Evaluation of chili accessions for resistance against *Thrips* sp. (Thysanoptera: Thripidae)

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Abstract. *Thrips* sp. (Thysanoptera: Thripidae) is one of chili pests that can cause significant crop losses by 23% and be even more harmful due to its ability to transmit virus. The use of resistant variety is one sensible strategy to control this pest attack. Thirty chili accessions were evaluated for resistance by counting of the number of pest, recording leaf damage and observing accessions morphological characters. The evaluation was conducted in the Research Field Station of Indonesian Vegetable Research Institute, Lembang, West Java from March to July 2020. Ten of the 30 accessions had low leaf damage and were considered to be used as female parents in breeding program of resistant chili against *Thrips* sp.

1. Introduction

Chili or hot pepper (*Capsicum annum* L.) belongs to Solanaceae family is among the most common vegetable cultivated worldwide, including in Indonesia [1]. It is commonly used as spice in Indonesian cuisines. High productivity and quality are important to fulfil demand of this commodity in Indonesia that reaches in 1.5 kg/capita/year in average [2] or 397,500 ton/year. However, various pests and diseases regular occurrence in the field is considered as major constrains and can cause 20 – 100% losses in Indonesia. There are 14 chili pest species that commonly found in Indonesian including *Thrips parvispinus* Karny, (Myzus persicae Sulz.), *Polyphagotarsonemus latus* Banks., *Helicoverpa armigera* Hubn., *Spodoptera litura* F., *Bemisia tabaci* Genn., *Bactrocera dorsalis* Hendel, *Empoasca* sp., *Brachytrypes portentotus* Licht., *Gryllotalpa africana* Pal., *Agrotis ipsilon* Hufn., *Phyllophaga* spp, *Spodoptera exigua* Hubn., and *Liriomyza huidobrensis* Blanchard [3].

Vos [4] reported that *Thrips parvispinus* Karny (Thysanoptera: Thripidae) is one of the most aggressive pests in Southeast Asia and causing major destruction on chili farming in Java. The thrips management in chili cultivation is challenging due to its ability to directly attacking crop by feeding on leaves, flowers and fruits, and indirectly attacking crops by transmitting viruses [5]. Thrips can persistently transmit virus *Tomato spotted wilt virus* (TSWV) [6]. The nature of thrips that included polyphagous mode of feeding, high reproductive capacity, facultative parthenogenic reproduction style, their high capacity in developing resistance to pesticide, and their ability to conceal themselves
in bud during larval phase and in soil during pupating stage caused significant difficulty in managing such pest [7,8].

Chemical application is considered as the most effective approach to control this pest. Workers have reported various negative impact of synthetic pesticide excessive and indiscriminate use including the increase of pest population, pest resistance to pesticides [9], mortality of beneficial organism [10], and human diseases [11]. It is important to develop an alternative approach in order to solve this serious problem. The resistant host plant can be used as one of environment-friendly pest management approaches in controlling thrips. Screening of chili accessions is the first important step to obtain female parent to be used for breeding program of chili resistant against thrips. This study aims to select promising accessions that can be used as female parent for such purpose.

2. Methods

Thirty accessions of chili from Indonesian Vegetables Research Institute (IVEGRI) germplasm collection were evaluated under field condition in IVEGRI’s Research Field Station, Lembang, West Java, Indonesia (6°47′11′′S, 107°42′7′′E; 1250 asl) from March to July 2020. Twenty plants of each line were planted to follow IVEGRI’s chili cultivation guideline. The plot size was 1m x 8m with 70 cm and 50 cm plant spacing.

Pest data collection were carried out on 55, 59, 62, 69, 77, 85, 92, 105, 113 days after planting (DAP), by randomly selecting 5 plants/line. In each of sample plant, thrips population/3 leaves/plant and thrips attack intensity were recorded. Observations of the incident of the *Thrips* sp. were conducted on 55, 59, 62, 69, 77, 85 DAP.

In addition, various morphological characteristics of chili lines were observed including plant height, leaf blade length, leaf blade width, green leaf color intensity, leaf anthocyanin coloration, leaf shape, leaf margin undulation, blistering, leaf profile in cross section, leaf glossiness, flower peduncle attitude, stigma exertion, anther anthocyanin coloration, filament anthocyanin coloration, corolla secondary color, initial flowering setting time and number of abnormal fruits. Observed data were analyzed using Principle Component Analysis and correlation analysis.

3. Results and discussion

In the evaluation of thrips resistance, the number of thrips found in crops was used as the resistance parameter. Those number reflect thrips preference and accessions with low number of thrips were selected for female parent in chili breeding program. However, as shown in Table 1, the number of thrips in chili lines were low (less than thrips control threshold i.e. 10 nymph/leaves [12] and its fluctuation was inconsistent. Hamilton [13] stated that low number of thrips that found in particular lines might be caused by the genetic resistance of those lines or merely coincidently present. In fact, thrips population commonly found in cluster rather than random distribution. Thus, selecting resistance lines based on thrips population only was unable to be generated due to its low number of thrips. Additionally, the differences of the number of thrips among lines was unable to be properly evaluated since there were no replication lines in this study.

The evaluation result shows that the fluctuation of the averages percentage of thrips damage were also inconsistent (Table 2). However, if resistant chili accession were selected based on the incidence of attack that is <10 plants and intensity of attack <10%/plant sample, then accessions number 1,16, 18, 21, 22, 24, 27, 28, 29, and 30 could be selected to be used as female parents. There were 2 chili lines that had 9 incidents of attack i.e. lines number 17 and 22. However, because the intensity of the attack and the population of thrips in accessions no 17 was higher than in number 22, then accession number 22 was preferable for female parent. In the peanut cultivars screening, the use of plant damage parameter also more preferable compared to the use of thrips number [14]. Visschers [15] further suggested the use of thrips leaf damage measurement in Capsicum leaf discs to predict overall thrips population development on plant.

The evaluation of thrips resistance was continued by using PCA to examine multidimensional data included the population of thrips, incident and intensity of thrips attack and morphological...
characteristics data. The result of this analysis is shown in Figure 1. Based on the PCA analysis of the pest parameters (i.e. population, intensity, and incidence of thrips) there were variations in the resistance of thirty lines against thrips. The Eigen values indicating the existence of this variation spread to the range from -2 to +2. The accessions that have Eigen values of more than 0.5 were considered as susceptible to thrips attack, and this was confirmed by the high population number, intensity, and incidence of thrips. Based on the Eigen values of PC-1, screened accessions can be grouped into susceptible, moderate, and resistant to thrips. The result showed that eleven lines were included in the susceptible category (i.e. number 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, and 15), eight lines were considered as moderate lines (1, 2, 3, 16, 17, 23, 25, and 26) and ten lines were categorized as resistant lines (5, 18, 19, 21, 22, 24, 27, 28, 29 and 30). Accessions number 20 was excluded in the analysis since there was only 3 of 20 plant survived during the evaluation.

### Table 1. Average numbers of thrips population

| Line number | Observation day (…days after transplanting) |
|-------------|---------------------------------------------|
|             | 55  | 59  | 62  | 69  | 77  | 85  | 92  | 105 | 113 |
| 1           | 0.00| 0.00| 0.00| 0.00| 0.20| 0.40| 1.00| 1.40| 1.20|
| 2           | 0.00| 0.00| 0.00| 0.00| 0.40| 0.40| 0.40| 0.20| 0.00|
| 3           | 0.20| 0.00| 0.00| 0.00| 0.40| 1.60| 0.60| 0.40| 1.60|
| 4           | 0.20| 0.00| 0.00| 0.00| 0.60| 0.20| 1.60| 1.40| 1.80|
| 5           | 0.00| 0.00| 0.00| 0.00| 0.20| 0.60| 0.40| 1.40| 1.00|
| 6           | 0.20| 0.00| 0.00| 0.00| 0.40| 1.00| 0.80| 1.20| 1.60|
| 7           | 0.20| 0.00| 0.00| 0.00| 0.60| 0.20| 2.00| 2.00| 1.60|
| 8           | 0.00| 0.00| 0.00| 0.00| 0.20| 1.20| 1.00| 1.80| 1.00|
| 9           | 0.00| 0.00| 0.00| 0.00| 1.80| 1.00| 0.40| 1.60| 1.20|
| 10          | 0.00| 0.00| 0.00| 0.00| 3.00| 1.00| 0.80| 1.60| 2.00|
| 11          | 0.00| 0.00| 0.00| 0.00| 2.40| 0.80| 0.80| 2.40| 0.80|
| 12          | 0.00| 0.00| 0.00| 0.00| 2.80| 1.60| 0.80| 2.00| 2.40|
| 13          | 0.00| 0.40| 0.00| 0.80| 2.00| 1.40| 0.40| 1.60| 2.20|
| 14          | 0.00| 0.40| 0.00| 0.20| 4.40| 1.00| 1.20| 1.80| 2.20|
| 15          | 0.00| 0.00| 0.00| 0.00| 0.40| 2.20| 1.40| 2.00| 2.00|
| 16          | 0.00| 0.20| 0.00| 0.00| 0.00| 3.40| 1.40| 1.60| 1.60|
| 17          | 0.20| 0.00| 0.00| 0.00| 0.00| 0.40| 0.40| 1.20| 0.40|
| 18          | 0.00| 0.00| 0.00| 0.00| 0.20| 1.00| 0.60| 1.20| 1.00|
| 19          | 0.00| 0.00| 0.00| 0.00| 0.20| 0.20| 0.00| 0.60| 0.80|
| 20          | 0.00| 0.00| 0.00| 0.00| 0.00| 0.33| 0.00| 0.00| 0.00|
| 21          | 0.00| 0.00| 0.00| 0.00| 0.20| 0.60| 0.20| 0.80| 0.80|
| 22          | 0.00| 0.00| 0.00| 0.00| 0.00| 0.00| 0.40| 0.80| 0.40|
| 23          | 0.00| 0.20| 0.00| 0.00| 1.20| 2.40| 0.60| 1.00| 0.80|
| 24          | 0.20| 0.00| 0.00| 0.00| 0.00| 1.20| 1.20| 0.40| 0.00|
| 25          | 0.20| 0.00| 0.00| 0.00| 0.40| 0.60| 1.20| 0.80| 0.00|
| 26          | 0.00| 0.00| 0.00| 0.00| 1.40| 1.60| 1.60| 1.60| 0.80|
| 27          | 0.00| 0.00| 0.00| 0.00| 1.20| 0.80| 0.80| 0.60| 1.20|
| 28          | 0.00| 0.00| 0.00| 0.00| 0.20| 0.40| 0.40| 0.60| 0.40|
| 29          | 0.00| 0.00| 0.00| 0.00| 0.00| 0.80| 0.80| 0.20| 0.20|
| 30          | 0.00| 0.00| 0.00| 0.00| 0.00| 0.80| 0.80| 0.60| 0.40|

The observation result of the sixteen morphological characters of plants and the number of abnormal fruits of 29 chili lines showed that the variations among accessions were only found in the eight characters and not found in the other eight characters. Further, the correlation results test indicated that population, intensity, and the incidence of thrips, were positively correlated with leaf size characters, but negatively correlated with fast flowering characters. Additionally, these three parameters had a positive correlation with the number of abnormal fruits. The larger the leaf size, the higher the population, intensity, and incidence of thrips. The attack of thrips affected the number of abnormal fruits. In contrast, the population, intensity, and incidence of thrips decreased in the fast-flowering lines. While the reason on how the leave size and flowering setting time affecting the thrips has not been fully understood, these findings suggested that leave size and flowering setting could be included in the accessions screening for thrips resistance. In her study, Visschers [15] stated that ontogenetic stage should be considered when conducting screening for thrips resistant, since plant’s
developmental and its genetic background could affect thrips resistance. According to Latha and Hunumanthraya [16], population of *Thrips* sp. was negatively correlated with trichome density, chlorophyll and phenol content of chili. Highly susceptible genotypes tend to have very thin and light green color leaves, while moderately resistant genotypes showed thick and dark green color leaves.

### Table 2. Average percentage of thrips damage

| Line number | Observation day (...days after transplanting) |
|-------------|----------------------------------------------|
|             | 55 | 59 | 62 | 69 | 77 | 85 | 92 | 105 | 113 |
| 1           | 0.00 | 0.00 | 0.00 | 2.44 | 1.65 | 5.52 | 5.14 | 4.01 | 6.80 |
| 2           | 0.00 | 0.00 | 0.00 | 7.35 | 2.65 | 7.39 | 6.82 | 4.68 | 18.00 |
| 3           | 1.00 | 25.96 | 6.28 | 0.38 | 1.23 | 4.00 | 2.71 | 0.95 | 1.66 |
| 4           | 1.00 | 13.78 | 6.47 | 12.87 | 8.53 | 21.59 | 27.47 | 26.67 | 25.93 |
| 5           | 0.00 | 3.95 | 3.16 | 0.00 | 2.82 | 3.12 | 3.14 | 4.84 | 6.99 |
| 6           | 0.00 | 0.00 | 0.00 | 5.35 | 5.28 | 3.72 | 6.59 | 2.14 | 4.42 |
| 7           | 0.00 | 6.53 | 6.79 | 11.30 | 11.97 | 8.75 | 6.24 | 7.76 | 6.51 |
| 8           | 0.00 | 8.95 | 2.37 | 0.00 | 15.83 | 9.94 | 9.36 | 10.75 | 10.23 |
| 9           | 0.00 | 10.99 | 3.48 | 0.00 | 5.38 | 3.67 | 3.48 | 9.16 | 0.00 |
| 10          | 0.00 | 2.22 | 5.00 | 2.86 | 10.30 | 6.50 | 0.81 | 4.53 | 0.00 |
| 11          | 0.00 | 1.43 | 4.39 | 0.00 | 4.85 | 2.76 | 1.07 | 0.53 | 0.00 |
| 12          | 0.00 | 10.99 | 4.08 | 0.00 | 3.27 | 5.95 | 0.48 | 1.00 | 0.55 |
| 13          | 0.00 | 13.88 | 14.55 | 8.03 | 20.82 | 27.03 | 5.26 | 11.98 | 18.37 |
| 14          | 0.00 | 0.00 | 0.00 | 2.80 | 9.21 | 9.04 | 10.12 | 6.35 | 11.26 |
| 15          | 0.00 | 1.82 | 1.18 | 0.56 | 3.22 | 7.41 | 10.92 | 5.44 | 8.50 |
| 16          | 0.00 | 5.00 | 2.50 | 0.00 | 2.45 | 1.73 | 3.38 | 0.23 | 1.06 |
| 17          | 0.00 | 8.65 | 2.41 | 0.00 | 0.45 | 0.62 | 0.79 | 1.06 | 3.22 |
| 18          | 0.00 | 0.00 | 0.00 | 0.00 | 4.37 | 6.44 | 1.74 | 8.34 | 7.73 |
| 19          | 0.00 | 10.00 | 1.43 | 0.00 | 2.03 | 5.13 | 9.84 | 5.72 | 4.71 |
| 20          | 0.00 | 0.00 | 0.00 | 8.57 | 2.00 | 0.00 | 22.22 | 5.92 | 0.00 |
| 21          | 0.00 | 0.00 | 0.00 | 5.71 | 2.20 | 1.32 | 0.26 | 0.87 | 0.56 |
| 22          | 0.00 | 6.25 | 0.00 | 0.00 | 3.17 | 1.95 | 2.15 | 0.67 | 0.61 |
| 23          | 0.00 | 0.00 | 3.53 | 11.18 | 12.58 | 10.99 | 5.00 | 3.52 | 4.43 |
| 24          | 0.00 | 8.33 | 2.73 | 1.87 | 4.10 | 0.64 | 5.36 | 0.00 | 0.00 |
| 25          | 0.00 | 11.67 | 5.29 | 7.58 | 9.59 | 9.99 | 7.98 | 1.04 | 4.20 |
| 26          | 0.00 | 17.58 | 1.76 | 2.84 | 1.27 | 3.25 | 3.25 | 0.58 | 3.78 |
| 27          | 0.00 | 4.43 | 5.55 | 5.58 | 3.98 | 0.00 | 0.00 | 0.00 | 0.22 |
| 28          | 0.00 | 3.57 | 1.33 | 3.75 | 3.70 | 0.40 | 0.40 | 5.29 | 12.84 |
| 29          | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 0.82 | 0.82 | 0.09 | 3.35 |
| 30          | 0.00 | 8.00 | 0.00 | 0.00 | 2.86 | 8.04 | 8.04 | 2.49 | 5.17 |

![Figure 1](image-url). The Eigen values of chili accessions resistance against *Thrips* sp.
Figure 2. Correlation of morphological characters with pest attack parameters (1 = plant height; 2 = leaf length; 3 = leaf width; 4 = leaf green color intensity; 7 = waves on leaf edges; 9 = cross-section of leaves; 10 = gloss on leaves; 16 = age of flowering; 17 = abnormal fruit; P = thrips population; IT = damage intensity; and IS = pest incidence).

Maharijaya [17] mentioned that biology of the thrips, particularly, its oviposition rate and larval mortality was significantly affected by resistant accessions. They further suggested that antibiosis plays as key role in resistance of pepper, while morphological characters have no role on pepper resistance. Other works, however, has identified various morphological mechanism of crop resistance against thrips. Latha and Hunumanthraya [16] mentioned plant resistance against thrips caused by various factors that responsible for working simultaneously to react against pest attack. For instance, morphological characteristic such as dark leave color caused by high total chlorophyll might prevent thrips attack [18]. In addition, thrips incidence in chili was reportedly negatively impacted by chlorophyll and total phenol content [19]. The present study suggested leaf size and time of flowering setting have correlation with chili resistance against thrips. That result is promising since in addition to obtain 10 resistant lines for breeding program, the information collected from the current study also provide additional guidelines for further screening strategies of chili breeding program. This additional information is important to formulate effective and consistent selection techniques in breeding program for developing new resistant chili cultivars.

4. Conclusion
From the result, it can be concluded that all screened accessions were attacked by thrips. Accession number 5, 18, 19, 21, 22, 24, 27, 28, 29 and 30 were selected as resistant against thrips and proposed to be used as female parent in the new variety developing program. The leaf size was positively correlated with thrips attack, while flowering time were negatively correlated with thrips attack.
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