Resistence of ten local probolinggo tobacco accessions to armyworm (*Spodoptera litura F.*) in field

H Prabowo 1, S Adikadarsih 1, J Damaiyani 2

1 Indonesian Sweetener and Fiber Crops Research Institute, Jl.Raya karangploso Kotak Pos 199, Malang 65152, Tel./Fax. +62-271-663375
2 Plant Conservation Center of Botanical Garden of Purwodadi, Indonesian Institute of Sciences

Corresponding author : heri_prabowo@mail.litbang.pertanian.go.id; heribalittas@gmail.com

Abstract. Tobacco (*Nicotiana tabaccum* L.) is an important cash crop of Indonesia. This commodity is great economic importance and a source of revenue, employment, and foreign exchange. Tobacco production in Indonesia faces several obstacles, one of which is damage caused by armyworm (*Spodoptera litura*) infestation. The armyworm cause destructive effects on plant so that it is necessary to obtain information regarding the types of tobacco, especially new tobacco varieties which are resistant to armyworm. Therefore, the production of tobacco could be improved. This research aimed to identify the resistance of local Probolinggo tobacco to armyworm so that they can be utilized to develop armyworm resistant tobacco and to improve productivity. A study to test the field resistance of local Probolinggo Tobacco was conducted in Besuk and Krejengan Village, Probolinggo. Eight accessions with two controlling accessions (Paiton 1 and 2) were used. The results showed that the average percentage of armyworm infestation on Vis-à-vis tobacco accession was approximately 9.0 up to 17.33 %. The most attracting accessions are DB Srongsong Sadhana, DB Srongsong Gajah, and Paiton 1 with the percentage of infestation of 19.50; 14.34 and 14.17 %, respectively. The lowest armyworm infestation was found in two tobacco accessions i.e. Samporis and Jimamwut. The level of resistance based on Chiang and Talekar showed that Samporis and Jimamwut were moderately resistant to armyworm, but accession DB Serongsong Sadhana dan Paiton 1 were susceptible. Samporis and Jimamwut can be developed as candidates to face army worm infestation.

Keywords: Armyworm; tobacco; resistance

1. Introduction
Tobacco plants are a vital commodity in Indonesia, which can improve the national economy. The anti-tobacco national campaign is incapable to cease the existence of tobacco plants in Indonesia. It is a solution for farmers in agriculture without economic haggling, and it is a commodity that offers abundant profit. The presence of tobacco plants have several advantages including creating more jobs in a large number for locals, becoming one of exported commodities, making considerably high national income especially from customs [1]. Tobacco made 207.5 trillion customs revenue in 2015.
The customs revenue generated from tobacco is higher than ethyl-alcohol products or alcoholic beverages [2]. Nonetheless, tobacco plants are susceptible to pest attack. One of the pests that reduces the tobacco production, and its outbreak could result in the death of tobacco plants, is tobacco armyworm (Spodoptera litura). This pest is an insect pest that can be found across Asia [3]. S. litura is a polyphagous pest with various ranges of hosts, i.e. more than 112 agricultural crops from 44 families [4]. S. litura larvae commonly attacks leaves and flowers [5,6]. Usually, S. litura attack in group. They lay their eggs in group; each group can consist of 350 eggs [7]. This cause the newly hatched larvae to attack and spread in group on their third instar. On their first and second instar, they would band together and attack the epidermis layer of castor oil plants, causing them to dry out. Concurrently, they would spread and chew all parts of the leaves except for the stalks on their third until fifth instar [8].

Some technologies that are commonly used to control tobacco armyworm include the use of tobacco liquid smoke, trap crop, insect pathogen, natural enemy, chemical pesticide, pest control based on morphological character variation, and resistant variety [9,10,11,12,13,14]. The use of resistant variety is more advantageous among farmers since it is simple and does not require any specific technological training [15,16,17]. The use of pest-controlling variety can be integrated into an integrated pest management system and it can control a wide area of herbivores when applied in large-scaled integrated pest management [18]. The cultivation of resistant variety faces an obstacle caused by armyworm’s attack on quality tobacco plants. The presence of armyworm could weaken tobacco plant’s resistance to pests. Hence, in order to support the control of armyworm pest, it is crucial to collect information on the resistance of ten accessions of local tobacco in Probolinggo to armyworm. This research is aimed to identify the resistance of ten accessions of local tobacco in Probolinggo to armyworm in the field.

2. Materials and Methods

The research was implemented on Besuk and Krejengan Village, Probolinggo Regency, East Java from February – December 2017. The test was performed on a well-known local cultivar (cigarette factory) such as DB Serongsong originated from farmers/manufacturers/other institutions shown in Table 1.

Table 1. Local accessions of Paiton / Probolinggo tobacco to test for resistance to armyworms.

| No. | Local accessions | Origin                        |
|-----|------------------|-------------------------------|
| 1.  | DB Serongsong Gajah | Farmer in Besuk Village       |
| 2.  | DB Serongsong Besuk | Farmer in Besuk Village       |
| 3.  | DB Serongsong Sadhana | PT. Sadhana               |
| 4.  | DB Serongsong AOI  | PT. AOI                      |
| 5.  | DB Serongsong Balittas | ISFCRI             |
| 6.  | Jimamut            | ISFCRI                       |
| 7.  | Samporis           | ISFCRI                       |
| 8.  | DB Serongsong Super | Farmer in Besuk Village      |
| 9.  | Paiton 1 (control variety) | ISFCRI             |
| 10. | Paiton 2 (control variety) | ISFCRI             |

The study was performed using random group sampling in three repetitions. Each phenotype that was grown composed of 150 – 200 plants/plots with 50 x 100 cm planting distance. The basic fertilizer used was: 15 g NPK/plant (15, 15, 15) and 15 g ZA/plant, equivalent to 100 kg N, 45 kg...
K2O, and 45 kg P2O5 per ha. The NPK fertilizer was applied during the planting while the ZA fertilizer on the 21st day after planting.

The researchers observed pest attacks on ten local accessions with ± 2 months of age in Probolinggo. The observation was implemented by random group sampling in three repetitions. The examination was performed to 100 plants/repetitions to identify the number of plants attacked by armyworm. Such evaluation was performed to the real armyworm outbreak in the field instead of setting an artificial armyworm attach. It resulted in more valid results because Probolinggo has been the central of tobacco for some time so that armyworm’s presence is common, and the obtained results showed more real data of tobacco resistance to pest. The observation on pest attack was followed by the calculation of armyworm outbreak percentage with the following formula:

$$R = \left( \frac{a}{b} \right) \times 100\%$$

with R = pest outbreak percentage, a = number of attacked plants, b = number of observed plants

Anova was utilized to analyze the outbreak percentage. Duncan multiple range test was taken in case of actual differences via SPPS software. The evaluation on local tobacco clones’ resistance to armyworm in Probolinggo was implemented by grouping the outbreak percentage into several pest resistance criteria based on Chiang and Talekar’s method (1980) [19], composing of 'high resistant ', 'resistant', 'moderate resistant', 'susceptible', and 'highly susceptible'.
Figure 1. Ten local probolinggo tobacco accessions: DB Serongsong Gajah (A), DB Serongsong Besuk (B), DB Serongsong Sadhana (C), DB Serongsong AOI (D), DB Serongsong Balittas (E), Jimamut (F), Samporis (G), DB Serongsong Super (H), Paiton 1 (I), Paiton 2 (J)

In addition to pest attack percentage, an agronomic parameter calculation was done to identify the response of local tobacco resistance to pest attack. The agronomic parameters included height of plants, and number, thickness, length, and width of leaves. The leaves’ length was measured from their base until tip while the leaves’ width was measured from the widest middle part of the leaves. The measurement was taken before the plants were cut while the age of flowering was observed from the sample plants. The plants were considered to blossom when there were 1 – 3 flowers blossom.

3. Result and Discussion
It was challenging to obtain local tobacco accessions with resistance to armyworm. The pest is able to detoxify itself so that it is persistent and can spread on various kinds of plants. The pest is polyphagous and difficult to control. The research shows that the type of tobacco accession determines the average percentage of armyworm attack. There was 7.0 until 19.50 % outbreak of armyworm found from the ten local tobacco accessions in Probolinggo Regency. Each tobacco accession shows different resistance level to armyworm attack. All the ten tobacco accessions that were being observed were not classified as having being highly resistant and resistant. 60 % of them are moderate resistant while the remaining 40 % are susceptible to armyworm pest. The local tobacco accessions with moderate resistant to armyworm consist of DB Serongsong AOI, DB Serongsong Balittas, Jimamut, Samporis, DB Serongsong Super, and Paiton 2. DB Serongsong Balittas, Jimamut, Samporis, DB Serongsong Super, and Paiton 2 are classified as susceptible (Table 2 and 3).

5 accessions of potential varieties were released on this research with 1 controlling variety (Paiton 2) that is classified as moderate resistant to armyworm. It will be extremely challenging to acquire local accessions with high resistance or enough resistance to armyworm without importing tobacco plants’ parents that are reported to be resistant to armyworm from another country. Adie et al. (2015) [20], reported that from a test of soybean’ resistance showed one genotype that is resistant, five genotypes that are moderate resistant, and four genotypes that are prone to S. litura. The susceptible genotypes include G511H/Arg//Arg///Arg-12-15, G 511 H/Anj//Anj///Anj-6-3, G 511 H/Arg//Arg///Arg-19-7, and Anjasmoro variety while the only genotype with resistance is G100H. Plant’s resistance to armyworm commonly depends on its antixenosis and antibiosis (Kogan and Ortman 1978). Antibiosis is a resistance mechanism in plants that cease pests from attacking, growing, and reproducing as well as altering the physiological effect of pests. Further,
antixenosis is a resistance mechanism of plants that repels the existence of pests (repellent) and where plants characterize themselves to prevent pests to lay eggs and grow on them. It is still become a debate on which is the best resistance mechanism of plants to pests. However, it is agreed that the assembly of a pest-resistant plant shall combine antibiosis with antixenosis [21].

Armyworm outbreak in Krejengan Village showed higher percentage compared with that in Besuk Village with a percentage of pest attack of 11.37 % (Table 3). It is because the low soil and water contents in Krejengan Village so that its tobacco resistance is hampered and less responsive to armyworm attack when compared to Besuk Village. The failure caused by several factors including inability to fulfill the standard ecological and economic conditions for plants with pest resistance.

A successful assembly of plants with pest resistance in an ecosystem requires a complex tritrophic interaction between plant, bugs, and environment [22]. Plant cultivation system, fertilization, dry environment may cause tobacco plants not to grow maximally so that it lacks of resistance to armyworm.

Table 2. Percentage of armyworm infestation in the Besuk and Krejengan villages.

| Location | Location | Accession                  | Percentage of Infestation (%) | Average of Infestation |
|----------|----------|----------------------------|--------------------------------|------------------------|
| Besuk Village | DB Serongsong Gajah | 17.33 d                     |                                |                        |
|          | DB Serongsong Besuk | 12.33 bc                    |                                |                        |
|          | DB Serongsong Sadhana | 13.33 c                    |                                |                        |
|          | DB Serongsong AOI | 10.67 b                     |                                |                        |
|          | DB Serongsong Balittas | 9.00 a                     |                                |                        |
|          | Jimamut | 9.00 a                     |                                | 10.6                  |
|          | Samporis | 7.33 a                     |                                |                        |
|          | DB Serongsong Super | 9.33 a                     |                                |                        |
|          | Paiton 1 (control variety) | 15.00 d                    |                                |                        |
|          | Paiton 2 (control variety) | 10.33 bc                    |                                |                        |
|          | DB Serongsong Gajah | 11.00 bc                    |                                |                        |
|          | DB Serongsong Besuk | 11.00 bc                    |                                |                        |
|          | DB Serongsong Sadhana | 25.67 d                    |                                |                        |
|          | DB Serongsong AOI | 8.33 b                      |                                |                        |
|          | DB Serongsong Balittas | 8.00 b                     |                                |                        |
|          | Jimamut | 6.67 a                     |                                | 11.37                 |
|          | Samporis | 6.67 a                     |                                |                        |
|          | DB Serongsong Super | 6.67 a                     |                                |                        |
|          | Paiton 1 (control variety) | 13.67 bc                    |                                |                        |
|          | Paiton 2 (control variety) | 8.33 a                     |                                |                        |

* Note: values followed by the same letter in the same column is not significantly different according to DMRT with 95% confidence level.
### Table 3. Criteria for resistance of ten Probolinggo local tobacco accessions to armyworms.

| Accessions          | Percentage of infestation (%) | Criteria for resistance of ten Probolinggo local tobacco |
|---------------------|------------------------------|----------------------------------------------------------|
| DB Serongsong Gajah | 14.17 b                      | Susceptible                                              |
| DB Serongsong Besuk | 11.67 ab                     | Susceptible                                              |
| DB Serongsong Sadhana | 19.50 c                  | Susceptible                                              |
| DB Serongsong AOI   | 9.49 a                       | Moderate resistant                                        |
| DB Serongsong Balittas | 8.50 a                   | Moderate resistant                                        |
| Jimamut             | 7.84 a                       | Moderate resistant                                        |
| Samporis            | 7.00 a                       | Moderate resistant                                        |
| DB Serongsong Super | 8.00 a                       | Moderate resistant                                        |
| Paiton 1 (control variety) | 14.34 b                | Susceptible                                              |
| Paiton 2 (control variety) | 9.33 a                   | Moderate resistant                                        |

* Note: values followed by the same letter in the same column is not significantly different according to DMRT with 95% confidence level.

Figure 2. Effects of accession on susceptible and moderately resistant categories Of leaf numbers, plant height, leaf thickness, leaf length, and leaf width.

Armyworm outbreak found on local tobacco from Probolinggo destroy the plants and cause a great economic loss since it directly attacks the commercial part of tobacco plants, i.e. the leaves. The plants themselves will resist the attack naturally by creating a self-resistant mechanism by volatile excretion to attract predators and parasitoid for minimizing the damage caused by the pest attack [17]. Such defence mechanism of tobacco plants certainly disrupt their development since they channel their energy to fight the pest. Figure 2 demonstrates that the plants with moderate resistance is taller than plants that are susceptible to pests. Plants with moderate resistance show greater capability in tolerating pest attack so that it develops better than plants that are prone to pest. Nevertheless, the parameter shows that their leaves have similar number, thickness, and width. Susceptible plants able to tolerate the presence of pests so that the presence of pests does not really affect plant agronomic parameters such as number, thickness, and width. Sandhyarani and Rani (2013) [23] stated that armyworm tends to thrive on plants with low resistance.
4. Conclusion

- The most attracting accessions are DB Paiton and DB Paiton 1 with the percentage of infestation of 19.50; 14.34 and 14.17 %, respectively. The lowest armyworm infestation was found in two tobacco accessions i.e. Samporis and Jimamwut.

- Resistance levels based on Chiang and Talekar show that Samporis and Jimamwut are classified as resistant criteria and DB Serongsong Sadhana and Paiton 1 are classified as susceptible Samporis and Jimamwut can be developed as candidates to faces with army worm attacks.

5. Acknowledgement

We would like to give appreciation for East Java Government for support and funding this research.

References

[1] Rachmat M and Nuryanti S 2009 Dinamika Agribisnis Tembakau Dunia dan Implikasinya Bagi Indonesia Forum Pen. Agr. E. 27 73-91
[2] Romadhon M, Mochammad A M and Sri S 2016 Evaluasi Pemungutan Cukai hasil Tembakau Di Kantor Pelayanan dan Pengawasan Bea dan Cukai Tipe Madya Cukai Malang J. Perp. (JEJAK) 8(1) 1-3
[3] Hadapad A, Chaudhari C S, Kulye M, Chaudele AG and Salunkhe GN 2001 Studies on chitin synthesis inhibitors against gram pod borer, Helicoverpa armigera (Hub.) J. of Natcon 13(2) 137-140
[4] Singh A K, Parasnath and Ojha J K 1998 Antifeeding response of some plant extract against Spodoptera litura (Fab.) of groundnut Indian J.of App. Ent. 12 9-13
[5] Devanand P and Pathipati U R 2008.Biological potency of certain plants in management of two lepidopteran pests of Ricinus communis L. J. of Biopest 1(2) 170 - 176
[6] Amir A M and Heri 2011 Hama Tanaman Tembakau Dalam Monograf Tembakau Virginia (Malang: Balai Penelitian Tanaman Pemanis dan Serat) 81-96
[7] Pracaya 2008 Hama dan Penyakit Tanaman (Jakarta: Penebar Swadaya)
[8] Sudarmo S 1998 Pengendalian Serangga Hama Kacang Tanah (Yogyakarta: Penerbit Kanisius)
[9] Prabowo H 2012 Pemanfaatan Nematoda Patogen Steinernema spp. Isolat Malang Dan Nusa Tenggara Barat Dalam Pengendalian Spodoptera litura L. Yang Ramah Lingkungan J. Bumi Lest. 12(2)
[10] Prabowo H, Martono E and Witjaksono W 2016 Activity of Liquid Smoke of Tobacco Stem Waste as An Insecticide on Spodoptera litura Fabricius Larvae J. Perlin. Tan. Indonesia 20 (1) 22-27
[11] Prabowo H, Adikadarsih S and Damaiyani J 2019 Mass Production Of The Entomopathogenic Nematode, Steinernema Carpocapsae On Tenebrio Molitor And Spodoptera litura Biodiversitas J. of Biol. D. 20(5)
[12] Prabowo 2019 Sublethal Effect Of Physic Nut Wangi Variety Oil (Jatropha Curcas L.) on Helicoverpa Armigera Hubner J. of Phy Conf. Series 1175 (1) 012010
[13] Arista R G, Permadi C G, Ariesta C, Larasati B, Kasiamdari R S, and Prabowo H 2019 Evaluation Of Pest Control Based On Morphological Character Variation On 20 Varieties And Genetic Variation Based On RAPD Of Sugarcane (Saccharum Officinarum L.) In Indonesia IOP Conf Series: Earth and Env. Science 347(1) 012103
[14] Prabowo H and Damaiyani J 2019 Evaluation of Kemiri Sunan (Reutealis trisperma Blanco) Seed Oil Nanoemulsion as insecticide against Planococcus minor (Homoptera: Pseudococcidae) J. of Phys: Conf. Series 1363(1) 012006
[15] Dhaliwal G S, Koul O and Arora R 2004 Integrated Pest Management: Restrospect and
Prospect In: Koul, O., Dhaliwal, GS., and Cuperus, GW. Integrated Pest Management Potentials, Constraints, and Challenges (London: CAB International)

[16] Stout M J 2014 Host-PlanResistance in Pest Management In: Integrated pest management: current concepts and ecological perspective (eds D.P. Abrol) (San Diego: Academic Press)

[17] Bruinsma M and Dicke M 2008 Herbivore-Induced Indirect Defense: From Induction Mechanisms to Community Ecology. In: Induced Plant Resistance to Herbivory. (eds Andreas Schaller) (Dordrecht: Springer Science+Business Media) P. 31-60.

[18] Vendramim J D and Elio C G 2012 Plant Resistance and Insect Bioecology and Nutrition. In: Insect Bioecology and Nutrition for Integrated Pest Management (eds. Antônio R. Panizzi José R. P. Parra) (Florida: CRC Press) p 657

[19] Chiang H S and Talekar N S 1980 Identification of sources of resistance to the beanfly and two Agromizid flies in soybean and mungbean J. Econ. Entomol. 73 197–199

[20] Adie M, YIB M S, and Ayda Krisnawati 2015 Ragan ketahanan kedelai terhadap ulat grayak from Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang dan Umbi (Malang: Balai Penelitian Tanaman Aneka Kacang dan Umbi. P 66-69

[21] Oki N, Komatsu K, Sayama T, Ishimoto M, Takahashi M and Takahashi M 2012 Genetic analysis of antixenosis resistance to the common cutworm (Spodoptera litura Fabricius) and its relationship with pubescence characteristics in soybean (Glycine max (L.) Merr.). Breeding Science 61 608–617

[22] Nicholls C I and Altieri M A 2004 Agroecological bases of ecological engineering for pest management in: Ecological Engineering for Pest Management Advances in Habitat Manipulation for Arthropods (eds Geoff M. Gurr, Steve D. Wratten, and Miguel A. Altieri). (Collingwood, Australia and Wallingford, UK: CSIRO Publishing) p 33-40

[23] Sandhyarani K and Rani P U 2013 Morphometric and developmental consequences in Spodoptera litura due to feeding on three varieties of sweet potato plants (Ipomoea batata) Phytoparasitica 41(3) 317–325