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REVIEW: CONTROL OF STRAWBERRY APHIDS (*Chaetosiphon fragaefolii; Aphididae*) THROUGH SUSTAINABLE NATURAL MATERIALS IN STRAWBERRY (*Fragaria x ananassa*) CULTIVATION

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ABSTRACT

Leaf aphid (Chaetosiphon fragaefolii; Aphididae) is one of the pests that attack Strawberry plants (Fragaria x ananassa) which can transmit infective viruses to Strawberry plants (Fragaria x ananassa). Symptoms caused by leaf aphids (Chaetosiphon fragaefolii) include sooty mold, dwarfed growth, twisted stems, curling, and yellowing. Farmers will suffer losses caused by the symptoms of leaf aphids (Chaetosiphon fragaefolii) such as significant decreases in Strawberry (Fragaria x ananassa) harvest yields. The methodology used in this article review is by conducting literature studies from various platforms such as Google Scholar, Science Direct, Bing AI, Publish or Perish, and SINTA from the Ministry of Education and Culture. The literature obtained consists of 60 journals discussing leaf aphids (Chaetosiphon fragaefolii) attacking Strawberry plants (Fragaria x ananassa), symptoms caused by leaf aphids (Chaetosiphon fragaefolii), and leaf aphid (Chaetosiphon fragaefolii) control methods. Then the literature obtained is summarized and organized using Mendeley. The aim of this literature study is to examine ways to control leaf aphids (Chaetosiphon fragaefolii) attacking Strawberry plants (Fragaria x ananassa) using natural materials. The results for controlling leaf aphids (Chaetosiphon fragaefolii) through natural materials are as follows: Entomopathogenic fungi: Beauveria bassiana and Metarhizium sp. Parasitoids: Aphelinus varipes, Predators: Syrphidae family, Asilidae family, Orius insidiosus, Cycloneda sanguinea, Eriopis connexa, and Coleomegilla quadrifasciata. Organic pesticides: neem leaves with a concentration of 35 (g/l of water) and mortality of 8.76 individuals, while papaya leaves using a concentration of 30 ml/liter of water.

KEYWORDS *Aphididae, Control, Strawberry*

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INTRODUCTION

Strawberry (*Fragaria x ananassa*) is one of the favorite fruits in Indonesia. Although strawberries are not native to Indonesia, people often consume them in both raw and processed forms. Processed products derived from strawberries, such as syrup, jam, dodol, and strawberry juice, are popular (Amri, 2022). Strawberry plants originate from the American continent. According to Soviet botanist Nikolai Ivanovich Vavilov, who traveled through Asia, Africa, Europe, and America from 1887 to 1942, strawberries are believed to have originated from Chile. The first variety or seed of strawberries found in Chile is *Fragaria chiloensis* (L), known as Duchene or Chili strawberries (Sinaga & Laia, 2020). Therefore, considering the origin of strawberries (*Fragaria x ananassa*), these plants require a cool and humid environment. The suitable growing conditions include an average temperature ranging from 17–20°C, humidity of 80–90%, 8-10 hours of sunlight per day, and annual rainfall of around 600mm–700mm (Mahardika et al., 2023).

In Indonesia, the main areas for strawberry (*Fragaria x ananassa*) cultivation are Lembang, Ciwidey in Bandung, Cipanas in Cianjur, Tawangmangu in Karanganyar, Batu in Malang, Bedugul in Bali, Karangmulya in Garut, and Sawangan in Magelang (Hutajulu et al., 2018). The production of strawberries in Indonesia fluctuated from 2008 to 2017, showing a declining trend. It contributed to 73.32% of the total domestic strawberry production (Silaban & Trimo, 2021). In 2014, the harvest yielded 58,884 tons, while in 2020, strawberry production only reached 8,350 tons (Oktavia et al., 2022).

The decrease in strawberry production is influenced by Plant Pests (*Pest Organisms*) (Offayana et al., 2016). Pest attacks on strawberry plants (*Fragaria x ananassa*) can be observed in changes to leaves, roots, stems, and fruit (Efrilla et al., 2020). Identifying pests in strawberry plants is crucial to detect diseases early for early prevention before these pests spread. Failure to promptly identify and control strawberry pests can lead to losses for farmers (Dong et al., 2021). One of the pests in strawberry cultivation (*Fragaria x ananassa*) is the aphid, which belongs to the Aphididae family (Indira & Trimo, 2021).

Currently, the trend in pest control involves the use of synthetic pesticides, but the results obtained are often ineffective and even detrimental to humans and the agroecosystem environment (Sopialena et al., 2020). This is evident in the absence of natural enemies, leading to an increase in the number of pest insects, diseases, and even weeds tolerant to pesticides, as well as a reduction in natural enemies in cultivation habitats. Broad-spectrum chemical pesticides can have negative impacts on the environment, non-target insects, and human health due to resistance factors (Baroffio et al., 2018). Resistance to insecticides has been reported in 500 species of insects, 100 species of pathogens, 50 species of weeds, 5 species of rodents, and 2 species of nematodes. This number increases every year (Robika et al., 2019). The use of broad-spectrum chemical insecticides can result in the accumulation of pesticide residues in the soil, making them difficult to degrade. If consumed, fruits containing residues can cause various degenerative diseases such as cancer due to their toxic nature. Accumulated pesticides in the soil can lead to resistance in pests and soil damage (Patmawati et al., 2020). Therefore, sustainable alternatives for insect pest control are increasing, including biological control using

parasitoids, predators, and entomopathogenic fungi (Bischoff et al., 2023). The use of botanical pesticides provides an environmentally friendly alternative for controlling plant pests in strawberry cultivation (Hutapea et al., 2020).

RESEARCH METHOD

The methodology used in this article review involves conducting a literature study from various platforms such as Google Scholar, ScienceDirect, Bing AI, Publish or Perish, and SINTA from the Ministry of Education and Culture. A total of 60 journals discussing the strawberry aphid (Chaetosiphon fragaefolii) attacking strawberry plants (Fragaria x ananassa), the symptoms of aphid infestation caused by Chaetosiphon fragaefolii, and the control of Chaetosiphon fragaefolii were obtained. The obtained literature was then summarized and organized using Mendeley.

RESULT AND DISCUSSION

BACKGROUND OF APHIDS

Aphids (Aphididae) are one of the pests that attack strawberry plants (*Fragaria x ananassa*) (Indira & Trimo, 2021). Aphids (Aphididae) are pests classified under the order Hemiptera (Puspita et al., 2022). They are considered one of the most destructive groups of pests worldwide. Approximately 450 out of more than 5,000 plant species have been documented, with about 100 belonging to the Aphidinae subfamily and are considered economically significant. Most aphid species feed on one or more plant species, but only 18 species are considered truly polyphagous (Bass & Nauen, 2023). Polyphagous aphids are more likely to transmit plant diseases (Maharani et al., 2018).

In the Aphididae family, a common pest found on strawberry plants (*Fragaria x ananassa*) is Chaetosiphon fragaefolii. This species can transmit viruses that infect strawberry plants. The transmitted viruses include yellow edge virus (*Potexvirus; Alphaflexiviridae*), streak virus (*Secoviridae*), Strawberry Crinkle Virus (*Fragaria x ananassa*) (*Cytorhabdovirus; Rhabdoviridae*), and Strawberry Vein Banding Virus (*Fragaria x ananassa*) (*Caulimovirus; Caulimoviridae*) (Bonneau et al., 2019).

MORPHOLOGY

Figure 1. Alata type

Figure 2. Aptera type

(sumber:www6.inrae.fr) (sumber :antropocene.it)

Chaetosiphon fragaefolii

According to the study by (Rondon & Cantliffe, 2004), the morphology of the aphid Chaetosiphon fragaefolii reveals that its eggs are whitish to yellowish. The nymph is small, measuring around 0.8–1.1 mm, making it similar in appearance to the adult Chaetosiphon fragaefolii. The nymph's color varies from light green to pale yellow. Adult Chaetosiphon fragaefolii has a length of 1.3–1.5 mm, with a pale to yellowish-green color and short setae (hairs) covering its entire body. The antenna is of the same length as its body or longer. Cornicles are approximately 1/4 of the body length, pale in color, slender, and the legs are pale green and almost transparent. Adult Chaetosiphon fragaefolii without wings are small, ranging from 0.9-1.3 mm, while winged ones are medium-sized, ranging from 1.3–1.5 cm, elongated, transparent, and either whitish-yellow or pale green.

Life Cycle

Aphids have two types of life cycles: sexual and asexual. Asexual reproduction in aphids occurs only through parthenogenesis, where aphids can reproduce without mating. Aphids live attached to a host throughout the year and undergo sexual morph reproduction to produce genetically recombined eggs on the host plant in the fall. In cold temperatures, aphids reproduce parthenogenetically without wings (fundatrix) giving birth to viviparous nymphs (Bhatt et al., 2018). There are two types of aphids in the life cycle: alate types with wings (sexual) and aptera types without wings (asexual) (Manuhutu et al., 2020). A wingless female can give birth to an average of 68.2 nymphs, while a winged female gives birth to 49 nymphs. Aphids have four instars, and the nymphal stage lasts for 16 days at 15°C, nine days at 20°C, five days at 30°C, and adults can live for about 4-12 days. Adult aphids are more active at warm temperatures ranging from 17°C to 27°C (Sari et al., 2020).

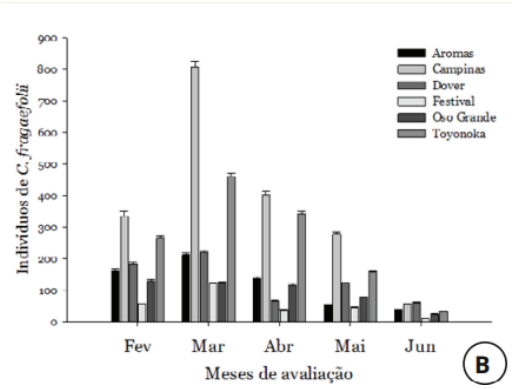

Table 1.Population density of Chaetosiphon fragaefolii (Guimarães et al., 2018)

Meses	Temperatura média (ºC)	Umidade (% b.u.)
jan	20,33	77,94
fev	21,09	70,18
mar	22,02	60,85
abr	19,18	77,90
mai	16,47	81,42
jun	16,95	67,00

Table 2. Average temperature and humidity during the experiment (Guimarães et al., 2018)

Based on research conducted (Guimarães et al., 2018) of the 6 varieties tested the highest population density in aphids (*Chaetosiphon fragaefolii*) occurred in March which was caused by the air temperature in the study environment reached 22.02 °C, while in April, May and June began to experience a decrease in population which was also caused by the temperature dropping. This is because at high temperatures or dry seasons, pests can experience population spikes (Taylo &; Magdalita, 2021). While pest populations at the lowest temperatures, will experience slow growth (Wardani, 2015).

Symptoms

Figure 3. Symptoms of Chaetosiphon fragaefolii infestation (source: personal documentation)

This pest damages plants directly by extracting their nutrients and excreting honeydew, leading to the growth of sooty mold (Capnodium sp.) on the leaf surfaces (Foda et al., 2021). The honeydew can attract ants that use it as a food source (Maharani et al., 2020). As a result, photosynthesis and respiration in strawberry plants (*Fragaria x ananassa*) are hindered. Aphids also indirectly harm plants by transmitting viruses to them (Marianah, 2020). Symptoms of the infestation are more clearly visible on younger plants. In severe infestations, the growth becomes stunted, and the stems may twist, curl, and sometimes turn yellow (Kessek et al., 2015).

CONTROL

Control of aphids (Chaetosiphon fragaefolii) on strawberry plants (*Fragaria x ananassa*) can be achieved using four natural substances: Entomopathogenic fungus, Parasitoid, Predator, and Organic Pesticide.

Entomopathogenic Fungus

The entomopathogenic fungi that can control aphids (*Chaetosiphon fragaefolii*) are *Beauveria bassiana* and *Metarhizium sp*.

Beauveria bassiana

Beauveria bassiana is an entomopathogenic fungus that can control aphids. This fungus can produce various extracellular enzymes such as chitinase, lipase, and protease, which function to break down the insect cuticle and release toxins. The produced toxins include bassianin, bassiacridin, beauvericin, bassianolide, beauverolides, tenellin, isoralit, oosporein, and oxalic acid, which can increase blood pH, blood clotting, and stop blood circulation. The toxins from *Beauveria bassiana* also cause damage to tissues in muscles, the digestive system, the respiratory system, and the nervous system (Fadhilah & Asri, 2019). *Beauveria bassiana* can effectively control pests with a mortality rate of 90% at a concentration of 0.4 grams/L of water (Arsensi et al., 2022). The attack mechanism of *Beauveria bassiana* involves spores entering the body of the host insect through the skin, digestive tract, spiracles, and other openings. Additionally, fungal inoculum attached to the body of the host insect can germinate and develop into germ tubes, then penetrate the insect's cuticle. The penetration is done mechanically and/or chemically by releasing enzymes or toxins. The fungus then releases the toxin beauverin, causing damage to the insect's body tissues. Within days, the insect will die. Subsequently, the fungal mycelium will grow throughout the insect's body. The infected insect will die with its body hardening like a mummy and covered by white hyphal threads (Sopialena et al., 2021).

***Metarizium* sp.**

Metarhizium sp. is an entomopathogenic fungus that can control pests in the Aphididae family (Wathi et al., 2015). This fungus can penetrate the body of the host insect through two methods: mechanical pressure and the assistance of toxins produced by the entomopathogenic fungus (Hasyim et al., 2016). The attack of the fungus on insects is characterized by the insect's body becoming stiff and hard, resembling a mummy, and hyphae emerging from the insect's body attacked by the fungus. However, for *Metarhizium sp*., over time, the infected larvae will change color from white hyphae to green (Arsi et al., 2020). The application of *Metarhizium sp*. is done once during the vegetative phase of the plants. The application is carried out in the evening with a concentration of 20 g per liter of water, with a spraying volume of 70 m per plant cluster. This application is effective in infecting and causing death to aphids, reducing the population of aphids (*Chaetosiphon fragaefolii*) (Hasibuan et al., 2014).

Parasitoid

Parasitoids that can control aphids (*Chaetosiphon fragaefolii*) are *Aphelinus varipes* (Lahiri et al., 2022).

Aphelinus varipes

Aphelinus varipes is a species of parasitoid wasp found attacking aphids. Aphelinus species are small in size (about 1 mm long) and are weak fliers. In search of hosts and mates Aphelinus varipes often performs walking. Aphelinus females

in parasitizing aphids prefer instar 2 to 4th intar to lay eggs, but can also lay eggs at all stages (Hopper et al., 2019). The parasitoid mechanism *of Aphelinus varipes* is carried out by the mother who lays eggs in the host's skin or inserts directly into the host's body through its ovipositor. after hatching, parasite larvae suck body fluids from the host or feed on body parts (Hopper et al., 2017). there is a temperature of 20o C, wasps develop from eggs to pupae in about 14 days; third instar wasps kill their host, leaving the host intact, the external skeleton of the tick host; (exoskeleton) hardened and black, in a process called mummification. Adult aphelinus varipes appears about one week after pupation by chewing a hole through the host's exoskeleton (Stewart, 2021).

Predator

The order Diptera includes two families that can act as natural controllers of aphids (*Chaetosiphon fragaefolii*). The two families are Syrphidae and Asilidae. Syrphidae is one of the important predators that control the presence of aphids (*Chaetosiphon fragaefolii*). Syrphidae populations reach their maximum at a food density of 100 aphids per day at 22°C. This makes Syrphidae a potential predator that responds positively to the presence of aphids (*Chaetosiphon fragaefolii*) (Rizal et al., 2018). In the family Asilidae also called robber flies or grass flies, have predatory properties and attack various insects, can even attack animals larger than their bodies. Most of the Asilidae family catches flying prey, but *Leptogastinae* usually attack resting or perching insects (Solikhatin et al., 2021). The natural predator of aphids (*Chaetosiphon fragaefolii*) is also present in the order Hemiptera and order Coleoptera. In the order Hemiptera there is *Orius insidiosus,* while the order Coleoptera there are 3 predatory insects, namely *Cycloneda sanguinea*, Eriopis connexa *and* Coleomegilla quadrifasciata *(Francesena et al., 2019).* Generalist predators of the genus Orius (small pirate insects) feed on various types of prey. They are voracious predators at all stages of their active life, which means they can be released at different stages of development. *Orius insidiosus* attacks many soft-bodied arthropods such as aphids (*Chaetosiphon fragaefolii*) (Johnson & Hooks, 2021). Predatory insects from the Order of coleoptera known as cocci beetles can control aphids (*Chaetosiphon fragaefolii*) by preying on 20-90 pests per day, so that the effectiveness ability is very high both imago and larvae (Efendi et al., 2018).

Organic Pesticides

Organic pesticides that effectively control aphids (*Chaetosiphon fragaefolii*) are neem leaves (*Azadirachta indica)* and papaya leaves (*Carica papaya*)

Azadirachta indica

Neem leaves (*Azadirachta indica*) are biopesticides that can affect the phylum of Arthropods which include the aphididae family, *Chaetosiphon fragaefolii* (Pramita &; Murlistyarini, 2020). Neem leaf extract contains the active ingredient azadirachtin. Azadirachtin is toxic although this extract compound does not directly

kill insects, but affects activities such as reducing appetite, inhibiting growth, and inhibiting egg reproduction and hatching (Sidauruk et al., 2019). Azadirachtin active compounds enter the nymph's body through three pathways, namely the respiratory tract, toxic compounds, physical contact, and digestive tract (Rajab et al., 2018). The concentration of neem leaf insecticide (*Azadirachta indica A.Juss.*) that had the most effect on aphid death was 35 (g/l water), and the number of dead aphids was 8.76 (Javandira et al., 2022).

Papaya leaves (*Carica papaya*)

Papaya leaves (*Carica papaya*) is an alternative vegetable pesticide that can control aphids (*Chaetosiphon fragaefolii*) which belongs to the family of Aphididae. This is in agreement with (Setiawan &; Oka, 2015) that papaya leaves can control aphids (*Chaetosiphon fragaefolii*) because they contain toxic compounds such as papain, alkaloids, flavonoids and saponins. The content of papaya leaves, namely papain, also works actively as a stomach poison that enters the body or responds to aphids, thereby reducing the feeding activity of aphids. The working system of papain as a stomach poison in the body of aphids is absorbed by the walls in the digestive organs of aphids then will be delivered to the nerve center of aphids so that it will potentially provide pressure and reduce the metabolic process of internal organs and inhibit the eating activities of aphids so as to cause aphids to die (Vandalisna et al., 2021). The use of papaya leaf extract as a vegetable pesticide will certainly have a positive influence on plant growth because it contains flavonoid compounds that work as neurotoxins and have residues that can cause pests to decrease activity and even stop (Nanda et al., 2022). Alkaloids are secondary metabolites that act as stomach poisons in pests (Fauzana &; Faradila, 2018). If alkaloid and flavonoid compounds enter the stomach of insects, it will block the digestive process and can be toxic (toxin) for insects. This compound can also cause taste receptors in insects to be inhibited so that insects are unable to identify their food (Bumulo et al., 2021). Saponin substances can affect the digestive system of pests by making different bonds with some digestive enzymes. Due to strong binding with certain enzymes, saponins damage the mucosal lining of some cells in the digestive system. So that aphids can lose appetite which causes aphids to become lethargic and die due to saponin toxicity (Qasim et al., 2020). To use papaya leaf vegetable pesticides to effectively control aphids, papaya leaf extract with a concentration of 30 ml / liter of water is needed (Yudiawati &; Hapis, 2016). Spray 3 times a week in the morning or evening when the air temperature is lower and the humidity is higher (Jujuaningsih et al., 2021).

CONCLUSION

Strawberry plant nuisance organisms (*Fragaria x ananassa*) are aphids with the species Chaetosiphon fragaefolii. This species can transmit viruses that infect strawberry plants (*Fragaria x ananassa*). Viruses carried include yellow edge virus (*Potexvirus; Alphaflexiviridae*), striped virus (*Secoviridae*), Strawberry wrinkle virus (*Cytorhabdovirus; Rhabdoviridae*), and Strawberry vein band virus

(*Caulimovirus; Caulimoviridae*). To control Chaetosiphon fragaefolii there are 4 ways, namely: 1. Fungus entomopathogen : Beaubevia bassiana and Metarizium sp. 2. Parasitoid : Aphelinus varipes. 3. redator : family Syrphidae, family Asilidae, Orius insidiosus, Cycloneda sanguinea, Eriopis connexa dan Coleomegilla quadrifasciata. 4. Organic pesticides: neem leaves (Azadirachta indica) with a concentration of 35 (g / l water) and mortality of 8.76 heads, while papaya leaves (*Carica papaya*) use a concentration of 30 ml / liter of water.

REFERENCES

Amri, A. (2022). Analisis Tingkat Resiko Usahatani Stroberi Di Kawasan Wisata Malino. *Jurnal Sains Agribisnis*, *2*(1), 1–11. https://doi.org/10.55678/jsa.v2i1.674

Arsensi, I., Hang, Y. Y., & Noor, R. B. (2022). IDENTIFIKASI SERANGAN HAMA KUTU PUTIH (Pseudococcus citri) PADA BUAH KAKAO (Theobroma cacao L.) DAN UPAYA MENEKAN SERANGAN DENGAN CENDAWAN *Beauveria bassiana*. *Ziraa'Ah Majalah Ilmiah Pertanian*, *47*(2), 247. https://doi.org/10.31602/zmip.v47i2.6831

Arsi, A., Pujiastuti, Y., Kusuma, S. S. H., & Gunawan, B. (2020). Eksplorasi, isolasi dan identifikasi Jamur entomopatogen yang menginfeksi serangga hama. *Jurnal Proteksi Tanaman Tropis*, *1*(2), 70. https://doi.org/10.19184/jptt.v1i2.18554

Baroffio, C. A., Sigsgaard, L., Ahrenfeldt, E. J., Borg-Karlson, A. K., Bruun, S. A., Cross, J. V., Fountain, M. T., Hall, D., Mozuraitis, R., Ralle, B., Trandem, N., & Wibe, A. (2018). Combining plant volatiles and pheromones to catch two insect pests in the same trap: Examples from two berry crops. *Crop Protection*, *109*(September 2017), 1–8. https://doi.org/10.1016/j.cropro.2018.02.025

Bass, C., & Nauen, R. (2023). The molecular mechanisms of insecticide resistance in aphid crop pests. *Insect Biochemistry and Molecular Biology*, *156*(March), 103937. https://doi.org/10.1016/j.ibmb.2023.103937

Bhatt, D., Duhlian, L., Koramutla, M. K., Dhatwalia, D., Tamta, S., Subramanian, S., & Bhattacharya, R. (2018). Developmental genes related to parthenogenesis revealed sinusoidal pattern of gene-expression in mustard aphid Lipaphis erysimi. *Indian Journal of Entomology*, *80*(4), 1521. https://doi.org/10.5958/0974-8172.2018.00335.8

Bischoff, delia M., Araujo, E. S., Benatto, A., Zimmermann, R. C., Oliveira, M. C. H. de, Rosa, J. M. da, Bernardi, D., & Zawadneak, M. A. C. (2023). Evidence of antibiosis resistance of four strawberry cultivars against Duponchelia fovealis (Lepidoptera: Crambidae). *Crop Protection*, *186*(106213).

Bonneau, P., Brisson, J. D., Tellier, S., & Fournier, V. (2019). Flight phenology and trap selection for monitoring potential viral vector Aphididae and Aleyrodidae (Hemiptera) in strawberry (Rosaceae) fields of Québec, Canada. *Canadian Entomologist*, *151*(3), 378–390. https://doi.org/10.4039/tce.2019.15

Bumulo, A. S., Due, H., Puluhulawa, N., Pasune, S., Abdullah, D., Pauweni, R., Ahmad, T., & Mahmud, N. (2021). PENGARUH PERASAN DAUN

GULMA AJERAN (Bidens pilosa. L) TERHADAP MORTALITAS KUTU DAUN PADA TANAMAN TOMAT. *Seminar Nasional Teknologi*, *2021*(SemanTECH), 73–77.

Dong, C., Zhang, Z., Yue, J., & Zhou, L. (2021). Automatic recognition of strawberry diseases and pests using convolutional neural network. *Smart Agricultural Technology*, *1*(September), 100009. https://doi.org/10.1016/j.atech.2021.100009

Efendi, S., Yaherwandi, Y., & Nelly, N. (2018). Biologi dan Statistik Demografi Coccinella transversalis Thunberg (Coleoptera: Coccinellidae), Predator Aphis gossypii Glover (Homoptera: Aphididae). *Jurnal Perlindungan Tanaman Indonesia*, *22*(1), 91. https://doi.org/10.22146/jpti.28409

Efrilla, A., Sulistyo, S., Wijaya, K., Kuncoro, P., & Sudarmaji, A. (2020). Klasifikasi Penyakit Pada Daun Stroberi Menggunakan K-Means Clustering dan Jaringan Syaraf Tiruan. *Jurnal Keteknikan Pertanian Tropis Dan Biosistem*, *8*(2), 161–170. https://doi.org/10.21776/ub.jkptb.2020.008.02.06

Fadhilah, L. N., & Asri, M. T. (2019). Keefektifan Tiga Jenis Cendawan Entomopatogen Terhadap Serangga Kutu Daun Aphis gossypii (Hemiptera : Aphididae) pada Tanaman Cabai. *Lentera Bio*, *8*(1), 1–12.

Fauzana, H., & Faradila, N. (2018). Uji Konsentrasi Ekstrak Daun Krinyuh (*Eupatorium odoratum* L.) sebagai Racun Perut terhadap Mortalitas Ulat Grayak (*Spodoptera litura* F.). *Jurnal Agrotek. Trop*, *7*(2), 108–115.

Foda, Y. L., Wibowo, L., Lestari, P., & Hasibuan, R. (2021). INVENTARISASI DAN INTENSITAS SERANGAN HAMA TANAMAN JERUK (Citrus sinensis L.) DI KECAMATAN SEKAMPUNG UDIK KABUPATEN LAMPUNG TIMUR. *Jurnal Agrotek Tropika*, *9*(3), 367. https://doi.org/10.23960/jat.v9i3.5276

Francesena, N., Rocca, M., Rizzo, E., Arneodo, J. D., & Greco, N. M. (2019). Potential of predatory neotropical ladybirds and minute pirate bug on strawberry aphid. *Anais Da Academia Brasileira de Ciencias*, *91*(4), 1–11. https://doi.org/10.1590/0001-3765201920181001

Guimarães, A. G., Soares, M. A., De Andrade Júnior, V. C., Da Silva, I. M., Guimarães, C. G., & Pires, E. M. (2018). Resistência varietal de morangueiro aos pulgões Cerosipha forbesi (Weed) e Chaetosiphon fragaefolii (Cockerell) (Hemiptera: Aphididae). *EntomoBrasilis*, *11*(3), 216–219. https://doi.org/10.12741/ebrasilis.v11i3.751

Hasibuan, R., Haska, E., Purnomo, P., & Wibowo, L. (2014). EFIKASI Metarhizium anisopliae TERHADAP HAMA KUTU DAUN (Aphis glycines Matsumura) DAN PENGARUHNYA TERHADAP ORGANISME NONTARGET DAN PERTUMBUHAN TANAMAN KEDELAI. *Jurnal Agrotek Tropika*, *2*(2), 171–176. https://doi.org/10.23960/jat.v2i2.2031

Hasyim, A., Setiawati, W., Hudayya, A., & Luthfy, N. (2016). Sinergisme Jamur Entomopatogen Metarhizium anisopliae Dengan Insektisida Kimia untuk Meningkatkan Mortalitas Ulat Bawang Spodoptera exigua. *Jurnal Hortikultura*, *26*(2), 257. https://doi.org/10.21082/jhort.v26n2.2016.p257-266

Hopper, K. R., Lanier, K., Rhoades, J. H., Hoelmer, K. A., Meikle, W. G., Heimpel, G. E., O'Neil, R. J., Voegtlin, D. G., & Woolley, J. B. (2017). Host specificity

of Aphelinus species collected from soybean aphid in Asia. *Biological Control*, *115*, 55-73Hopper, Keith R. et al. 2017. "Host Specifici. https://doi.org/10.1016/j.biocontrol.2017.09.004

Hopper, K. R., Oppenheim, S. J., Kuhn, K. L., Lanier, K., Hoelmer, K. A., Heimpel, G. E., Meikle, W. G., O'Neil, R. J., Voegtlin, D. G., Wu, K., Woolley, J. B., & Heraty, J. M. (2019). Counties not countries: Variation in host specificity among populations of an aphid parasitoid. *Evolutionary Applications*, *12*(4), 815–829. https://doi.org/10.1111/eva.12759

Hutajulu, E. D., Made Sudiana Mahendra, & I Nyoman Gede Astawa. (2018). Pengaruh Berbagai Jenis Kemasan Terhadap Umur Simpan dan Perubahan Fisiko-Kimia pada Buah Stroberi (Fragaria sp.). *Agroekoteknologi Tropika*, *7*(2), 211–219.

Hutapea, D., Rahardjo, I. B., Marwoto, B., & Soehendi, R. (2020). Potensi Insektisida Nabati dalam Mengendalikan Aphis gossypii pada Tanaman Gerbera dan Kompatibilitasnya dengan Predator Menochilus sexmaculatus. *Jurnal Hortikultura*, *30*(1), 75. https://doi.org/10.21082/jhort.v30n1.2020.p75-86

Indira, A., & Trimo, L. (2021). Analisis Risiko Produksi Stroberi Dengan Metode Z-Score Dan Value At Risk Pada Cv. Bumi Agro Technology, Jawa Barat. *Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, *7*(1), 331. https://doi.org/10.25157/ma.v7i1.4534

Javandira, C., Yuniti, I. G. A. D., & Widana, I. G. (2022). Pengaruh Pestisida Daun Mimba terhadap Mortalitas Kutu Daun (Aphis craccivora Koch) pada Tanaman Kacang Panjang. *Agro Bali : Agricultural Journal*, *5*(3), 485–491. https://doi.org/10.37637/ab.v5i3.998

Johnson, V., & Hooks, C. R. (2021). Minute Pirate Bug : A Beneficial Generalist Insect Predator. *University of Maryland Dept. of Entomology*, 6.

Jujuaningsih, Rizal, K., Triyanto, Y., Lestari, W., & Harahap, D. A. (2021). Penggunaan Pestisida Nabati Ekstrak Daun Pepaya (*Carica papaya* L.) pada Tanaman Kacang Panjang (Vigna Sinensis L.) untuk Mengurangi Dampak Pencemaran Lingkungan di Desa Gunung Selamat , Kec. Bilah Hulu, Kab.Labuhanbatu. *Jurnal Pengabdian Magister Pendidikan IPA*, *4*(3), 1–4.

Kessek, L. I. M., Tulung, M., & Salaki, C. L. (2015). JENIS DAN POPULASI HAMA PADA TANAMAN STROBERI (*Fragaria x ananassa* Duscesne). *Eugenia*, *21*(1), 32–44. https://doi.org/10.35791/eug.21.1.2015.11803

Lahiri, S., Smith, H. A., Gireesh, M., Kaur, G., & Montemayor, J. D. (2022). Arthropod Pest Management in Strawberry. *Insects*, *13*(5). https://doi.org/10.3390/insects13050475

Maharani, Y., Hidayat, P., Rauf, A., & Maryana, N. (2018). Kutudaun (Hemiptera: Aphididae) pada gulma di sekitar lahan pertanian di Jawa Barat. *Jurnal Entomologi Indonesia*, *15*(2), 74–84. https://doi.org/10.5994/jei.15.2.74

Maharani, Y., Maryana, N., Rauf, A., & Hidayat, P. (2020). Insect parasitoid and ant of associated on aphids (Aphididae) colonies on plants in West Java. *CROPSAVER - Journal of Plant Protection*, *3*(2), 59.

https://doi.org/10.24198/cropsaver.v3i2.30645

Mahardika, I. K., Bektiarso, S., Santoso, R. A., Novit, A., Saiylendra, R. B., & Dewi, R. K. (2023). ANALISIS PERAN SUHU PADA PERTUMBUHAN DAN PERKEMBANGAN TANAMAN STROBERI. *Jurnal Fisika Dan Pembelajarannya (PHYDAGOGIC)*, *5*(2), 6.

Manuhutu, J. B. J., Tumbel, F., & Rengkuan, M. (2020). Efektivitas Perangkap Hama Kutu Daun Pada Pertanaman Stroberi (Fragaria Sp.) di Kelurahan Rurukan Satu, Kota Tomohon. *Jurnal Nukleus Biosains*, *1*(1), 31–36.

Marianah, L. (2020). Serangga Vektor dan Intensitas Penyakit Virus pada Tanaman Cabai Merah. *AgriHumanis: Journal of Agriculture and Human Resource Development Studies*, *1*(2), 127–134. https://doi.org/10.46575/agrihumanis.v1i2.70

Nanda, G. W., Oktarina, O., & Murtiyaningsih, H. (2022). Efektifitas Pestisida Nabati Ekstrak Daun Pepaya Dan Kenikir Terhadap Intensitas Serangan Ulat Grayak (Spodoptera litura)vDan Hasil Tanaman Sawi (Brassica juncea L.). *National Multidisciplinary Sciences*, *1*(2), 152–161. https://doi.org/10.32528/nms.v1i2.73

Offayana, G. M., I Wayan Widyantara, & Anggreni, I. G. A. A. L. (2016). Analisis Risiko Produksi Stroberi pada UD Agro Mandiri di Desa Pancasari Kecamatan Sukasada Kabupaten Buleleng. *Journal of Agribusiness and Agritourism*, *5*(1).

Oktavia, C., Voutama, A., & Dermawan, B. A. (2022). Sistem Pakar Diagnosis Hama Dan Penyakit Tanaman Stroberi Dengan Metode Certainty Factor Berbasis Web. *Jurnal Ilmiah Wahana Pendidikan*, *8*(15), 117–127.

Patmawati, K., Amalia, D. R. K., Retnoningsih, D., Purniati, R., & Puspitasari, R. P. (2020). PESDAYA (Pestisida Daun Pepaya) Alternatif Pembasmi Hama Kutu Putih pada Tanaman. *National Conference PKM Center Sebelas Maret University*, 5.

Pramita, V. L., & Murlistyarini, S. (2020). Tinjauan Literatur Peran Azadirachtin dalam Pohon Mimba (Azadirachta indica A. juss.) sebagai Terapi Anti Skabies. *Journal of Dermatology, Venereology and Aesthetic*, *1*(1), 40–48.

Puspita, D., Christin, E. I., & Palimbong, S. (2022). Prosiding Konser Karya Ilmiah Tingkat Nasional (Kkin) Tahun 2022. *Prosiding Konser Karya Ilmiah Nasional 8 2022*.

Qasim, M., Islam, W., Ashraf, H. J., Ali, I., & Wang, L. (2020). Saponins in Insect Pest Control. *Reference Series in Phytochemistry*, *February*, 897–924. https://doi.org/10.1007/978-3-319-96397-6_39

Rajab, A. M., Hayati, A., & Zayadi, H. (2018). Pengaruh Larutan Kombinasi Daun Mimba (Azadirachta indica) dengan Buah Cabai Rawit (Capsicum frutescens) terhadap Mortalitas Kutu Daun Hijau (Aphis gossypii) Secara In Vitro. *Jurnal SAINS ALAMI (Known Nature)*, *1*(1), 1–6. https://doi.org/10.33474/j.sa.v1i1.1390

Rizal, A. N., Putra, N. S., & Suputa, S. (2018). Comparison of Feeding Ability between Ischiodon scutellaris (Diptera: Syrphidae) and Menochilus sexmaculatus (Coleoptera: Coccinellidae) on Aphis craccivora (Hemiptera: Aphididae). *Jurnal Perlindungan Tanaman Indonesia*, *22*(2), 210. https://doi.org/10.22146/jpti.26191

Robika, Navia, Z. I., Nadilla, F., Rosanti, E., & Pelawi, L. H. B. (2019). Identifikasi jenis tumbuhan yang berpotensi sebagai pestisida nabati di desa Sukamulia , Kecamatan Rantau, Kabupaten Aceh Tamiang. *Pros. SemNas. Peningkatan Mutu Pendidikan*, *1*, 153–156.

Rondon, S. I., & Cantliffe, D. J. (2004). Chaetosiphon Fragaefolii (Homoptera: Aphididae): A potential new pest in Florida? *Florida Entomologist*, *87*(4), 612–615. https://doi.org/10.1653/0015-4040(2004)087[0612:CFHAAP]2.0.CO;2

Sari, S. P., Suliansyah, I., Nelly, N., & Hamid, H. (2020). IDENTIFIKASI HAMA KUTUDAUN (Hemiptera: Aphididae) PADA TANAMAN JAGUNG HIBRIDA (Zea mays L.) DI KABUPATEN SOLOK SUMATERA BARAT. *Jurnal Sains Agro*, *5*(2). https://doi.org/10.36355/jsa.v5i2.466

Setiawan, H., & Oka, A. A. (2015). PENGARUH VARIASI DOSIS LARUTAN DAUN PEPAYA (*Carica papaya* L.)TERHADAP MORTALITAS HAMA KUTU DAUN(Aphis craccivora)PADA TANAMAN KACANG PANJANG(Vigna sinensis L.) SEBAGAI SUMBER BELAJAR BIOLOGI. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *6*(1), 54–62. https://doi.org/10.24127/bioedukasi.v6i1.158

Sidauruk, E. J., Fauzana, H., & Salbiah, D. (2019). KEEFEKTIFAN EKSTRAK TEPUNG DAUN MIMBA (Azadirachta indica A. JUSS) DENGAN PENAMBAHAN BEBERAPA JENIS SURFAKTAN TERHADAP ULAT GRAYAK (Spodoptera litura FAB.) PADA TANAMAN KEDELAI (Glycine max L. MERRILL). *Dinamika Pertanian*, *33*(3), 223–230. https://doi.org/10.25299/dp.2017.vol33(3).3835

Silaban, D. M. G., & Trimo, L. (2021). Strategi Pengembangan Agribisnis Stroberi Pada Cv. Bumi Agro Technology, Jawa Barat. *Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, *7*(1), 169. https://doi.org/10.25157/ma.v7i1.4475

Sinaga, A. H., & Laia, F. (2020). ANALISIS EFISIENSI USAHATANI STROBERI (*Fragaria x ananassa*) (Studi Kasus : Desa Dolat Rakyat Kecamatan Dolat Rakyat Kabupaten Karo). *Jurnal Darma Agung*, *28*(2), 170. https://doi.org/10.46930/ojsuda.v28i2.615

Solikhatin, U., Purnomo, P., Hariri, A. M., & Fitriana, Y. (2021). PENGARUH APLIKASI COMPOST TEA YANG MENGANDUNG B.bassiana TERHADAP KEANEKARAGAMAN ARTHROPODA, PERTUMBUHAN, DAN PRODUKSI TANAMAN PADI. *Jurnal Agrotek Tropika*, *9*(2), 215. https://doi.org/10.23960/jat.v9i2.5020

Sopialena, S., Suyadi, S., Sofian, S., Tantiani, D., & Fauzi, A. N. (2020). EFEKTIVITAS CENDAWAN ENDOFIT SEBAGAI PENGENDALI PENYAKIT BLAST PADA TANAMAN PADI (Oryza sativa). *Agrifor*, *19*(2), 355. https://doi.org/10.31293/af.v19i2.4813

Sopialena, Sahid, A., & Hutajulu, J. (2021). EFEKTIVITAS JAMUR Metarhizium anisoplae DAN *Beauveria bassiana* Bals LOKAL DAN KOMERISIAL TERHADAP HAMA KUTU DAUN (Aphis craccivora C.L. Koch) PADA

TANAMAN KACANG PANJANG (Vigna sinensis L.). *Jurnal Agrifor*, *XXI*(1), 220–226.

Stewart, C. D. (2021). Field Release of Aphelinus hordei (Hymenoptera : Aphelinidae) for Biological Control of the Russian Wheat Aphid , Diuraphis noxia (Hemiptera : Aphididae), in the Contiguous United States Final Environmental Assessment , July 2021 Field Release of Aphe. *Animal and Plant Health Inspection Service U.S DEPARTMENT OF AGRICULTURE*, *July*.

Taylo, L. D., & Magdalita, P. M. (2021). Incidence of insect pests on Hibiscus rosa sinensis L. germaplasm in the plant nursery. *Science and Engineering Journal*, *14*(1), 130–138.

Vandalisna, V., Mulyono, S., & Putra, B. (2021). Penerapan Teknologi Pestisida Nabati Daun Pepaya Untuk Pengendalian Hama Terung. *Jurnal Agrisistem*, *17*(1), 56–64. https://doi.org/10.52625/j-agr.v17i1.194

Wardani, N. (2015). Perubahan Iklim Dan Pengaruhnya Terhadap Serangga Hama. *Agroinovasi Spesifik Lokasi*, *6*(3), 1013–1030.

Wathi, E., Hasibuan, R., & Indriyati. (2015). PENGARUH FREKUENSI APLIKASI ISOLAT JAMUR ENTOMOPATOGEN Metarhizium anisopliae TERHADAP KUTUDAUN (Aphis glycines Matsumura). *Jurnal Agrotek Tropika*, *3*(2), 204–210.

Yudiawati, E., & Hapis, S. (2016). Efektifitas ekstrak daun pepaya sebagai pestisida nabati terhadap intensitas serangan aphid (Homoptera: Aphididae) pada tanaman cabe merah (Capsicum annum). *Jurnal Sains Agro*.