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Biocontrol of Potato Aphids by Insect Bio-Agents

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Abstract

This research was conducted on potato plant in greenhouse of people friendship university of Russia in Moscow region in July 2024 at temperature of 20 – 27 C and optimal humidity of 70-80%. The aim of this study was to evaluate the efficiency of biological control of aphids by four bio-agents to know which one of these bio-agents has more biological efficiency on aphids. Parasite wasp, Lady beetle, Damsel and lacewings on potato. Interval of this research was two weeks and four bio-agents have been released on potato plant in greenhouse. The release rate of beo-agents is 100/10m2. Per day each these four bio-agents Damsel bug, Ladybug, parasitic wasp and Green lacewing eliminated (42, 50, 47 and 45 respectively. The efficiency of bio-agents and the result of this study indicated, that these four bio-agents, Damsel bugs, Lady Beetles, parasitic wasps and Lacewings have controlled the population of aphids on potato plants 84%, 100%, 94% and 90% respectively. Among four bio-agents Damsel bugs had the lease biological efficiency and Ladybug had the most biological efficiency in controlling of aphids on potato plants. In overall, they controlled 92% population of the potato aphids in greenhouses. The most effective biological control of potato aphids are these three beneficial insects such as ladybugs, parasitic wasps and lacewings.

Keywords: Pests, Biocontrol, Plants, Bio-Agents, Macrosiphum Euphorbiae, Potatoes

1. Introduction

Potato aphids (Macrosiphum euphorbiae) is origin from north America then distributed throughout the world [1]. Potato aphid color is green or pink, and rarely with a darker dorsal stripe. It has a pear-shaped body almost 0,7 to 7 millimetres long and well-known to plant-ice [2]. The antennae are dark. Their legs are longer than other aphids. Develop at optimal temperature of 20-25 C and optimal humidity of 70-80%. Colonies on plants of the same species; In the autumn, a bisexual generation develops, the females of which lay wintering eggs. Potatoes aphids feed commonly on the leaves of the plants which cause the leaves to become curling, distorted and yellow, the damage commonly appears on the younger parts of the plants. Heavy infestation of aphids decreases the growth of plants and can stunt. Potatoes aphids are a serious problem to the farmers in the world, the damage of the aphids can be 40% to the plants and the aphids can be cause potential damages to the human purposes and ecosystems [3].

The use of biological control method seems to be the most reasonable way in the modern world, the harmful effects of the use of pesticides on humans and other living beings on earth are more or less known to everyone. The recorded history of biological control dates back to 4,000-year-old Egyptian documents, where domestic cats were used as useful in controlling rodents. Chinese citrus growers placed nests of predatory ants. (A. H. S. Smith, 1919), first used term "biological control" to signify the use of natural enemies whether introduced to control insect pests [4]. (B. P. De Bach, 1964), further refined the term and distinquished "natural control" from "biological control" [5].

From very ancient times, even from the Renaissance in Europe, there have been examples of attempts by human of that time to use the biological method. Pesticides contaminate the soils, environment and foods and they are very dangerious to human that they do not need further explanation. But the problems caused by the indiscriminate use of pesticides become more tangible when we know that the continuation of this uncertain process will cause an outbreak of pests and, what is worse, the emergence of new pests, they will complicate the situation even more than before. Given these explanations for the development, the use of the biological control method seems to be the most reasonable way in the modern world. The harmful effects of the use of pesticides on human and other living beings on earth are more or less known to everyone. human in the modern world has realized that pesticides not only have not solved the problems but also can cause the emergence of new pests. (B. P. De Bach,1964), further refined the term and distinquished "natural control" from "biological control" [5].

Parasitoids, predators and pathogens are components of biocontrol of insect pests (Memmott et al, 2000). In biocontrol, parasitoids have an advantage over predators because they are host-specific, better adapted in their relationships, and also have a lower food requirement per person, thus maintaining equilibrium with their host species at lower host densities and their larvae don't need to forage (van Lenteren, 1986; Sigsgaard and Hansen, 2000). Parasitoids are used more frequently than predators in biocontrol programs for about 80% of all biocontrol (Hokkanen, 1985). More than 300 agricultural and urban insect pests in over 100 countries are currently controlled by biocontrol agents. Although the above success rate is very low (about 10,000 species of insects are recognized as pests). Research and development in the field of biocontrol is very limited compared to synthetic pesticides Voilier (1976) [6].

The efficiency of bio-agents and the result of this study indicated, that these four bio-agents, Damsel bugs, Lady Beetles, parasitic wasps and Lacewings have controlled the population of aphids on potato plants 84%, 100%, 94% and 90% respectively. Among four bio-agents Damsel bugs had the lease biological efficiency and Ladybug had the most biological efficiency in controlling of aphids on potato plants. In overall, they controlled 92% population of aphids [7].

2. Materials & Methods

A field experiment to evaluate the effectiveness of the use of four bio-agents against Aphids on potatoes was done on an experimental field of the people friendship university of Russia Research Agro-biotechnology institute, which is located in the city of Moscow in July 2024. The objective of this research was to estimate the efficiency of four bio-agents against aphid on potatoes plants. We released bio-agents against aphids to evaluate the efficiency of four bio-agents in greenhouses. The soil PH was 6 in greenhouse. Aphidius colemani, Coccinella septempunctata, Nabis rogusus and Chrysoperla spp. The release rates and time of these four bio-agents were the same 100 bio-agents in 10-meter square in two weeks, four bio-agents (Damsel bug, Ladybug, parasitic wasp and lacewings) were applied and were tested, the number of bio-agents against aphids on potato plants in greenhouses, 400 bio-agents were in total. 100 Damsel bugs, 100 Ladybugs, 100 parasitic wasps and 100 Lacewings. We have calculated the numbers of aphids that were controlled by each bio-agents on potato plants in four separated greenhouses, each bio-agents were tested and each greenhouse were 10 meters square. The calculation of biological efficiency of bio-agents was carried out according to the formula E = (A x B / C) 100 where: E - efficiency in % A – Number of Aphids controlled per days; C – the total aphids before control or processing [9].

3. Results & Discussions

To protect potato plants from aphids in greenhouses, in the presence of food, the larvae complete their development and pupate in greenhouses. The duration of the protective effect from release is 3-14 days depending on the temperature and the type of bio-agents. In potato plantings, protective measures should ensure the complete absence of aphids in greenhouses. Therefore, the strategy of releasing younger larvae in the expectation of further development of bio-agents due to feeding on phytophages can't be implemented. In the absence of the pest, Aphidius colemani, Coccinella septempunctata age die without food within 2 days. Even if the larva finds a victim after a 2-day starvation, this cannot compensate for its loss in weight and viability. Compensatory growth of larvae after a short-term starvation is possible only at the IV age. According to our data obtained as a result of mass and individual breeding of Aphids, Coccinella septempunctata, a 2-day food deficit for II-III instar larvae led to irreversible negative consequences, which was expressed in a decrease in the proportion of larvae that molted to IV instar to 8-12% with individual breeding. With mass breeding, this indicator rose to 25-28%, apparently due to cannibalism [10].

After the release of younger larvae, already after 4-8 days, a significant (85-95%) decrease in their numbers is observed, despite the presence of aphids in the agrocenosis. Obviously, in the absence of a victim, the decline in the number of released larvae will be even more rapid A possible ecogenetic mechanism that ensures the effectiveness of the proposed variant of preventive colonization of Coccinella septempunctata was the heterogeneity of the physiological reactions of this species to food stress (absence of aphids). The population included a certain proportion of instar larvae that delayed metamorphosis under food stress, despite the fact that the amount of accumulated nutrients allowed them to pupate. It can be assumed that these larvae remained on the plants and contributed to the protective effect of preventive colonization. However, the main role in the preventive release of Coccinella septempunctata was apparently played by IV instar larvae that had not gained the threshold mass necessary for metamorphosis. In laboratory experiments, when kept individually without food, larvae with a mass deficit retained motor activity 3-4 times longer than individuals that had already reached the pupation threshold. Among the larvae (20-29 mg) released into the greenhouse, the proportion of individuals with a subthreshold mass was significant (about 50%). In order to survive in the greenhouse, they had to find food. This could be aphids or individuals of their own species (larva, pupa, young imago). C. septempunctata are characterized by cannibalism. Eating individuals of their own species is an integral part of the behavioral stereotype of C. septempunctata [11]. Perhaps it was cannibalism that gave larvae with a subthreshold mass a chance to survive in the greenhouse. When using larvae from the size class (20-29 mg) recommended by us, the expected losses from cannibalism will be partially compensated by a decrease in mortality among larvae with a subthreshold mass [12]. In the green house experiment of people friendship university of Russia on the control without bio-agents, potato plants were affected by dangerous aphids' pests' figure 1.

Figure 1: Shows the Aphids are Under the Potato Leaves

The highest percentage potato plants affected by aphids was recorded - 35%. At the same time, the less damage of 25% was noted against the natural background of mineral nutrition. In the variants, where bio-agents were used a significant decrease in the harmfulness of the aphids was observed. The tendency to increase the infestation of plants with aphids with an increase in the level of mineral nutrition of plants has been observed. The degree of aphid Development before the applying of Damsel bugs, Ladybugs, parasitic wasps and Lacewings was 30 % in greenhouses. 100 lady bugs have been released on potato plants in greenhouse, the adults and larvae lady bugs attacked on potato aphids Macrosiphum eurphorbiae. Every adult or larvae ladybug eliminated 50 aphids per day in greenhouse which we recorded. In this study was the highest among four bio-agents Parasitic wasps laid their eggs inside the aphids then the eggs developed inside the aphids become larvae, the larvae killed the aphids, leaving mammies, (Figure 2) [13].

Figure 2: Shows the Aphids are Under the Potato Leaves

Single female lacewings laid up 295 eggs in groups on surface of leaves. The larvae of lacewings are well-known to aphidlions and they are feeders that consumed around 400 aphids in two weeks, Lacewings its larvae attacked on potato aphids. Each these four bio-agents per day (Damsel bug, Ladybug, parasitic wasp and Green lacewings) eliminated (42, 50, 47 and 45 respectively. The efficiency of four bio-agents and the results of this study have been indicated as follow: these four bio-agents (Damsel bugs Lady Beetles, predators' wasps and Lacewings (84%, 100%, 94% and 90% respectively against aphids on potato plants. In over all They have controlled 92% of the population of the plant aphids on potato plants in greenhouse during two weeks (Figure 3 and table 1). Aphids have so many natural enemies like predators and parasites that they can be have so high effective, the abilities and potentialities were very high for successful biological control of potato aphids in the greenhouses [14].

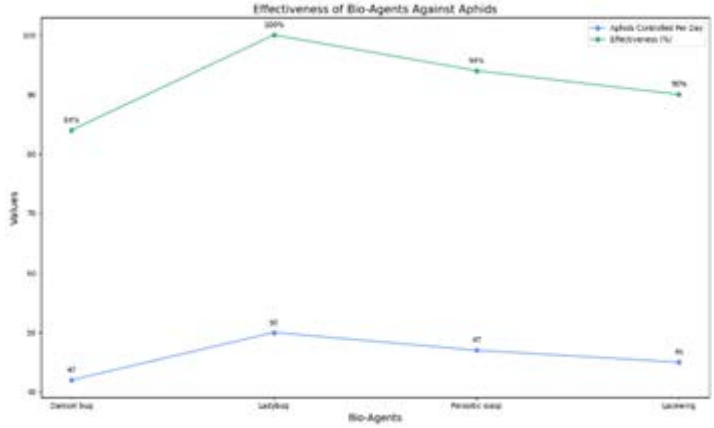

Figure 3: Bar Chart Indicates the Effectiveness of Four Bio-Agents on Potato Aphids in Greenhouses

Bio-agent	Host plant	No of release	interval	Aphids before control	Aphids controlled per day by single bio-agent	Effectiveness
Damsel bug	potato	100/10m2	14 days	700	42	84%
Lady bug	potato	100/10m2	14 days	700	50	100%
Parasitic wasp	potato	100/10m2	14 days	700	47	94%
Lacewing	potato	100/10m2	14days	700	45	90%

Table 1: Indicates the Biological Effectiveness of four Bio-Agents Against Potato Aphids in Greenhouse that was Tested.

Shows the effectiveness of bio-agents, number of release and single bio-agent controlled per day the potato aphids in greenhouses during two weeks of this study [15].

Equations:

(Eq. (1)). $E = \left(\frac{A \times B}{C}\right) 100$

where: E - efficiency in % A – Number of Aphids controlled per days; B- the number of days; C – the total aphids before control or processing.

$$\text{Effectiveness (\%)} = \left(\frac{\text{Total Aphids Controlled}}{\text{Total Aphids before Control}}\right) \times 100$$

Interval: 2 weeks (14 days)

Total Aphids have been Controlled by single bio-agent per day: [42, 50, 47, 45]

We first calculate the total aphids controlled be single bio-agents in 14-days interval:

1. Damsel Bug
Total Aphids Controlled=42×14=588
2. Ladybug
Total Aphids Controlled=50×14=700
3. Parasitic Wasp
Total Aphids Controlled=47×14=658
4. Lacewing
Total Aphids Controlled=45×14=630

Effectiveness Calculation

1. Damsel Bug
Effectiveness (%)=(588/700)×100=84
2. Ladybug
Effectiveness (%)=(700/700)×100=100
3. Parasitic Wasp
Effectiveness (%)=(658/700)×100=94
4. Lacewing
Effectiveness (%)=(630/700)×100=90

Summary of Effectiveness:

- Damsel Bug: 84%
- Ladybug: 100%
- Parasitic Wasp: 94%
- Lacewing: 90%

In overall, effectiveness 0f bio-agents on potato aphids $= \left(\frac{84\%+100\%+94+90\%}{4}\right) = 92\%$

4. Conclusion

In contrast to chemical pesticides, biocontrol methods are environmentally sustainable. They do not abandon harmful compounds into water, soil and food and have minimal impact on beneficial organisms and our ecosystems. These bio-agents are the most effective when they are used as part of an integrated pest management strategy. Higher effectiveness is expected, when they are properlyapplied, in recommended release rates and at optimal timing. In the result of the studies, it has shown that the use of bio-agents on potato plants against aphids in the humidity conditions of Moscow climate and region ensured effectiveness against aphids by Damsel bugs, Ladybugs, Parasitic wasps and Lacewings at the level of 84%, 100%, 94% and 90% respectively. The biological effectiveness of four bio-agents treatments in controlling aphids on potato plant in greenhouses was evaluated in field trials conducted in July 2024, in Moscow Oblast. Among these four bio-agents Green Lacewings had the lease efficiency and Ladybugs had the most efficiency in controlling of aphids on potato plants in experimental greenhouse of RUDN university. in over all They have controlled nearly 92% of the population of the aphids on potato aphids in greenhouses during two weeks of this research, we have found in this research that among these four bio-agents Lady bugs have the more biological efficiency in control of potatoes aphids. We recommend to the farmers to use from these three beneficial insects such as ladybugs, parasitic wasps and lacewings in controlling of potato aphids.

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