Effect of botanical insecticides against Fall Armyworm 

*Spodoptera frugiperda* J. E. Smith (Lepidoptera: Noctuidae)

A Kardinan and P Maris*

Indonesian Spice and Medicinal Crops Research Institute, Indonesian Agency for Agricultural Research and Development, Jalan Tentara Pelajar No. 3, Cimanggu, Bogor 16111, West Java, Indonesia

Corresponding author: paramitamaris@yahoo.com

**Abstract.** *Spodoptera frugiperda* or Fall Armyworm is an insect pest that highly polyphagous and considered to have greater damage than the other *Spodoptera*. Two botanical insecticides, i.e. aqueous extract of tobacco leaf (*Nicotiana tabacum*) and tuba roots (*Derris elliptica*) were examined for their effects in mortality (applied by contact and residue) and as a feed reduction. The mortality study was designed in a Completely Randomized Design with three treatments and thirty replications. One replication consists of one larva, then there are thirty larvae in one replication. The results showed that the aqueous extract of tobacco leaf and tuba roots which were applied by contact gave mortality rates as much as 50.0% and 56.7% consecutively, whereas by residual application, the aqueous extract of tobacco leaf (40% mortality) was more toxic compared to aqueous extract of tuba root (23.6% mortality). Aqueous tobacco leaf and tuba root caused feeding reduction of FAW as much as 12.30% and 21.53%, respectively. This showed that these insecticides have potential to be used in the field by farmers because of its has simple preparation method.

1. **Introduction**

One genus of insects that often become pests and causes serious damage is *Spodoptera*. Currently, one species of *Spodoptera* is considered to have greater damage than the other *Spodoptera* type, namely *Spodoptera frugiperda* or often called FAW (Fall Armyworm). FAW, a new destructive insect pest, is one of the major problems for agricultural crop production, especially maize due to its ability to rapid breed, migrate, and feed on a wide range of host plants. All of that factors were makes it very difficult to control [1,2]. FAW is a new pest in maize plants in Indonesia, this insect is originally from America. In the early 2019, this pest has attacked maize plants in the Sumatra Island, Bandung, Garut, and Sumedang – West Java [3]. Its larvae heavily damaged the early stage of corn (approximately 2-week old) with 100% plants infested and each plant was occupied by a medium or large larva; while older corn received less damage [4].

Using synthetic insecticide to control this insect is not a wise solution since synthetic insecticide sometimes causes negative impacts to the environment as well as to the human health. Botanical insecticides are a promising method to control the pest such as FAW since it has biodegradable characteristic. Tobacco (*Nicotiana tabacum*) and Tuba roots (*Derris elliptica*) are the two kinds of botanical insecticides which have been used widely by farmer to control pest in the field. Rotenone is
the main active ingredient of *D. elliptica* which is highly toxic against fish [5] and also significantly affected the mortality of termites [6]. *D. elliptica* aqueous extract is toxic to the larvae of *Oryctes rhinoceros* Linnaeus [7] and also is very toxic to *Leptocorisa acuta* pest insect since the roots have a chemical compound in the form of rotenone C$_{23}$H$_{22}$O$_6$ which has the potential as a bioinsecticide [8]. The main active ingredient of tobacco is nicotine C$_{10}$H$_{14}$N$_2$ [9], and nicotine cause mortality to some pest such as whitefly [10], larvae of *Aedes* sp. [11], *Grapholita molesta* [12], sweet potato weevil *Cylas formicarius* [13], and *Plutella xylostella* [14]. Liquid smoke of tobacco stem waste has activity as an insecticide to *Spodoptera littura* larvae, meanwhile the sub lethal concentration of tobacco liquid extract did not cause mortality of *S. littura* larvae, but inhibited the growth such as indicated by lower weight of larval and pupal in treated larvae than in control [15]. The objective of the research is to find the most effective and efficient measure to control FAW then farmer may apply the technique on their farm.

**2. Materials and methods**

Research was conducted at Laboratory of Entomology, Indonesian Spice and Medicinal Crops Research Institute (ISMECRI) during April to July 2020. The research consisted of two activities, i.e. mortality study and feeding reduction study.

**2.1. Mortality study**

Two kind of botanical insecticides, i.e. aqueous extract of tobacco leaf (*N. tabacum*) and tuba roots (*D. elliptica*) were examined for their effects on FAW mortality, which both applied by (1) contact i.e. spraying directly to the third instar larvae then the larvae was subsequently placed in the fresh baby corn and (2) residue i.e. spraying at the diet (baby corn) then the fresh third instar larvae was placed in the treated baby corn. The mortality study was designed in a completely randomized, three treatments, and thirty replications. One replication consists of one larvae, therefore in one replication there were thirty larvae. This kind of treatment was done because FAW is considered cannibalistic. The treatments consist of (1) aqueous extract of tobacco leaf *N. tabacum* (5 gram/200 ml of water), (2) tuba roots *D. elliptica* (5 gram/200 ml of water) and (3) control (water).

**2.2. Feeding reduction**

As much as 10 pieces of corn husk (0.4 gram each) was treated by each treatment, then it is subsequently being fed to the third instar larvae (one each). Observation was done at sixth hour after treatment by weighing the rest of corn husk at each treatment. Feed Reduction experiment was carried out by formula as follow: [16]

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%FR = \left(1 - \frac{\text{Weight of treated leaf consumed}}{\text{Weight of control leaf consumed}}\right) \times 100\%
\]

**3. Results and discussion**

**3.1. Mortality study**

**3.1.1. Contact/direct application.** Result showed that both aqueous extract of tobacco leaf and tuba roots gave significant different compared to the control treatment. At the 8th day after treatment observation showed that aqueous extract of tobacco leaf and tuba roots caused 50% and 56.7% mortality consecutively against tested larvae of FAW (Table 1).
Effect of Toba cks indicated that those botanical insecticides (tobacco leaf and tuba roots) have significantly different compared to the control treatment. At the 8th day after treatment observation showed that aqueous extract of tobacco leaf and tuba roots caused 40% and 23.6% mortality consecutively against tested larvae of FAW (Table 2). This rate of mortality is a little bit lower compared to contact/direct application (50% and 56.7% mortality). It is indicated that by contact/direct application of both botanical insecticides are more effective to control S. frugiperda compared to by residual application.

### Table 1. Effect of Tobacco leaf and Tuba root aqueous extract against mortality of S. frugiperda applied by contact

| Treatments      | Mortality percentage at the day of |
|-----------------|-----------------------------------|
|                 | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
| Tobacco leaf    | 3.3 a| 10.0 a| 13.3 a| 20.0 a| 26.7 a| 40.0 a| 46.7 a| 50.0 a|
| Tuba root       | 0.0 a| 3.3 a| 10.0 ab| 30.0 a| 36.7 a| 43.3 a| 53.3 a| 56.7 a|
| Control         | 0.0 a| 0.0 a| 0.0 b| 0.0 b| 0.0 a| 0.0 b| 0.0 a| 0.0 b|

Note: numbers followed by the same letter at the same column are not significantly different at 5% DMRT

### 3.1.2. Residual application

Result showed that by residual application, both aqueous extract of tobacco leaf and tuba roots gave significantly different compared to the control treatment. At the 8th day after treatment observation showed that aqueous extract of tobacco leaf and tuba roots caused 40% and 23.6% mortality consecutively against tested larvae of FAW (Table 2). This rate of mortality is a little bit lower compared to contact/direct application (50% and 56.7% mortality). It is indicated that by contact/direct application of both botanical insecticides are more effective to control S. frugiperda compared to by residual application.

### Table 2. Effect of Tobacco leaf and Tuba root aqueous extract against mortality of S. frugiperda applied by residue

| Treatments      | Mortality percentage at the day of |
|-----------------|-----------------------------------|
|                 | 1st | 2nd | 3rd | 4th | 5th | 6th | 7th | 8th |
| Tobacco leaf    | 26.7 a| 33.3 a| 36.7 a| 40.0 a| 40.0 a| 40.0 a| 40.0 a| 40.0 a|
| Tuba root       | 6.7 b| 10.0 b| 10.0 b| 13.3 b| 13.3 b| 13.3 b| 20.3 b| 23.6 b|
| Control         | 0.0 b| 0.0 b| 0.0 b| 0.0 c| 0.0 c| 0.0 c| 0.0 c| 0.0 c|

Note: numbers followed by the same letter at the same column are not significantly different at 5% DMRT

In the residual application of mortality study, tobacco leaf can cause higher mortality than tuba root significantly. Tobacco main ingredient, nicotine, kills insects by disrupting their nervous system, causing vital functions to cease and finally the death [17]. Meanwhile, tuba root acts as contact and food poison (residual) [18]. It stops insects from feeding, leading to their demise via starvation and interference with respiration at cellular level [17]. This is quite matched with the tuba root mortality result in residual application. Because if we want to kill the insect, disrupting its vital function usually kills more and faster than making the insect dies from starving.

### 3.2. Feeding reduction

### Table 3. Effect of Tobacco leaf and Tuba root aqueous extract as antifeedant against S. frugiperda

| Treatments      | FR (Feeding Reduction) (%) |
|-----------------|----------------------------|
| Tobacco leaf    | 12.30                      |
| Tuba root       | 21.53                      |

Result showed that aqueous extract of tobacco and tuba roots can cause feeding reduction of the larvae of FAW (Table 3). The data indicated that those botanical insecticides (tobacco and tuba roots) have the potential to be elaborated as a measure to control FAW in the field conducting by the farmers since this technique is a simple technique (aqueous extraction). There is no need of any laboratory equipment. This result is quite similar with other research which stated that tobacco leaf can reduce the level of damage caused by *P. xylostella* in mustard greens (*Brassica juncea*) [14]. The tuba root extract also has the same effect. A research stated that a phytochemical test for tuba root in several fractions including distilled water was demonstrated flavonoid substance [19]. It means that rotenone,
the main ingredient of tuba root which is considered as flavonoid, can still be found in aqueous extract. Tuba root is usually effective against leaf-feeding insects including caterpillar [20], so it is quite matched with the feeding reduction result.

4. Conclusion and recommendations
The result showed that in mortality test, contact/direct application of both botanical insecticides are more effective to control S. frugiperda compared to residual application. In the feeding reduction activity, although the feeding reduction of tuba root is a little bit higher than the feeding reduction of tobacco leaf, but the result shows that both extracts can cause feeding reduction even in a short amount of time. The result of these two activities (mortality study and feeding reduction study) show that both aqueous extracts of tobacco (N. tabacum) and tuba roots (D. elliptica) have the potential to be elaborated as botanical insecticides which can be used easily by farmers in the field to control FAW.

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