

The Effect of Botanical Insecticide Mixed Formulation from *Piper aduncum* Fruit and *Tephrosia vogelli* Leaf Against the Diversity of Soil Arthropods in Cabbage Plantation (*Brassica oleracea* L)

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Abstract— An arthropod is one of the critical animal groups in the agriculture ecosystem. The purpose of this research is to determine the effect of botanical insecticide mixed with formulation from *Piper aduncum* fruit and *Tephrosia vogelii* leaf as well as their application intensity against the diversity of soil arthropods. The research was conducted in cabbage plantation regularly applied with pesticide using Randomized Block Design two factorial with 5 treatments and 3 duplications in three regions (Jorong Jambu Kaniki, Batipuh Atas, and Tanah Datar) from March to July 2017. The treatments included control, WP (wettable powder) botanical insecticide formulation, EC (Emulsifiable concentrate) botanical insecticides formulation, BT (*Bacillus thuringiensis*) formulation, and synthetic insecticide (chlorfenapyr). Soil arthropod samples were taken by pitfall trap at 75 points representing all treatments. The type of formulations and intensity of application affect the number of soil arthropods individuals. There is an interaction between formulations and intensity of application, enhancement on formulations application of WP, and EC tend to increase the number of soil arthropods individual. Otherwise, the use of synthetic insecticide significantly decreases the number of soil arthropod individuals. The application intensity did not affect the type of soil arthropods. Further identification of soil arthropod samples from the experimental field showed the diversity of soil arthropods is categorized as moderate (2,23–2,97), evenness is categorized medium to high (0,25-0,65), index similarity formulations are categorized high (0,923- 1,000), and index similarity intensity application in categorizing medium to high (0,667-1,000). Soil arthropods were found in cabbage plantations consist of 3 classes: Arachnida (1 Order; 1 Family), Insecta (1 Order; 4 Family), Entognata (1 Order; 2 Family). Order Collembola, Family Onychiuridae dominated soil arthropods.

Keywords— diversity; soil arthropods; cabbage (*Brassica oleraceae* L.); botanical insecticides; synthetic insecticides.

I. INTRODUCTION

Cabbage (*Brassica oleraceae* L) is one of the horticultural commodities with high economic value and still requires serious handling through increasing the yield and quality of cabbage [1]. Cabbage productivity in West Sumatra fluctuated from 2011-2015 in a row namely 31.40; 31,59; 29.49; 29.78 and 31.36 tons/ha [2]. The productivity is relatively low than cabbage's productivity potency in West Sumatra that reaches 40 tons/ha [3]. The low productivity of cabbage was caused by a disruption of Plant Disturbing Organisms (OPT) such as cabbage head caterpillar (*Crociodolomia pavonana*), leaf caterpillar (*Plutella xylostella*), soil caterpillar (*Agrotis ipsilon*), and armyworm (*Spodoptera litura*) [1]. The yield loss caused by *C. pavonana* and *P. xylostella* reached 100% without proper control taken immediately [4]. Cabbage pest control is

generally carried out by farmers using synthetic insecticides. The excessive and continuous use of synthetic insecticides harms the environment, including resistance, resurgence, the emergence of secondary pests (replacement) and residual buildup in plants [5] and affects soil organisms [6], so that decomposition of organic materials running slow and reduce the amount number of nutrients in the soil. The direct effect of insecticides was in target pests and natural enemies. The rest of the insecticide falls to the ground and accumulate in the soil that affects life and reduces the diversity of soil arthropods [7]. Soil arthropods are soil organisms that play a role in reforming or decomposing soil organic material so that the process of reformation in the soil runs fast [8].

The organisms that are often found in the soil from arthropod groups are Insecta, Arachnida, and Myriapoda. The most common group is Collembola, while the most common Arachnida group is Araneae [9], [10]. Soil

arthropods life is influenced by environmental factors [11] such as micro factors that affect soil insects' lives, which are seen from the thickness of litter, organic matter content, pH, fertility, soil type, soil density, and soil moisture. Meanwhile, macro factors are from the geology, climate, altitude of places, and plants' types. The loss of arthropods is very influential on the balance of the ecosystem [12]. Thus, insects, especially as decomposers, are unable to recycle organic material; consequently, the benefits become lost and impact their own vegetation and vice versa. Environmentally-friendly farming systems such as organic farming and botanical insecticides can support the survival of soil arthropods. The administration of plant-based pesticides from Ramayana leaves (*Cassia spectabilis*) and tobacco (*Nicotiana tabacum*) did not negatively affect the population of soil arthropods [13].

An alternative control technique by utilizing botanical insecticides is a single active ingredient or compound derived from plants. Plant-based insecticides function as repellents, pullers, antifertility, and killers [14]. This class of insecticides is safer and more comfortable than chemical-based insecticides to apply in the field with several advantages, easily decomposed in nature, relatively safe against non-target organisms, including natural enemies, and enable integration with other components of IPM (Integrated Pest Control) [15], [16]. Botanical insecticides result from extraction from plant parts, either leaves, fruit, seeds, or roots in the form of compounds or secondary metabolites, which have toxic properties against certain pests and diseases. The insecticides work through a combination of various ways or singly. Some ways of plant insecticides working to inhibit skin turnover, disrupt insect communication, inhibit reproduction of female insects, reduce appetite, repel insects, block the ability to eat insects, cause insects to refuse to eat, and inhibit the development of pathogenic diseases [17].

One factor caused the low use of botanical insecticides among farmers, such as the lack of ready-made, effective, and safe botanical insecticides available in sufficient quantities [18]. The botanical insecticides in the form of formulations are more effective and efficient in controlling pests. The use of formulations in agriculture is closely related to safety in storage, ease of application, and active ingredient activity [18]. Formulations that are widely used in agriculture are formulations in the form of emulsifiable concentrate (EC) and wettable powder (WP) [19], [18].

The use of botanical insecticides mixed from two or more plant extracts reduces dependence on one type of plant to minimize potential plant sources' loss as botanical insecticides. Plant species with the potential as a source of botanical insecticides include *P. aduncum* and *T. vogelii* fruit. This mixture of two types of ingredients are more effective and efficient in controlling *Crocidolomia pavonana*. Testing a mixture of plant-based insecticide *P. aduncum* and *T. vogelii* (5: 1) fruit has good activity and synergistic effects whereas with LC50 and LC95 values of 0.014% and 0.06% and the use of formulations in agriculture-related closely with aspects of security in storage, ease of application and activity of an active ingredient [18]. The formulation mixture of *P. aduncum* and *T. vogelii* is safe against natural enemies *Eriborus argenteopilosus* [18].

The effect of the application intensity of plant-based insecticides mixed with formulations of *P. aduncum* and *T. vogelii* fruit for soil arthropods has never been done before. Based on this, we would like to explore the effect of mixed formulations of botanical insecticides *P. aduncum* and *T. vogelii* leaves and the application intensity on the diversity of soil arthropods in planting Gabbage (*Brassica oleracea L*). Therefore, the purpose of this study was to determine the effect of the application of botanical insecticides formulations to the diversity of soil arthropods.

II. MATERIALS AND METHODS

A. Materials

The tools used are rotary evaporator, analytical scales, blenders, 0.5 mm gauze sieves, 100 ml measuring cups, Petri dishes, pipettes (1 ml, 5 ml, and 10 ml), filter paper, extract bottles, bottle formulations, spatulas, Erlenmeyer flasks, glass funnels (5 cm and 9 cm in diameter size), steam gourds, boiling pumpkins, small brushes, tape, meters, Pitfall traps, microscopes, plastic boxes, plastic bags, bamboo trays, knapsack sprayers, collection bottles, ruler, stationery, and Boror 7th edition identification book.

The ingredients used during the research are 70% alcohol, and plant extract ingredients are *P. aduncum* and *T. vogelii* leaves and cabbage seeds (SAKATA varieties), *Bacillus thuringiensis*, ethyl acetate solvents, pure acetone, methanol, tween 80, kaolin, aquades, tissue, Whatman filter paper No 41, ordinary filter paper, aluminum foil, rubber, labels, newspaper, synthetic insecticides made from chlorphenapir and logbooks.

This study used a Randomized Block Design (RBD) with 2 factors, namely pesticide formulation including untreated control, WP (wetable powder), EC (Emulsifiable concentrate), while BT (*Bacillus thuringiensis*) and synthetic insecticides made from active ingredients (klorfenapir) were compared. Application intensity was 0 applications, 5 after application, 10 after application. The study area was chosen, which did not have many local people planting cabbage, and pesticide use was low.

B. Methods

1) *Extraction of Piper aduncum and Tephrosia vogelii*: The source plants of *Piper aduncum* extract were purchased from Bungus Teluk Kabung District (Padang) and *Tephrosia vogelii* that both are from the Agropolitan Area, Pacet District (Cianjur Regency, West Java). *P. aduncum* fruits and *T. vogelii* leaves were cut into pieces (± 3 cm), then placed on a bamboo tray covered with newsprint and dried with the wind without being exposed to direct sunlight. After drying, the ingredients were ground using a blender. The blended plant-material were sifted using a 0.5 mm sieve to obtain a fine form of powder. The used method is the immersion/maceration method using ethyl acetate solvents [18], [20]. In the first stage, 50 g of *P. aduncum* and *T. vogelii* powder were put into an Erlenmeyer flask separately and soaked in 500 ml of ethyl acetate solvent for 24 hours, then extracted liquid was filtered using a glass funnel (9 cm in diameter size), which lied on filter paper and stored with 500 ml Erlenmeyer. The first filter was refiltered using a glass funnel (5 cm in diameter size), which lay on Whatman

filter paper no. 41 and stored in a steam flask, then evaporated with a rotary evaporator at a temperature of 50°C and a pressure of 250 mbar. Ethyl acetate obtained from evaporation was used to re-soak up the extracted plant pulp up for three times soaking. The extract obtained in the pumpkin was left in a pumpkin mouth with gauze for 3 days until the ethyl acetate smell lost. The obtained thick extract was transferred to a storage bottle, covered with aluminum foil, and given plastic. The extract was stored in a refrigerator with a temperature of 3°C before testing.

2) *Preparation of Mixed Formulations*: An extract mixture formulation that showed the most active toxicity test, *T. vogelii* and *P. aduncum* (with a ratio of 1: 5) [18], was used as a base for making liquid formulations (EC: emulsifiable concentrate) and flour (WP: wettable powder). The 20 EC mixture extract formulation was made by mixing 20% extract with 10% emulsifier that was able to dissolve the extract and 70% methanol carrier material (based on volume), then shaking until all ingredients were mixed and ready for use. The preparation of 20 WP mixture extract formulation was made by mixing 20% extract, 10% emulsifier and 70% kaolin (based on weight), and sufficient acetone to make it easier to homogenize the ingredients. After being homogeneous, acetone in the mixture was taken back by evaporating via a rotary evaporator at a temperature of 50°C and a pressure of 240 mbar. The evaporated mixture was awaited overnight to ensure there are no remaining acetone. The dried mixture was then scraped from the pumpkin, mashed, and sifted using a 0.5 mm filter. The mixture formulation of *P. aduncum* and *T. vogelii* extract 20 WP were stored in a light-tight container and placed in the refrigerator.

3) *Cabbage planting*: Preparation of land and making beds for plot sizes of 4.5 m x 7 m in the distance between 70 cm x 50 cm plots arranged in a randomized block design (RBD) with 2 factorials, 5 treatments, and 3 replications in each bed. In each bed, cabbage seedlings were planted with a spacing of 1 m x 1 m. Each bed contained 34 cabbage seedlings labelled at each treatment and replication. The used cabbage seeds were sown first, then after 2 weeks old, the seeds were transferred to the field.

4) *Sampling*: Sampling used was a pitfall trap, which its installation of pitfall traps was made of plastic cups. The soil was excavated for making the holes inputted with 5 plastic cups into each hole then filled with 70% alcohol as much as a ¼ glass of plastic and let stand for 24 hours. The caught insects (sample) found in the aqua glass were collected using tweezers and small brushes, putting into a collection bottle that has been given 70% alcohol. Each bed consists of 5 pitfall traps. Sampling was carried out three times (namely: 0, 5, and 10 times the application). The trap was then left for 1x24 hours and continued with the identification of samples in the Insect Bioecology Laboratory.

5) *Application in the Field*: Application activities were conducted when the cabbage was 3 MTS (weeks after planting) or after the appearance of pest attacking symptoms on cabbage plants. Applications were carried out in the morning with the interval of one-week treatment. The concentration level of botanical insecticides tested was

determined based on the results of the toxicity test in the laboratory (equivalent to 2 x LC95) [18]. The application of botanical insecticides was done by making a spray 20 EC with a concentration of 7ml /l and 20 WP (a concentration of 7 g/l), BT application of recommended position as much as 1.25 gr / l, and synthetic insecticides made from active chlorphenapir taken as much as 1.2 ml/l. Spray liquid from each treatment was applied with 2 knapsack sprayers, namely for the application of EC, WP, and BT using 1 knapsack sprayer. Meanwhile, for synthetic insecticides, active chlorfenapyr used 1 knapsack sprayer. The need for spray fluid needed was adjusted to how much we need it in the field. For 10 times of the application, the EC, WP, BT, and the insecticide chlorphenapir formulation required around 238 ml, 238 gr, 42.5 gr, and 36.48 ml, respectively.

6) *Identification of Insects*: Identification was made in order to observe the insects obtained in the field, which was helpful to know the characteristics of the order until the level of morphospecies. Insects obtained in the field were identified using the Borror and DeLong's introduction to insect 7th book [21].

III. RESULTS AND DISCUSSION

A. Research Location Description

Based on the geographical location of the sampling area (Tanah Datar District, Batipuh Nagari District, Batipuh Ateh, Jorong Jambu Kandikie, and Bato Land positioned at 0° 22 '32 "- 100° 30' 00" BT and 0° 23 '38 "- 0° 34' 25" LS with area of 144.26 km²) are geographically classified as plain, with a height of 500-850 meter above sea level. Each location's height varies from flat, bumpy to hilly with an elevation of ± 200 - 1000 m above sea level [22].

The research location was the former planting of sweet potatoes and around the research area farmers generally plant sweet potatoes. It can be recognized from a land condition that the location of a site determines soil arthropod species' presence. For community livelihoods are vegetable farmers, where the types of vegetables that are most widely planted by farmers are tomatoes, eggplants, and cabbage plants themselves. Farmers in the area rarely plant them due to unable to control pest attacks and costly so that some farmers prefer to plant sweet potatoes rather than cabbage plants.

The condition of land greatly affected the diversity of soil arthropods around it. The diversity was able to be identified from the various aspects such as temperature, weather, location height, cropping pattern, cultivated plants, insecticide use to control pests, and diseases and planting areas that were overgrown with weeds. [23] stated that the abundance of diversity of soil arthropods was highly dependent on their habit. Therefore, the population's existence or density is very dependent on the environment (namely the biotic and abiotic environment).

B. Types of Soil Arthropods in Cabbage Plants.

As the results of the study found soil arthropods as much as 3 classes of Insecta, Arachnida, entognata, 4 orders (namely Collembola, Coleoptera, Orthoptera, and Araneae) spread in 7 families (namely Onychiuridae, Isotomidae, Cicindelidae, Staphylinidae, Elateridae, Grillydae, and

Lycosidae). The order of Collembola is found more than the other orders. Collembola can live in various habitats, but it is generally known as soil insects because most of its members live on the ground. These insects have not been widely known in Indonesia; only around 375 species, it is estimated that no less than 1500-2000 species exist [8] and according to [10] Collembola is an insect that is abundant in the soil. Collembola, as well as decomposers, can also increase soil respiration, and accelerate nitrogen mineralization [24].

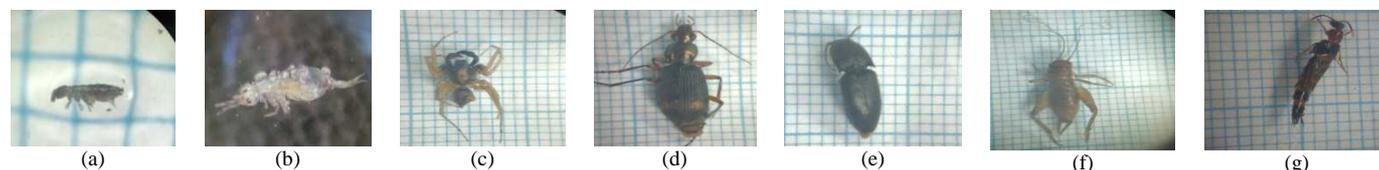


Fig 1. Family of soil arthropods; A. Onychiuridae, B. Isotomidae, C. Lycosidae, D. Cicindelidae, E. Elateridae, F. Grillydae, G. Staphylinidae.

C. The Abundance of Soil Arthropod Populations in Cabbage Plants

The arthropod population was found consisting of 7 species. The dominant soil arthropods were from the family Onychiuridae Colembolla order (Table I). There were as many as 3 classes of Insecta, Arachnida, entognata, 4 orders, namely Collembola, Coleoptera, Orthoptera, and Araneae spread in 7 families Onychiuridae, Isotomidae, Cicindelidae, Staphylinidae, Elateridae, Grillydae, and Lycosidae found as soil arthropods. The order of Collembola was found more than the other orders. Collembola can live in various habitats, but it is generally known as soil insects because most of its members live on the ground. These insects have not been widely known in Indonesia; only around 375 species, it is estimated that no less than 1500-2000 species exist [8], and Collembola is an insect that is abundant in the soil [10]. Collembola and decomposers can also increase soil respiration and accelerate nitrogen mineralization [24].

TABLE I
ABUNDANCE OF SOIL ARTHROPODS POPULATIONS IN CABBAGE PLANTS

Name of Arthropoda	Treatment			
	Control (Number of Application)			
	0	5 times	10 times	total specimen
Collembola	On	On	On	8.712
	Is	Is	Is	1.923
Coleoptera	Ci	Ci	-	4
	St	St	St	10
	-	El	El	3
Orthoptera	Gr	Gr	Gr	10
Araneae	Ly	Ly	Ly	8
WP (Number of Application)				
	0	5 times	10 times	total specimen
Collembola	On	On	On	2.697
	Is	Is	Is	71
Coleoptera	-	Ci	Ci	3
	St	-	St	8
	El	-	El	1
Orthoptera	Gr	Gr	Gr	4
Araneae	Ly	Ly	Ly	5
BT (Number of Application)				

The types of soil arthropods found in cabbage plants consisted of 3 classes, namely Insecta, Arachnida, Entognata, 4 orders, and 7 families, namely Onychiuridae (Collembola), Isotomidae (Collembola), Ciceandelidae (Coleoptera), Staphylinidae (Coleoptera), Elateridae (Coleoptera), Grillydae (Orthoptera) and Lycosidae (Araneae) (Figure 1).

	0	5 times	10 times	total specimen
Collembola	On	On	On	1.780
	Is	Is	Is	42
Coleoptera	Ci	-	-	1
	St	St	St	3
	-	El	El	2
Orthoptera	Gr	Gr	Gr	4
Araneae	Ly	Ly	Ly	4
EC (Number of Application)				
	0	5 times	10 times	total specimen
Collembola	On	On	On	2.447
	Is	Is	Is	45
Coleoptera	-	Ci	Ci	2
	St	St	-	2
	El	El	El	2
Orthoptera	Gr	Gr	Gr	8
Araneae	Ly	Ly	Ly	3
Synthetic (Number of Application)				
	0	5 times	10 times	total specimen
Collembola	On	On	On	468
	Is	Is	Is	33
Coleoptera	-	Ci	-	1
	St	St	-	2
	-	El	-	1
Orthoptera	Gr	Gr	Gr	4
Araneae	Ly	-	Ly	2

Note: On (Onychiuridae), Is (Isotomidae), Ci (Cicaandelidae), St (Staphylinidae), El (Elateridae), Gr (Gryllidae), Ly (Lycosidae).

D. Diversity of Soil Arthropods in Cabbage Crops

The diversity of soil arthropods in cabbage plants ranged from 2.23 to 2.97 among the treatments with a moderate category (Table II). In the study results, we found the soil arthropods as much as 3 classes of Insecta, Arachnida, entognata, 4 orders, namely Collembola, Coleoptera, Orthoptera, and Araneae spread in 7 families namely Onychiuridae, Isotomidae, Cicindelidae, Staphylinidae, Elateridae, Grillydae, and Lycosidae. The order of Collembola is found more than the other orders. Collembola can live in a variety of habitats but is generally known as soil insects because most of its members live on the ground.

These insects have not been widely known in Indonesia; only around 375 species, it is estimated that no less than 1500-2000 species exist [8] and according to [10]. Collembola is an insect that is abundant in the soil. Collembola and decomposers can also increase soil respiration and accelerate nitrogen mineralization [24].

TABLE II
DIVERSITY INDEX (H') OF SOIL ARTHROPODS IN CABBAGE PLANTS

Treatment	Diversity of soil arthropods (Number of application)			Average
	0	5 times	10 times	
Control	2.34	2.37	2.40	2.37
WP	2.65	2.28	2.38	2.43
BT	2.70	2.23	2.42	2.46
EC	2.46	2.40	2.45	2.43
IC	2.97	2.38	2.36	2.57

Description: WP (wettable powder), BT (*Bacillus thuringiensis*), EC (Emulsifiable concentrate), and IC (Insecticide Chlorphenapir).

E. Evenness of Soil Arthropods in Cabbage Crops

Evenness of soil arthropods in cabbage plants ranged from 0.25 to 0.65 between treatments with medium-high categories (Table III).

TABLE III
EVENNESS INDEX (E) OF SOIL ARTHROPODS IN CABBAGE PLANTS

Treatment	Evenness of Soil Arthropods (Number of application)			Average
	0	5 times	10 Times	
Control	0.34	0.30	0.25	0.29
WP	0.41	0.63	0.33	0.45
BT	0.45	0.59	0.44	0.49
EC	0.30	0.51	0.34	0.38
IC	0.45	0.60	0.65	0.56

Description: WP (wettable powder), BT (*Bacillus thuringiensis*), EC (Emulsifiable concentrate), and IC (Insecticide Chlorphenapir).

The low evenness index value indicates that there is a dominant species, whereas if high evenness means, there is no dominant species. The evenness index of soil arthropods in cabbage plantations ranged from 0.25 to 0.65 classified as medium-high, meaning that individual families' distribution is relatively even and there is no dominant family. [26] stated, the species evenness index was very sensitive to the abundance of species in the sample. Evenness values tends to be high if the number of species populations dominates cropping, whereas evenness tends to be low if a species has a small amount in cultivation.

This is presumably because the species found in cabbage plants can live well together. Factors that affect the evenness of each species are environmental factors, namely climate, and light intensity.

F. Similarity Index / Similarity (IS) of Soil Arthropods in Cabbage Crops

TABLE IV
SIMILARITY INDEX (IS) OF SOIL ARTHROPODS TO FORMULATION IN CABBAGE PLANTATIONS

Treatment	Formula (Number of application)		
	0	5 times	10 times
Control	1.000	0,923	0,923

WP	1.000	0,923	0,923
BT	0,923	1.000	1.000
EC	1.000	0,923	0,923
IC	0,923	1.000	1.000

Description: WP (wettable powder), BT (*Bacillus thuringiensis*), EC (Emulsifiable concentrate), and IC (Insecticide Chlorphenapir).

TABLE V
SIMILARITIES IN SOIL ARTHROPODS (IS) TO APPLICATION INTENSITY IN CABBAGE PLANTATIONS

Treatment	Application Intensities (Number of application)		
	0	5 times	10 times
Control	1.000	1.000	1.000
WP	1.000	0.857	0.933
BT	0.923	0.667	0.857
EC	1.000	0857	0.857
IC	0.923	0.933	0.727

Description: WP (wettable powder), BT (*Bacillus thuringiensis*), EC (Emulsifiable concentrate), and IC (Insecticides Chlorphenapir).

The index value of soil arthropods' similarity in cabbage plants at each sampling (Table IV). The similarity index of soil arthropods on the formulation in cabbage plantations ranged from 0.923- 1,000 can be seen in Table IV that the administration of various formulations for very similarities. The index similarity of soil arthropods in cabbage plants on application intensity ranged from 0.667 to 0.923 that can be seen in Table IV, the intensity of application for similarity is classified as medium-high. This shows that the types of soil arthropods found in each of these treatments were relatively the same. According to [27] the diversity of living things played an important role in maintaining the balance of the ecosystem. The more diverse of living things that exist in an ecosystem, it is making the ecosystem more stable.

G. Effect of formulation and application intensity on the number of individual soil arthropods in cabbage plants.

There was an interaction between formulation and the intensity of application affecting the number of individual soil arthropods in cabbage plants ($F = 2.58$; $P = 0.0284$). Giving the chlorphenapir formulation at the intensity of the application reduced the number of individual arthropods in cabbage plants. However, the more frequently applied on cabbage cropping land tends to increase the number of individuals, especially seen in WP and EC. the intensity of BT application and chlorphenapir did not affect the number of individual soil arthropods in cabbage plantations.

Application of WP and EC formulations did not cause some differences in the number of individual arthropods at the application intensity. The differences in the application of WP, EC, and BT formulations did not cause the differences in the number of arthropod individuals at the application intensity of 0 applications and at 5 times and 10 times after application for WP and BT formulations caused the differences in the number of arthropod individuals. EC and BT formulations did not cause the differences in the number of individuals. The provision of WP and EC formulations further increases soil arthropods compared to BT formulations.

The application of BT formulations to chlorphenapir did not cause the differences in the number of soil arthropod

individuals at application intensity i.e. 0 applications and at 5 times and 10 times after application caused the differences with the number of soil arthropod individuals. The chlorphenapir formulation application between the three applications intensities did not cause the differences in the number of individual arthropod individuals. When compared with the application of the WP formulation causing the differences in the number of individuals against soil arthropods in cabbage plants. The application of EC formulation to chlorfenapyr did not cause a difference in the number of individual arthropods at the application intensity of 0 applications, while 5 after and 10 after application caused the differences in the number of individual arthropod individuals. Giving formulations between BT and chlorfenapyr showed that BT administration was safer than chlorfenapyr.

As the study results, the mixture of *Piper aduncum* and *Tephrosia vogelii* with extract formulations (5: 1), the application of various formulations of insecticides and application intensity significantly affected the number of soil arthropod individuals. This shows that the more frequently applied on cabbage crop land, there is a tendency to increase the number of individuals in cabbage plantations seen in the WP and EC formulations. [28] stated that the synergistic nature of the mixture of *P. aduncum* and *T. vogelii* extracts was the active material of dilapiol compounds contained in *P. Aduncum* fruit. Dilapiol compounds can inhibit the work of the cytochrome P450 polysubstrat monooxygenase (PSMO) enzyme, which has a function to reduce the toxicity of metabolites in the body, thus the active ingredients of *T. vogelii* leaves cause active compounds, namely rotenone. Rotenone works directly towards cells by inhibiting electron transfer to inhibit cell respiration and decrease ATP (energy) production. Consequently, cell activity is inhibited, causing insects become paralyzed and die [29]. This is presumed that the proposition of more *P. aduncum* concentrations causes a greater inhibition of enzyme activity. The active compounds of *T. vogelii* can avoid decomposition by these enzymes continuing to attack the target parts [30]. The use of excessive synthetic insecticides reduces the amount of litter or vegetation in a field that can affect the diversity of the number of soil arthropods in one of the cabbage plantations [31] (Odum, 1993).

TABLE VI
EFFECT OF FORMULATION AND INTENSITY OF APPLICATION ON THE NUMBER OF INDIVIDUAL SOIL ARTHROPODS IN CABBAGE PLANTS

Formula	Application Intensities (Number of application)			Average
	0	5 times	10 times	
Control	2213.0 c	2596.7 b	3128.0 a	2649.9
WP	688.7 fgh	1010.7 def	1295.7 d	9983.7
BT	574.0 ghi	557.7 ghi	782 efhg	637.9
EC	499.3 hij	877.0 efg	1125.0 de	8337.7
IC	225.0 ijk	175.3 jk	107.3 k	169.2
Average	840.0	10434.8	1287.6	(+)

Description: WP (wetable powder), BT (*Bacillus thuringiensis*), EC (Emulsifiable concentrate), and IK (Insecticides Chlorphenapir). The numbers on the same lane are followed by lowercase letters, which are not the same significantly different according to the LSD test at the 50% real level

H. Effect of formulation and the intensity of application on types of soil arthropods in cabbage plants.

The study results showed no interaction between the formulation and the intensity of application to the diversity of soil arthropods in cabbage plantations (F = 1.28; P = 0.290). Giving various types of different formulations, significantly affected the diversity of soil arthropods (F = 3.62; P = 0.016) and different application intensities, did not significantly affect the diversity of soil arthropods (F = 0.79; P = 0.464). The application of various types of insecticidal formulations tends to reduce the type of soil arthropods in cabbage plants. The application of the chlorfenapyr formulation further reduces soil arthropods compared to the WP and EC formulations. EC formulations are better able to improve soil arthropods than other formulations.

The effect of the mixture extract formulation of *Piper aduncum* and *Throsia vogelii* (5: 1) can reduce the diversity of soil arthropods in cabbage plants. Application intensity did not affect the diversity of soil arthropods in cabbage plants. We assumed that the application of insecticides were washed by rainwater, therefore there was not accumulated properly and the formulations falling into the soil that did not affect the arthropod species. EC formulations' application was easier, without residue in plants, but has phytotoxic risks, including during storage and separation can reduce the effectiveness of formulations [19]. Meanwhile, WP formulations were easier to store, have a low risk of phytotoxicity, and deficiencies require constant stirring during application, leaving residues on plants.

TABLE VII
EFFECT OF FORMULATION AND INTENSITY OF APPLICATION ON SOIL ARTHROPOD TYPES IN CABBAGE PLANTS

Formula	Application Intensities (Number of Application)			Average
	0	5 times	10 times	
Control	4.3333	6.0000	6.0000	5.4444 a
WP	4.0000	3.0000	5.0000	4.0000 bc
BT	4.3333	3.3333	4.3333	4.0000 bc
EC	5.3333	4.6667	4.6667	4.8889 ab
IC	4.3333	3.3333	3.0000	3.5556 c
Average	44.666	40.666	46.000	(-)

Description: WP (wetable powder), BT (*Bacillus thuringiensis*), EC (Emulsifiable concentrate), and IK (Insecticides Chlorphenapir). The numbers on the same lane are followed by lowercase letters which are not the same significantly different according to the LSD test at the 50% real level

IV. CONCLUSION

The finding was the available of soil arthropods in cabbage plants, which consisted of 3 classes: Arachnida (1 order and 1 family), Insecta (1 order and 4 families), Entognata (1 order and 2 families). The dominant type of soil arthropod is the family Onychiuridae (Collembola). The effect of mixed formulations treatment made from *Piper aduncum* and *Tephrosia vogeli* (5: 1) to the diversity of soil arthropods are classified as moderate (2.23 - 2.97), evenness of soil anthrotops is classified as medium-high (0.23-0.65). The similarity index of soil arthropods on cabbage

plantations' formulation ranged from 0.923 to 1,000 and classified as very high. The intensity of application ranged from 0.667 to 0.923 are classified as medium-high. There are interaction formulations and application intensity. The more frequent application of WP and EC formulations tends to increase the number of individual arthropods. There is no interaction between the formulation and the intensity of application to the type of soil arthropods. WP formulations reduce soil arthropod types, but it is none for EC formulations. Meanwhile, the intensity of application affected the type of soil arthropods. The provision of excessive synthetic insecticides impacts the environment and reduces soil arthropods in a field.

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