

The Safety of Mixed Extracts of Piper Aduncum Fruit and Tephrosia Vogelii Leaf Against Parasitoid Diadegma Semicausum

Eka Candra Lina, Sisri Marleni, Ir. Nurbailis, Novri Nelly

Abstract: The mixed *Piper aduncum* fruit and *Tephrosia vogelii* leaf extracts processed to form emulsifiable concentrates (EC) or wettable powder (WP) that actively control the cabbage pest *Plutella xylostella*. The objective of this study was to determine the effect of EC and WP formulations on the parasitoid *Diadegma semicausum*. Their effects on parasitoid *D. semicausum* can be seen from the mortality, life time, parasitization ability, and sex ratio of the parasitoid. Completely randomized design was used with 4 treatments and 6 replications. The thin layer residue method was used with EC and WP at twice the LC_{95} value determined for *P. xylostella* (appropriate controls were used). The EC and WP formulations had not effect on the mortality, the life time, parasitization ability or the sex ratio of the parasitoid *D. semicausum*. These EC and WP formulations can be used to control the cabbage pest *P. xylostella* in field related to an integrated pest management system.

Index Terms: Botanical insecticide, emulsifiable concentrate (EC), wettable powder (WP), *Diadegma semicausum*

I. INTRODUCTION

Leaf caterpillar *Plutella xylostella* is one of the main pests in cabbage plants caused 50-100% yield loss without control effort (Winarto and Nazir, 2004). The presence of natural enemy decrease attack rate of *P. xylostella* 71% - 82%. Unfortunately The population of natural enemy parasitoid *D. semicausum* significantly decrease due to intensive use of synthetic insecticides (Mukholifah *et al.*, 2014).

All problems above meet to environmental friendly control technique called botanical insecticides. Lina *et al.*, (2014) develop formulations of mixture *T. vogelii* leaf and *P. aduncum* fruit (1:5). Formulations were strong synergistic action against *C. pavonana* and were safe against its natural enemies *Eriborus argenteopilosus*. Both formulations do not cause phytotoxic symptoms in broccoli plants. Lina *et al.*, (2018) determine the same formulations killed another main pest of cabbage plant *Plutella xylostella*. The values of LC_{95} EC and WP formulations were 0.35 % and 0.37% respectively. The safety of formulations against natural enemies. Of *P. xylostella*, parasitoid *D. semicausum* was very important to know before the formulations are used in field.

Revised Manuscript Received on May 05, 2019.

Eka Candra Lina, Faculty of Agricultural, Universitas Andalas Limau Manis, Padang, Sumatera Barat.

Sisri Marleni, Faculty of Agricultural, Universitas Andalas Limau Manis, Padang, Sumatera Barat.

Ir. Nurbailis, Faculty of Agricultural, Universitas Andalas Limau Manis, Padang, Sumatera Barat.

Novri Nelly, Faculty of Agricultural, Universitas Andalas Limau Manis, Padang, Sumatera Barat.

The purposes of this research to determine the effect of emulsifiable concentrates (EC) or wettable powder (WP) formulations of mixed *Piper aduncum* fruit and *Tephrosia vogelii* leaf extracts on the mortality, life time, parasitization ability or the sex ratio of the parasitoid *D. semicausum*.

II. METHODOLOGY

This research conducted at the Insect Bioecology Laboratory and wire house of Plant Pests and Diseases Department, Faculty of Agriculture, Andalas University, Padang from August to October 2017.

Botanical insecticides formulations from mixture extract of *P. aduncum* fruit and *T. vogelii* leaf in the form of formulations emulsifiable concentrate (EC) and wettable powder (WP) were tested at concentration $2 \times LC_{95}$ against parasitoid *D. Semicausum*. This study used a Completely Randomized Design (CRD) with 4 treatments and 6 replications as follows:

A= ControlEC

B= EC formulation (0.70%)

C= ControlWP

D= WP formulation (0.74%)

Preparation of formulations refer to Lina(2014). Determination of concentration was obtained from previous research which had been carried out by Widhianingrum (2017). Thin layer residues method on the surface of the test tube used to examine formulations safety against parasitoid *D. semicausum*. Each test included a pairs of imago *D. semicausum*. Mortality and sex ratio data of parasitoid *D. semicausum* were observed, while the data of life time and parasitization ability of parasitoid *D. semicausum* were analyzed by variance (Test F) at 5% significance level and continue with Least Significant Different (LSD) at the 5%.

III. RESULT

A. Mortality of imago *Diadegma semicausum*

Mixture extract of *P. aduncum* fruit and *T. vogelii* leaves in form EC and WP formulations at a concentration $2 \times LC_{95}$ did not cause mortality of male and female of *D. semicausum* parasitoid at 24 hours after treatment compare to control.



Table. 1 Imago mortality *D. semiclausum* at a concentration of $2 \times LC_{95}$ EC and WP formulation

Treatment	Number of individuals	Mortality (%)	
		Male	Female
EC Control	6	0	0
WP Control	6	0	0
$2 \times LC_{95}$ EC	6	0	0
$2 \times LC_{95}$ WP	6	0	0

B. Live Time of Imago *Diadegma semiclausum*

Life time of male and female of parasitoid *D. semiclausum* after treated with EC and WP formulations of mixture extract from *T. vogelii* and *P. aduncum* can be seen on Table 2. There is no significant different ($P_{male} = 0.9805$ and $P_{female} = 0.9818$) between the life time of treated parasitoid and control.

Table. 2 The average of Life Time imago *D semiclausum* after treated with botanical insecticides in the form of EC and WP formulations

Treatment	Life Time imago <i>D. semiclausum</i> (X ± SD) (Day)	
	Male	Female
EC Control	6,00 ± 3,40	6,16 ± 3,65
WP Control	6,00 ± 1,54	6,00 ± 1,54
$2 \times LC_{95}$ EC	5,83 ± 3,76	6,33 ± 3,66
$2 \times LC_{95}$ WP	6,50 ± 2,34	6,66 ± 2,25

An average life time value of male and female of treated imago parasitoid with EC and WP formulations were 6.33 ± 3.01 days, while in EC control and WP control 6.04 ± 2.53 days.

C. Parasitization ability of *Diadegma semiclausum*

The ability of parasitization of *D. semiclausum* to larvae *P. xylostella* was not significantly different ($P = 0.9814$) between control of EC and WP formulations and treatment of EC and WP formulation. The average ability of parasitization of parasitoid *D. semiclausum* can be seen from the number of parasitic pupae that appear from parasitized larvae (Table 3).

Table. 3 Average number of pupae parasitized by female imago *D. semiclausum* after treatment of vegetable insecticides in the form of EC and WP formulation

Treatment	Number of parasitic pupae (X ± SD)
EC Control	28,00 ± 22,04
WP Control	30,33 ± 8,64
$2 \times LC_{95}$ EC	26,50 ± 21,54
$2 \times LC_{95}$ WP	29,16 ± 9,74

An average number of parasitized pupae in control EC was 28.00 tails and the number of parasitized pupae in EC formulation treatment was 26.50 tails while the number of parasitized pupae in control WP was 30.33 and the number of parasitized pupae in WP treatment was 29.16 tails. Sample of parasitic pupae can be seen in Figure 1.



Fig. 1 The shape of the pupae: a) parasitized pupae, b) healthy pupae

In Figure 1. the parasitized pupae is distinguished by the shape and colour of the healthy pupae of *P. xylostella*. The parasitized pupae of *P. xylostella* has blackish brown colour and tube shape while healthy pupae of *P. xylostella* has yellowish green colour and ellipse shape Comparison of *D. semiclausum* male: female (sex ratio) that appears in the EC formulation treatment and WP formulation also on EC and WP control can be seen in Table 4.

Table. 4 Comparison of male and female imago (sex ratio) generated by imago *D. Semiclausum*

Treatment	Male : Female
EC Control	3 : 2
WP Control	2 : 1
$2 \times LC_{95}$ EC	3 : 2
$2 \times LC_{95}$ WP	3 : 2

Descendants of parasitoid *D. semiclausum* appearing from *P. xylostella* parasitized larvae tend to be male imago then female imago. In EC control treatment, $2 \times LC_{95}$ EC and $2 \times LC_{95}$ WP has the same ratio of males and females there were 3:2 whereas in WP control has a comparison of males and females 2: 1. The imago form of male and female *D. semiclausum* can be seen in Figure 2.



Fig. 2 Imago *D. semiclausum*: a) Female Imago, b) Male Imago

IV. DISCUSSION

Residue of EC and WP formulations of mixture extract of *Piper aduncum* fruit and *Tephrosia vogelii* leaves (5: 1) caused mortality of *Plutella xylostella* larvae (Widhianingrum, 2017). Same formulations did not cause the death of the parasitoid *Diadegma semiclausum* after 24 hours treatment (Table 1). The result shows that the active ingredients were contained on *P. aduncum* fruit and *T. vogelii* leaves have selective activity against *P. xylostella* and its natural enemy parasitoid *D. semiclausum*.

EC and WP Formulations worked more as stomach poisons than contact poisons, this pattern can be seen from the mortality of *P. xylostella* which consume leaf contain residue of formulation. Different from its parasitoid *D. semiclausum* where it was only contact with EC and WP formulation residues. Lina *et al.*, (2017) reported that EC and WP formulations of mixture extract from *P. aduncum* fruit and *T. vogelii* leaves did not cause death of the natural enemy of *Crociodolomia pavonana*, parasitoid *Eriborus argenteopilosus*.

The life time of treated male and female of imago parasitoid *D. semiclausum* was not significantly different from life time of control male and female (Table 2). This shows that the residues of EC and WP formulations besides do not causing mortality of parasitoid *D. semiclausum* also do not affect the physiology of parasitoid *D. semiclausum*. Lina *et al.*, (2015) stated that EC and WP formulations cause physiological interference to *C. pavonana* include food inhibition, food assimilation, and cytochrome P450 enzyme activity. This is prove a selective properties on active ingredients of EC and WP formulations as described above. Tarwotjo (2015) reported that at LC₂₅ (85.99 ppm) the mixture of leaves and twigs *Aglaiia odorata* had no effect on the longevity of *Apantheles sp.*

Insecticides were used in pest management have to fulfil several criteria such as save to untarget organism for example predator, ground arthropods, parasitoid etc. Zarkani *et al.*, (2009) reported that the fraction of liquid vacuum chromatography of *Piper retrofractum* caused death of imago *D. semiclausum* more than 50%. Application of insecticide Abamectin for 30 minutes caused 85-100% mortality of egg parasitoid of *Anagrus nilaparvatae* (Sasmito *et al.*, 2017). Meilin and Praptana (2014) stated that the use of deltamethrin insecticide can shorten the life time of many parasitoids.

Parasitization ability of parasitoid *D. semiclausum* was not affected by the treatment of EC and WP formulations. The number of pupae parasitized in EC and WP treatment were not significantly different to EC and WP controls according to statistical analysis (Table 3). This shows that the fitness of parasitoid *D. semiclausum* is not affected by EC and WP formulations. Sidauruk *et al.*, (2013) reported that the parasitization process is way to continue the off spring of the parasitoid. In order to maintain the balance of parasitoid populations in field, the parasitoid must be able to parasitize the host. The use of botanical insecticides EC and WP formulations of mixture extracts of *P. aduncum* and *T. vogelii* (5:1) are recommended as environmental friendly control technique, because they do not affect the parasitization process of the host larvae *P. xylostella*. As well as research Tarwotjo (2015) states that the LC₂₅(85,99ppm) mixture of

leaves and a twigs. *odorata* does not affect the parasitization process of *Apantheles sp* parasitoid.. Yudha *et al.*, (2017) reported that the insecticide active ingredient emamectin benzoate 5.7% at a concentration of 0,25-1,00 ml / l did not affect the parasitization level of *D. semiclausum* parasitoid in cabbage cultivation . The use of insecticides that can affect the process of the parasitoid unfit parasitization used as a control, such as in research Sasmito *et al.* (2017) application of insecticides abamectin administered to the egg parasitoid *Acontact. nilaparvatae* can reduce parasitization rate by 86.34% at a concentration of 2.28 ppm.

Comparison of male and female imago of *D. semiclausum* as parasitoid a whole was dominated by male imago (Table 4). *Sex ratio* in EC control treatment, 2 × LC₉₅ EC and 2 × LC₉₅ WP has the same comparison value, whereas different comparison on WP control. The difference in comparison on WP control and the higher comparison of appearing male than female imago can be influenced by environmental and food factors. This is no different from Fahrizal's (1998) study which states that *D. semiclausum* parasitoid tends to appear male sex ratio in laboratory conditions. According to Tampubolon *et al.*, (2015) the sex ratio of insects can be influenced by internal factors and external factors such as population density and food conditions. The use of a formulation mixture of fruit extract *P. aduncum* and leaves *T. vogelii* (5: 1) with a concentration of 2 × LC₉₅ did not significantly affect the *sex ratio* imago *D. semiclausum* because there was still a female imago that appeared.

The mixture of fruit extract *P. aduncum* and leaf *T. vogelii* form of EC and WP formulation as a whole is selective against *D. semiclausum* parasitoid because it does not cause the death of *D. semiclausum* parasitoid, does not affect the life time *D. semiclausum* parasitoid, does not affect parasitization and *sex ratio* of *D. semiclausum* parasitoid. So that it can be used as an alternative environmentally friendly control. This is in line with research Lina (2014) mixture of EC and WP formulations fruit *P. aduncum* and leaves of *T. vogelii* not cause death to the natural enemies against *E. argenteopilosus* which is a pest parasitoid of *C. pavonana*.

V. CONCLUSION

EC and WP formulations mixed fruit extract *Piper aduncum* and leaves *Tephrosia vogelii* with a concentration of 2 × LC₉₅ safe against parasitoid *D. semiclausum*. This is indicated by the absence of influence on life duration, parasitization ability and *sex ratio* and 0% mortality of parasitoid *D. semiclausum*.

REFERENCES

1. Abizar, M. dan D. Prijono. 2010. Aktifitas Insektisida Ekstrak Daun dan Biji *Tephrosia vogelii* J. D. Hooker (Leguminosae) Dan Ekstrak Buah *Piper cubeba* L. (Piperaceae) Terhadap Larva *Crociodolomia pavonana* (F) (Lepidoptera: Crambidae). JHPT Trop 10 : 1-12.
2. Asnan, W.A.T., D. Sartiami., R. Anwar., dan Dadang. 2015. Keefektifan ekstrak *Piper retrofractum* Vahl, *Anonna squamosa* L. dan *Tephrosia vogelii* Hook. Serta campurannya terhadap imago kutu putih pepaya *Paracoccus marginatus* Willianis dan Granara de Willink (Hemiptera : Pseudococcidae). Jurnal Entomologi Indonesia 12:2:80-90.



3. Atmadja, W.R. 2011. Pemanfaatan Lima Jenis Insektisida Nabati Untuk Pengendalian Ulat Grayak (*Spodoptera litura*) pada Tanaman Cabe. Semnas Pesnad IV. Bogor.
4. Badan Pusat Statistik dan Direktorat Jenderal Hortikultura. 2017. Produksi, Luas panen dan Produktivitas sayuran di Indonesia. http://www.pertanian.go.id/ap_pages/mod/datahorti [22 Februari 2017].
5. Bernard C.B., J. T Arnason., B.J.R. Philogene., J. Lam. and T. Waddell. 1989. Effect of lignans and other secondary metabolites of the Asteraceae on the monooxygenase activity of European corn borer. *Phytochemistry* 28: 1373-1377.
6. Bernard, C.B., H.G. Krishnamurty., D. Chauret., T. Durst., B. J. R. Philogene., P. S. Vindas., C. Hasbun., L. Poveda., L.S. Roman., J.T. Arnason. 1995. Insecticidal defenses of Piperaceae from the Neotropics. *J Chem Ecol* 21:801-814.
7. Dadang dan D. Priyono. 2008. Insektisida Nabati: Prinsip, Pemanfaatan, dan Pengembangan. Bogor: Departemen Proteksi Tanaman, Institut Pertanian Bogor.
8. Delfel, N.E., W.H. Tallent, D.G. Carlson, and I.A. Wolff. 1970. Distribution of rotenone and deguelin in *Tephrosia vogelii* and separation of rotenoid-rich fraction. *J Agric Food Chem* 188(3): 385-390.
9. Fahrizal, A. 1998. Pengaruh ekstrak biji srikaya (*Annona squamosa* L.) terhadap kualitas larva *Plutella xylostella* sebagai inang *Diadegma semiclausum* Hellen (Hymenoptera : Ichneumonidae) [skripsi]. Institut Pertanian Bogor.
10. Ganskins M.H., G.A White., F.W Martin., N.E. Delfel., E.G. Ruppel., D.K. Baernes. 1972. *Tephrosia vogelii*: A Source of Rotenoids for Insecticidal and Piscidal Use. Washington DC : United States Department of Agriculture.
11. Hasyim M.D. 2011. Potensi Buah Sirih Hutan (*Piper aduncum*) sebagai Insektisida Botani terhadap Larva *Crocidolomia pavonana* [skripsi]. Institut Pertanian Bogor.
12. Herlinda, S. 2005. Parasitoid dan parasitisasi *Plutella xylostella* (L.) (Lepidoptera) di Sumatera Selatan. *Hayati* 12 : 4 : 151 - 156.
13. Hollingworth, R.M. 2001. Inhibitors and uncouplers of mitochondrial oxidative phosphorylation. In: R. Krieger, J. Doull, D. Ecobichon, D. Gammon, E.
14. Indriati G. dan Samsudin. 2014. Aktifitas Insektisida Piperaceae terhadap *Helopeltis antonii* pada Kakao. *J. TIDP* 1(1): 7-14.
15. Lina, E.C. 2014. Pengembangan formulasi insektisida nabati berbahan ekstrak *Brucea javanica*, *Piper aduncum*, dan *Tephrosia vogelii* untuk pengendalian hama kubis *Crocidolomia pavonana* [Disertasi]. Bogor. Sekolah Pascasarjana Institut Pertanian Bogor.
16. Lina, E.C., Dadang., S. Manuwoto., dan G. Syahbirin. 2013. Synergistic action of mixed extracts of *Brucea javanica* (Simaroubaceae), *Piper aduncum* (Piperaceae), and *Tephrosia vogelii* (Leguminosae) against cabbage head caterpillar, *Crocidolomia pavonana*. *Journal of Biopesticides*.
17. 2014. Ekstraksi dan bioaktivitas *Brucea javanica*, *Tephrosia vogelii*, dan *Piper aduncum*. Bogor: Institut Pertanian Bogor.
18. 2015. Gangguan fisiologi dan biokimia *Crocidolomia pavonana* (F.) (Lepidoptera: Crambidae) akibat perlakuan ekstrak campuran *Tephrosia vogelii* dan *Piper aduncum*. *Jurnal Entomologi Indonesia* 12(2) : 94-101.
19. 2017. Safety and effectiveness of mixed plant extracts formulation against cabbages pests under field conditions. *Jbiopest* 10(1) : 25-34.
20. Maulina, F. 2005. Biologi oviposisi dan tingkat parasitisasi *Diadegma semiclausum* Hellen. (Hymenoptera: ichneumonidae), parasitoid larva *Plutella xylostella* Lin. (Lepidoptera: Yponomeutidae) [Tesis]. Padang. Program Pascasarjana Universitas Andalas.
21. Maulina, F. dan Muflihayati. 2013. Conservation of *Diadegma semiclausum* Hellen. Parasitoids as biological control to *Plutella xylostella* Linn. With adult food exploration. *International journal on advanced science engineering information technology*. 3 (5) : 2088 - 5334.
22. Meilin.A. dan R. H. Praptana. 2014. Dampak insektisida deltametrin konsentrasi subletal pada perlakuan dan biologi parasitoid. *IPTEK Tanaman Pangan* 9(2).
23. Mukholifah, S., Suharto., dan D. Sulistyanto. 2014. Inventarisasi dan identifikasi musuh alami pada ulat daun kubis *Plutella xylostella* (L.) daun ulat krop kubis *Crocidolomia binotata* Zell. Di Bromo. *Berkala Ilmiah Pertanian*
24. Ooi, P.A.C. 1980. Laboratory studies of *Diadegma cerophagus* (Hymenoptera : Ichneumonidae), a parasite introduced to control *Plutella xylostella* (Lepidoptera: Yponomeutidae) in Malaysia *Jurnal Entomophaga* 25(3): 249-459.
25. Prabaningrum, L., T. S. Uhan., U. Nurwahidah., Karmin, dan A. Hendra. 2013. Resistensi *Plutella xylostella* terhadap insektisida yang umum digunakan oleh petani kubis di Sulawesi Selatan. *J. Hortikultura* 23(2): 164-173.
26. Priyono, D. 2006. Peranan pestisida botani dalam pengendalian hama terpadu. Di dalam: *Pertemuan Koordinasi Pengembangan Pertanian Ramah Lingkungan dan Organik*. Bogor 17-18 Maret 2006. Bogor. Departemen Proteksi Tanaman, Fakultas Pertanian, Institut Pertanian Bogor. hlm 1-18.
27. Rakhman, A. 2014. Kerentanan *Plutella xylostella* dari Kecamatan Cipanas, Kabupaten Jawa Barat terhadap Lima Jenis Insektisida Komersial, Ekstrak *Piper aduncum* serta Campuran Ekstrak *Piper aduncum* dan *Tephrosia vogelii*. Institut Pertanian Bogor.
28. Sasmito, E. E., Y. A. Trisyono., dan T. Harjaka. 2017. Dampak abamektin terhadap *Anagrus nilaparvatae*, parasitoid telur *Nilaparvata lugens*. *Jduornia* 21 (2) : 80-86.
29. Sidauruk, D. L., M. C. Tobing., M. U. Taringan. 2013. Daya parasitisasi *Tetrastichus* sp. (Hymenoptera : Cossidae) di laboratorium. *Jurnal online agroekoteknologi* 1 (2) : 2337-6597.
30. Sumpena, U. 2013. Budidaya Kubis. Balai Penelitian Sayuran.
31. Susanto, M.S dan D. Priyono. 2015. Sinergis ekstrak *Piper aduncum* dan *Tephrosia vogelii* terhadap Penggerek Batang Padi Kuning, *Scirpophaga incertulas*. *Jurnal Agrikultura*, 26 (1): 7-14.
32. Sonyaratri, D. 2006. Kajian Daya Insektisida Ekstrak Daun Mimba (*Azadirachta indica* A. Juss) dan Ekstrak Daun Mindi (*Melia azedarach* L.) terhadap Perkembangan Serangga Hama Gudang *Sitophilus zeamais* Motsch. Institut Pertanian Bogor. hlm 1-38.
33. Syahroni, Y.Y. dan D. Priyono. 2013. Aktivitas insektisida ekstrak buah *Piper aduncum* L. (Piperaceae) dan *Sapindus rarak* DC. (Sapindaceae) serta campurannya terhadap larva *Crocidolomia pavonana* (F.) (Lepidoptera: Crambidae). *Jurnal Entomologi Indonesia* 10 : 1 : 39-50.
34. Syamsuhidayat, S.S., dan Hutapea, J. R., 1991, Inventaris Tanaman Obat Indonesia (I), Departemen Kesehatan RI, Jakarta, hlm 452-453.
35. Syakir, M., E. Karmawati., A. Kardinan., S.J. Munarso., Yusniati., S. E. Suyati., dan A. Butiharto. 2012. Pestisida Nabati. Pusat Penelitian dan Pengembangan Perkebunan.
36. Tampubolon, H., Marheni., dan D. Bakti. 2015. Pengaruh nisbah kelamin parasitoid *Cotesia flavipes* Cam. (Hymenoptera : Braconidae) dan ukuran panjang inang *Chilo sacchariphagus* Boj. (Lepidoptera : Crambidae) terhadap fekunditas yang dihasilkan di laboratorium. *Jurnal online Agroekoteknologi* 3 : 1 : 71-78.
37. Tarwojto. U. 2015. Beberapa aspek biologi *Apantheles* sp pada inangnya, *Spodoptera litura* Fab. Setelah perlakuan ekstrak daun dan ranting *Aglaia odorata* (Lour). *Bioma* 17(2) : 68-73.
38. Vos, H.C.A.A. 1953. Introduction in Indonesia of *Angitia cerophaga* Grav., a parasite of *Plutella maculipennis* Curt. *Pemberitaan Balai Besar Penyelidikan Pertanian Bogor*. No 134. hlm 32.
39. Wardani, N., dan Nazar, A. 2002. Evaluasi Tingkat Parasitisasi Parasitoid Telur dan Larva Terhadap *Plutella xylostella* L. (Lepidoptera: Yponomeutidae) pada tanaman kubis-kubisan. *J.HPTT* 2(2): 55.
40. Winarto, L., dan D. Nazir. 2004. Teknologi Pengendalian Hama *Plutella xylostella* dengan Insektisida dan Agen Hayati Pada Kubis Di Kabupaten Karo. *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian* 7 : 1 : 27 -33.
41. Widhianingrum, I. 2017. Formulasi Campuran Ekstrak Buah *Piper aduncum* dan Daun *Tephrosia vogelii* untuk pengendalian *Plutella xylostella* Linnaeus (Lepidoptera : Plutellidae) [Skripsi]. Universitas Andalas.
42. Wudianto, R. 2007. *Petunjuk Penggunaan Pestisida*. Jakarta : Penebar Swadaya.
43. Wulan R.D.R. 2008. Aktifitas Insektisida Ekstrak Daun *Tephrosia vogelii* Hook, F. (Leguminosae) terhadap Larva *Crocidolomia pavonana* F. (Lepidoptera : Pyralidae) [skripsi]. Institut Pertanian Bogor.
44. Yazid, M., N. Hakim., G. M. Ali., Y. Junaidi., dan H. Malini . 2013. Pemberdayaan petani melalui introduksi teknologi pembuatan dan aplikasi pestisida nabati pada demplot sayuran organik di Kelurahan Talaang Karamat Kabupaten Banyuwangi. *Jurnal Pengabdian Sriwijaya*.

45. Yudha. I. K. W., Susila. I. W., dan Adnyana. I. M. M. 2017. Pola interaksi parasitoid larva *Diadegma semiclausum* Hellen (Hymenoptera : Ichneumonidae) dengan *Plutella xylostella* L. (Lepidoptera) pada tanaman kubis yang diperlakukan dengan insektisida berbahan aktif Emamectin benzoat 5,7%. E-Jurnal Agroekoteknologi Tropika 6(4) : 2301-6515.
46. Zarkani, A., D. Prijono., dan Putjianto. 2009. Efektivitas ekstrak *Piper retrofractum* dan *Tephrosia vogelii* dan campuran terhadap *Crocidolomia pavonana* dan *Plutella xylostella* serta keamanan ekstrak tersebut terhadap *Diadegma semiclausum*. Jurnal Akta Agrosia 12:1:35 – 44.

AUTHORS PROFILE



First Author Dr. Eka Candra Lina is lecturer in Andalas University. She is concern to do research on Pesticide especially on Botanical insecticide. She has granted paten of botanical insecticide formulations and many publications related the topic. She Finish Doctorate degree in Bogor Agricultural Institute in 2014. She is active in Entomological Society of Indonesia branch West Sumatera as vice Chairman. Current she also active in Science Techno Park Andalas University as Manager. Several publications of Eka Candra Lina:

Lina EC, Widhianingrum I, Putri ME, Evalia NA and Makky M. 2018. Insecticidal activity of *Piper aduncum* fruit and *Tephrosia vogelii* leaf mixed formulations against *Plutella xylostella* (L.) (Lepidoptera: Plutellidae). JBiopest 11(1):69-75

Lina EC, Yulianti N, Ernis G, Arneti and Nelly N. 2018. Storage Temperature of Botanical Insecticide Mixture Formulations and Its Activity Againsts *Crocidolomia pavonana* (F.) (Lepidoptera: Crambidae). AGRIVITA Journal of Agricultural Science 41(2): 0-2

Lina EC, Dadang, Manuwoto S, Syahbirin G, Prijono D. 2017. Safety and Effectiveness of Mixed Extracts Formulation against Pest of Cabbages in Fields. Jurnal of Biopesticides 10(1): 25-34

Lina EC, Dadang, Manuwoto S, Syahbirin G, Prijono D. 2015. Gangguan Fisiologi dan Biokimia *Crocidolomia pavonana* (Lepidoptera: Crambidae) Akibat Perlakuan Ekstrak Campuran *Tephrosia vogelii* dan *Piper aduncum*. Jurnal Entomologi Indonesia 12(2):94-101.

Lina EC, Dadang, Manuwoto S, Syahbirin G, Prijono D. 2013. Synergistic action of mixed extracts of *Brucea javanica* (Simaroubaceae) *Piper aduncum* (Piperaceae), and *Tephrosia vogelii* (Leguminosae) against cabbage head caterpillar *Crocidolomia pavonana*. JBiopest 6(1):77-83.

Lina EC, Arneti, Prijono D, Dadang. 2010. Potensi Insektisida Melur (*Brucea javanica* L. Merr) dalam mengendalikan hama kubis *Crocidolomia pavonana* (Lepidoptera: Crambidae) dan *Plutella xylostella* (Lepidoptera: Yponomeutidae). Jurnal Natur Indonesia 12(2): 109-116



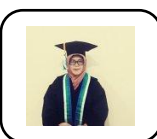
Second Author Sisri Marleni, SP, wasborn at Siguntur Muda / October,01th1994,from Parents M. Jamil and Martini. Sisri has finished her study in Faculty of Agriculture Department of Agrotechnology under supervised of Dr. Eka Candra Lina, SP.MSi and Prof. Dr. Ir. Nurbailis. Length of Study : 4 Years and 11 Months. Current Address : Koto, Desa Siguntur,

Kecamatan Koto XI Tarusan, Kabupaten Pesisir Selatan, Provinsi Sumatera Barat



Third Author Prof. Dr. Ir. Nurbailis, MS., She is Doktor of Phythopatology, Andalas University. She work in Fungi and Biological Control. She publish Many article such as:

THE CHITINASE ACTIVITY IN BANANA SEEDLING THAT INDUCE BY TRICHODERMA SPP AS RESISTANCE RESPONCE TO FUSARIUM OXYPORUM F.SP.CUBENSE; THE EXPLORATION OF ENDOPHYTIC FUNGI AND THEIR POTENTIAL FOR CONTROLLING PHYTOPHTHORA PALMIVORA CAUSES BLACK-POD DISEASE OF COCOA; VIABILITY AND ENVIRONMENTAL EFFECT TO CONIDIAL GERMINATION OF ANTAGONISTIC FUNGI THAT POTENTIAL AS BIOLOGICAL CONTROL OF COLLETOTRICHUM GLOEOSPOROIDES CAUSED ANTRACNOSE DISEASE ON CHILI



Fourth Author Prof. Dr. Novri Nelly is a Profesor in Plant Pest and Desease Departement of Andalas University in Biological Control Field She publish many article such as:

EFFECT OF SUBSTERILIZING DOSES OF RADIATION ON SPERM PRECEDENCE IN FALL ARMYWORM (LEPIDOPTERA: NOCTUIDAE) ; ABUNDANCE OF CORN PLANTHOPPER (STENOCRANUS PACIFICUS) (HEMIPTERA:DELPHACIDAE) AND THE POTENTIAL NATURAL ENEMIES IN WEST SUMATRA INDONESIA; PARASITIZATIONS LEVELS AND TEMPERATURE TOLERANCE OF RICE BUG (LEPTOCORISA ORATORIUS FABRICIUS) EGG PARASITIDS: MASS REARING FOR BIOLOGICAL CONTROL; ABUNDANCE OF CORN PLANTHOPPER (STENOCRANUS PACIFICUS KIRKALDY 1907, HEMIPTERA: DELPHACIDAE) ON FIVE NEW CORN VARIETIES