympha Thrips

Data on the number of nympha Thrips can be seen in Table 2.

Table 2. Effects of Various Control Agents on Number of Individuals of Thrips Nympa Insects

Treatments	Total individual Thrips for each stool						
	7	21	35	49	63	74	90
1. Neem plant	1.82 e	1.55 d	1.23 e	1.90 f	1.44 c	2.16 e	2.16 e*)
2. *Jatropha curcas*	5.47 d	14.62 b	17.84 d	20.79 bc	30.46 a	34.86 ab	40.83 b
3. *Annona muricata*	3.54 de	5.89 cd	5.62 e	5.66 ef	5.66 c	6.41 de	6.82 de
4. *Mentha cordifolia* leaves	18.24 a	20.06 ab	23.25 ab	11.43 de	17.55 b	11.27 cd	13.29 d
5. *Tinospora crispa*	8.08 cd	12.14 bc	13.04 d	13.73 cd	13.95 b	12.84 cd	13.51 d
6. Bacillus sp.	12.68 bc	18.05 ab	20.18 bc	29.67 a	29.16 a	27.02 b	27.05 c
7. Trichoderma sp.	14.06 ab	22.95 a	19.08 cd	24.66 ab	17.38 b	16.88 c	16.29 d
8. Beuveria sp.	1.42 e	2.15 d	1.31 e	1.45 f	1.29 c	1.83 e	1.89 e
9. Distilled water as control	19.11 a	24.59 a	29.80 a	30.30 a	32.12 a	41.05 a	52.56 a

*) The average number followed by the same letter in each column is not significantly different according to Duncan's multiple range test at a real 95%

Source: Own calculation

Results indicated that the number of nympha Thrips varied according the treatment applied on Chrysanthemum plants. The number of nympa thrips increases following the research time increase. Treatment of neem extracts was most effective in suppressing the amount of nympha thrips compared to other treatments except the Beuveria sp treatment, has no difference of influence than the others. *Azadirachta indica* is a multi-functional plant, hence this plant is also known as the wonderful tree. The leaves and seeds of *Azadirachta indica* have many benefits [15]. The Neems seed used as biopesticides, have been widely demonstrated in several studies, including the ability to suppress Thrips population. The Neems plant contains the active substance azadiractin, glyceride oil, polyphenols, acetyloxifuranl dekahidro-tetrametil acid, heksosiklo-pentanatofiran, acetate-ketone, monoterpen, and hexahidrosi-tetrametil fenantenon [5]. Compounds such as azadirachtin serve as antifeedant to prevent, and as a repellent, also as bioinsecticides and larvacides. Neems leaf extract is safer and efficient to use because it is easy to obtain, not toxic to humans and easy to decompose, so environmental friendly [7].

Neems effectiveness in suppressing nympha Thrips turns out to be equivalent to Beuveria sp., infected the nympha Thrips directly, using hyphae or spores direct into the cuticle through the outer skin of insects. The growth of hyphae will release enzymes such as proteases, lipolytics, amylases, and chitinases.

These enzymes are capable of hydrolyzing the protein plexus commodities in the integument [2] that attacks and destroys the cuticle, allowing the hyphae to penetrate and enter and develop within the insect body. Mechanisms of infection are mechanically infected through pressure caused by the growing of *B.bassiana* conidium. The mechanical fungal infection of *B. bassiana* originates from penetration of the cuticle mycelium and then germinates and forms the apresorium,, attacks the epidermis and hypodermis. Hyphae then attacks the tissues and multiply in haemolymph [14].

The application of *Annona muricata* extract and *Tinospora crispa* have more effective effect on the population of Thrips nympha compared to the influence of *Jatropha curcas* and *Mentha cordifolia* leaves. The effectiveness of *Annona muricata* extract has been studied by several researchers. *Aedes aegypti* mosquito control research using bioinsecticide *Annona muricata* seed extract showed that the concentration between 15% to 60% caused the number of dead mosquitoes 12,5% to 97.5% for 60% concentration [12]. While *Tinospora* stem extract has also been cultured effectively controlling the earth wall because it is thought to contain many alkaloids. Results showed that the stem extract of Tinnospora crispa was effective against groundcover insect (*Scotinophara coarctata*), with 75% w/v has the better effectiveness [6].

Applications of Bacillus sp. and Trichoderma sp. has no different effect and less than *Annona muricata* leaf extract or *Tinospora crispa* extract, but can suppress nympha Thrips population compared to control. The utilization of fungi and bacteria as biological control agents has a promising prospect because of easily obtained, can prevent the occurrence of secondary pest explosions; and the plant products are free of pesticide residues; also reduce the farmers' dependence on chemical pesticides; more cheaper, safe for humans and environmentally friendly [10]. Using biopesticides to control the nympha Thrips biologically by microorganisms either mushrooms or bacteria can occur through one or several mechanisms such as antibiosis, competition, hyperparasit, induction of resistance and stimulate plant growth [9].

Table 3. Effects of Various Control Agents on Number of Individual Adult Thrips Insects

Treatments	Total individual Thrips for each stool						
	7	21	35	49	63	74	90
1. Neems plant	0.00 e	1.24 c	1.58 f	2.27 f	2.84 f	3.25 e	3.68 cd
2.*Jatropha curcas*	13.27 b	23.07 a	26.77 a	27.58 a	12.85 cd	18.58 bc	11.35 b
3.*Annona muricata*	1.83 c	2.75 c	3.61 ef	4.83 ef	5.49 def	7.31 de	9.47 bc
4.*Mentha cordifolia* leaves	9.14 bc	10.35 b	12.47 bc	18.73 cd	22.73 b	31.74 a	32.51 a
5.*Tinospora crispa*	4.51 de	6.22 bc	7.31 de	8.81 de	9.80 cde	12.64 cd	14.67 b
6. Bacillus sp.	5.22 de	9.43 b	10.34 cd	12.74 d	14.67 bc	23.61 b	32.78 a
7.Trichoderma sp.	6.36 bcd	10.21 b	17.48 b	20.73 b	29.44 ab	30.51 a	32.73 a
8. Beuveria sp.	0 e	0 c	1.0 f	1.5 f	1.62 f	3.56 e	1.89 d
9. Distilled water as control	23.44 a	28.67 a	27.72 a	30.45 a	34.27 a	36.31 a	36.79 a

*) The average number followed by the same letter in each column is not significantly different according to Duncan's multiple range test at a real 95%.
Source: Own calculation

Adult Thrips Population Density

Adult Thrips population density in the first to third weeks is still low on all treatments. But the population density of Thrips increased significantly after that, because of the change in the growth phase of the nympha phase into adulthood. The treatment of Neems seed extract, *Annona muricata*, *Tinospora crispa* and microbial pesticide Beuveria sp., has significantly reducing adult Thrips population. In contrast, the application of leaf spacing, *Mentha cordifolia* leaves, and Bacillus sp. and Trichoderma sp. as microbial pesticides has no significant effect on the emphasis of Thrips population. This is evidenced by the density of adult Thrips in all treatments, which are not significantly different from the controls. The ability to control adult Thrips insects on *Jatropha curcas* extract and *Mentha cordifolia* leaves extract is low. From the results of chemical analysis is known that *Jatropha curcas* bark contains solution of b-amyrin, and tarasterol. Meanwhile, the roots of the distance contain b-sitosterol, b-D-glucoside, marmesin, propasin, curculathyrane A and B, diterpenoid jatrophol, jatropholone A and B, chomarin tomentin, comarino-lignan jatrophin, and saponinda and flavonoid. Spacing contains curcacyline A and B compounds, saponins, flavonoids, tannins, and polyphenolic compounds. In the seed distance contained alkaloida compounds, saponins, and a kind of toxic protein called kurin. The seeds also contain 35-45% fatty oils consisting of various triglycerides of palmitic acid, stearate, and kurkalonat [1, 13].

Effectiveness of Thrips Control from Various Treatments of Biological Agents

The data in Table 4 indicates that the microbial pesticide *Beuveria* sp. most effectively controlling Thrips population, has suppression capability of 94.18 to 96.39%. Meanwhile, Thrips population suppression power by Neems treatment ranged from 91.78 to 95.37. Thus the two biological agents exhibit the highest ability to control the Thrips, compared to other treatments. And *Annona muricata* leaf extract and *Tinospora crispa,* also able to suppress the population between 77.42 - 86.35% and 52.01 - 68.01%, successively.

Mentha cordifolia leaves extract, *Jatropha curcas*, and Bacillus sp. and *Trichoderma* sp as microbial pesticides have the ability to control Thrips population are lower compared to Neems extract, *Annona muricata*, *Tinospora crispa* and microbial pesticide *Beuveria* sp. *Jatropha curcas* extract is able to suppress the Thrips population between 4.02 - 24.42%, while *Mentha cordifolia* leaves extract able to suppress Thrips population between 20.52 - 86.35%. Microbial pesticides of Bacillus sp and Trichoderma sp 16.38 to 54.51 and 10.51 to 48.10% respectively.

Table 4. Effectiveness of Thrips Insect Control from Various Treatments of Biological Agents

Treatments	Total individual Thrips for each stool						
	7	21	35	49	63	74	90
1. Neems plant	95.37 a	92.71 a	91.98 a	91.78a	93.35 a	92.31 e	91.98 a
2.*Jatropha curcas*	24.42 d	14.56 ef	4.02 f	4.63 fg	14.10 f	14.09 f	11.90 e
3.*Annona muricata*	86.35 a	77.42 b	80.58 b	79.32 b	81.78 b	80.50 b	80.38 b
4.*Mentha cordifolia* leaves	30.42 d	20.52 d	25.04 de	20.82 d	37.44 d	38.87 d	37.13 d
5.*Tinospora crispa*	68.01 b	52.01 c	57.18 c	55.56 c	63.12 c	63.78 c	64.06 c
6. Bacillus sp.	54.51 bc	25.59 b	35.77 d	16.38 e	31.93 de	28.04 e	17.88 e
7.Trichoderma sp.	48.10 d	13.32 f	20.96 e	10.51ef	27.29 f	32.65 dc	32.71 d
8. Beuveria sp.	96.39 a	94.38 a	95.14 a	94.18 a	95.33 a	94.94 a	94.52 a
9. Distilled water as control	0 e	0 f	0 f	0 g	0 g	0 g	0 f

*) The average number followed by the same letter in each column is not significantly different according to Duncan's multiple range test at a real 95%.
Source: Own calculation

Percentage of Thrips Crops

Percentage of plants attacked by Thrips can be seen in Table 5. The percentage of plants attacked by Thrips on Neems application treatment, *Annona muricata* extract, *Tinospora crispa* leaves and microbial pesticide Beuveria sp. are less; compared to other treatments and controls. The ability of Neem leaves, *Annona muricata* leaves and *Tinospora crispa* in controlling the Thrips population is destroys the development of eggs, larvae and pupa, also to inhibits skin exchange, and interferes with insect communication; causes reducing appetite and blocking the ability to eat of insects, then refuse to eat, so inhibits the reproduction female insects, at least expelling the insects.

Meanwhile, Thrips stricken plants on the treatment of *Jatropha curcas, Mentha cordifolia* leaves, Bacillus sp. and Trichoderma sp. as biopesticide were not significantly different from controls. The inability of *Jatropha curcas* agents, *Mentha cordifolia* leaves, and Bacillus sp. and Trichoderma sp. as microbial pesticides is caused of the biological agents has low control. The low efficacy may be caused by the emergence of resistance to the applied biopesticide.

Table 5. Effects of Various Control Agents on Percentage of Thrips attacks

Treatments	Thrips attack percentage on each stool						
	7	21	35	49	63	74	90
1. Neems plant	9.24 f	12.61 e	13.72 e	19..16 g	20.37 de	25.19 c	27.08 d
2.*Jatropha curcas*	24.58 bc	28.51 bc	35.72 bc	47.35 bc	58.71 b	58.44 a	67.28 ab
3.*Annona muricata*	15.62 de	19.37 de	27.53 cd	30.42 ef	31.50 cd	33.09 bc	34.30 d
4.*Mentha cordifolia* leaves	26.28 b	32.63 b	36.71 b	41.36 cd	46.31 b	49.03 a	51.84 c
5.*Tinospora crispa*	17.31 cd	16.43 e	22.31 d	25.31 ef	33.15 c	38.45 b	36.17 d
6. Bacillus sp.	16.33 d	18.32 de	22.52 d	34.41 de	36.87 c	50.30 a	60.82 bc
7.Trichoderma sp.	13.26 de	23.17 cd	32.50 bc	55.39 b	48.42 b	51.12 a	62.14 b
8. Beuveria sp.	1.42 f	12.15 e	12.31 e	12.95 b	13.01 c	13.56 d	13.99 c
9. Distilled water as control	38.42 a	58.46 a	55.52 a	62.72 a	69.47 a	58.53 a	72.34 a

*) The average number followed by the same letter in each column is not significantly different according to Duncan's multiple range test at a real 95%
Source: Own calculation

Resistance in the field that is sometimes indicated by the decreased effectiveness of a control technology does not occur in a short period of time [8]. Pesticide resistance develops after a selection process that lasts for many generations. Resistance is an evolutionary phenomenon caused by selective selection of insecticide-treated insect pests.

In the natural frequency, the susceptible individual alleles are greater than the frequency of resistant individual alleles. Due to the persistent selection of sensitive individuals in a population and leaving resistant individuals. These resistant individuals will mate with one another to produce resistant offspring as well. Populations that remain alive in early pesticide applications will increase the proportion of individuals who are resistant to compounds and continue this trait on their offspring. Since pesticide users often assume that living pest individuals have not received lethal doses, farmers take action by increasing the dose of pesticides and application frequency. This action resulted in the disappearance of the proportion of sensitive individuals. This action increases the proportion of individuals who survive. From generation to generation the proportion of resistant individuals in a population will increase and eventually the population will be dominated by resistant individuals. Resistance will not be a problem until a population is dominated by resistant individuals so that pest control becomes ineffective.

One of the factors affecting the rate of development of resistance is the level of selection pressure received by an insect population. Under the same conditions, a population that receives more severe pressure will develop into a resistant population in a shorter time than the pest population that receives weak selection pressures.

Factors contributing to the development of resistance include genetic, biological and operational factors. Genetic factors include the frequency, number and dominance of resistant alleles. Biological-ecological factors include pest behavior, number of generations per year, longevity, mobility and migration [3]. Operational factors include the type and nature of the insecticides used previously, persistence, number of applications and target stage, dosage, frequency and mode of application, formulations, and others. Genetic and biological-ecological factors are more difficult to manage than operational factors [4]. Genetic and biological factors are the original properties of insects so that it is beyond of our control. By studying these properties can be calculated the risk of the emergence of a resident population of an insect species.

CONCLUSIONS

Neems seeds, *Annona moricata* leaves, and *Tinospora crispa* extracts are effectively controlled the total population of individual nymph and adult Thrips populations. The level of effectiveness of controlling the extracts of these three plant species on Thrips population density is not different from the microbial pesticide Beuveria sp. Meanwhile, *Jatropha curca* extract, *Mentha cordifolia* leaves, and microbial pesticide Bacillus sp. and Trichoderma sp. are less effective in controlling the Thrips population, although it is better than the Thrips population in control plants.

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