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The planthopper (hemiptera: delphacidae) attacking the local and hybrid maize varieties in Central Sulawesi-Indonesia: Identification, abundance and preferences

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The planthopper (hemiptera: delphacidae) attacking the local and hybrid maize varieties in Central Sulawesi-Indonesia: Identification, abundance and preferences

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Abstract. The planthopper may treat and reduce the corn productivity if not managed properly. This study aims to discover the planthopper species that attack the corn in Central Sulawesi and their abundance in the local and hybrid corn varieties. Three hybrid varieties (Pertiwi, Pioneer, and Arumba) and one local variety (Lamuru) of corn were used as the treatments. They were set up using a Randomized Block Design in 6 replications. The planthopper population was directly observed weekly both in the vegetative and generative stages and imago were randomly collected for identification at the laboratory. Differences in secondary metabolites of corn particularly total phenolic and silica content were analyzed. The study confirmed that the planthopper attacked corn in our study sites as the white-bellied planthopper *Stenocranus pacificus* Kirkaldy (Hemiptera: Delphacidae). The presence of the *S. pacificus* was first recorded 2 weeks after plantation (WAP) only at the Pertiwi variety. The highest population of S.pacificus was detected at 4 and 5 WAP and the most preferable variety was Pertiwi followed by Pioneer, Arumba, and Lamuru indicating that the hybrid variety seemed to be more susceptible to infest by planthopper than the local corn variety. Polyphenol but not silica contents of corn varieties may explain the preferences of planthoppers in attacking the corn

1. Introduction

The corn planthopper outbreak has been recorded in some provinces of Indonesia since 2016 like in Lampung and Sumatra Island [1] [2]. A high infestation of the planthoppers on corn plants can cause "hopperburn" characterized by leaf chlorosis, followed by necrosis, reduced plant vigor, and stunting [3]. In addition, corn plants attacked by WBP produce small cob and light seeds which are fragile and easily broken when knocked out by threshing machines. Besides damaging corn directly, planthoppers also can act as a vector of plant viruses. As a result, a high planthopper infestation may significantly reduce corn production. For example, in India, it has been estimated that the planthoppers attacks cause a loss of 10–15% due to leaf sugar exudation,10–18% loss of plant stand, and 30% of grain sorghum yield. While in Indonesia losses caused by viruses transmitted by P. maidis in corn/maize range from 9 to 90% with crop damage estimates of 22–64% [3]. Therefore this invasive pest could be a severe threat to the food security in the region that has no enough information about the current status of this pest.

There are two species of the planthopper recorded to attacking the corn in Lampung that are *Peregrinus maidis* Ashmead and the white-bellied planthopper *Stenocranus pacificus* Kirkaldy (Hemiptera: Delphacidae) [4]. *S. pacificus* seemed to be more harmful because this species was reported as a new invasive pest attacking many corn-growing areas in the Philippines [5]. In addition, this pest also attacks rice plants, throughout Asia [6]. Nevertheless, the attack levels of the planthopper on corn were different among the corn varieties [2] indicating that the susceptibility or resistance of the corn against the planthoppers varies. This is a normal phenomenon because differences in plant resistance to pest attack depend on the morphological and chemical character of the plants [7]. For instance, the population of brown planthoppers is lower in the rice variety with a higher silica content [8]. In addition, the growth rate of the fall armyworm [9] and the population of filbert aphid [10] were correlated to the phenolic acid content of the plant consumed or attacked.

A preliminary survey found a high-level infestation of the planthoppers on the corn plantation in Central Sulawesi and was the second dominant pest recorded by the farmers after fall armyworm [11]. However, what kind of planthopper species attack those corn and whether this planthopper attacks all corn variety or they more prefer a certain variety need to be clarified. These all are urgent to asses to provide basic data for a good pest management program.
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2. Materials and Methods

2.1. Experimental plots and corn cultivation

The study was conducted in the experimental plots in 2023 at the Labuan Toposo Village, Donggala Regency, one of the maize centers cultivated in Central Sulawesi. The study site is situated at 167 m a.s.l. with a geographic position of -0°38'41.46" S and 119° 50' 35.0052" E. The maize was grown in a 4.9 × 1.75 m plot as the experimental units consisted of 12 crops and the space between crops and plots were 70 × 25 cm and 50 cm. The plots were set up in a Randomized Block Design in 6 replications. Three hybrid varieties (Pertiwi, Pioneer, and Arumba) and one local variety (Lamuru) of corn were used as the treatments. Organic fertilizers (cow manure, 20 tons/ha), inorganic fertilizers (urea, SP-36, and KCL), as well as the recommended agronomic practices to grow the corns were applied. No chemical pesticides were used during the experimental period.
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2.2. Observation of planthopper population

The planthoppers population was observed directly using a hand-tally counter at the four sample crops at each plot. The plant samples were selected systematically following a rectangular pattern. Observation was done weekly from 2 weeks after planting (WAP) to 1 week before the plants were ready to be harvested.

2.3. Identification of planthopper, secondary metabolite of maize and data analysis

Plant hopper identification was done at the laboratory of Plant Pests and Diseases Faculty of Agriculture, University of Tadulako. The planthoppers collected from the field were brought to the laboratory for further identification based on the morphological character using available taxonomic keys and references [6] [12] [4]. The differences in secondary metabolites of maize were analyzed. The leaves of corn of the vegetative and generative phase were collected and then processed and analyzed their secondary metabolites in the Chemical laboratory of the Faculty of Mathematics and Sciences, University of Tadulako. The total phenolic content of the corn leaves was determined with Folin-Ciocalteu reagent and using gallic acid as a standard phenolic compound as described by Orak [13], while silica extraction was carried out by the precipitation method, then the extraction results were analyzed quantitatively by gravimetry [14]. Differences in the planthopper population and secondary metabolites among the maize varieties were analyzed using ANOVA and then followed by an LSD test at a 5% level of significance.

3. Results and discussion

3.1. Abundance and identification of the planthoppers

The presence of the *S. pacificus* was first recorded 2 weeks after plantation (WAP) only at the Pertiwi variety but at the 3 WAP they were recorded at all maize varieties (Figure 1). Based on their morphological character, the planthopper who attacked the maize is the white bellied-planthopper, *Stenocranus pacificus* Kirkaldy (Hemiptera: Delphacidae). The abdomen color of the female was white while the male's was orange. Female body size was bigger than male (Figure 1).

The morphological character of *S. pacificus* as mentioned above is in line with those described by Susilo et al. [12]. This study was the first to report the abundance and the species of plant hoppers attack several maize varieties in Central Sulawesi. In West Sumatra Syahrawati et al. also only found S.pacificus attacking the corn plantation.

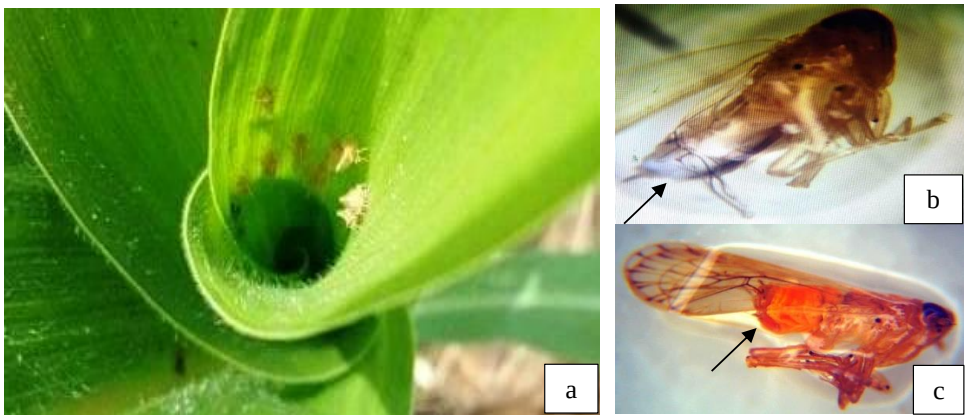

Figure 1. Abundance (a) and morphological character of the female (b) and male (C) of *S. pacificus* attacks the maize

In Lampung province, Hasibuan et al. [4] found two species of maize planthoppers dominated by *S. pacificus* and the second one is *P. maidis*. The planthopper population was varied during the time of observation. However, the highest population of *S. pacificus* was detected at 4 WAP and continued to decrease from 5 WAP to the end of the generative phase. Interestingly, their population also varies among the maize variety and the most preferred variety was Pertiwi followed by Pioneer, Arumba, and Lamuru (Figure 2).

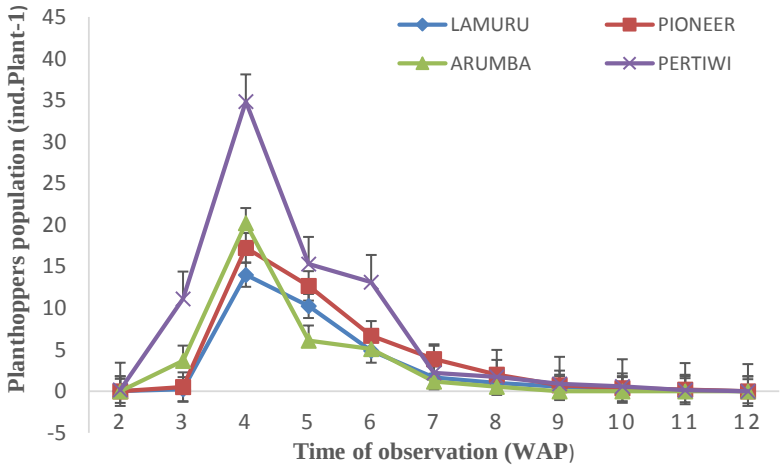

Figure 2. Fluctuation of the *S. pacificus* population on different maize variety during the study

Differences in the planthopper population are also found between the vegetative and generative phases of the maize. In all studied variety *S. pacificus* were more abundance in the vegetative phase that is about 6 to 12 individual/plants compared to 0.4 to 3.2 individual/plants in the generative phase Figure 3).

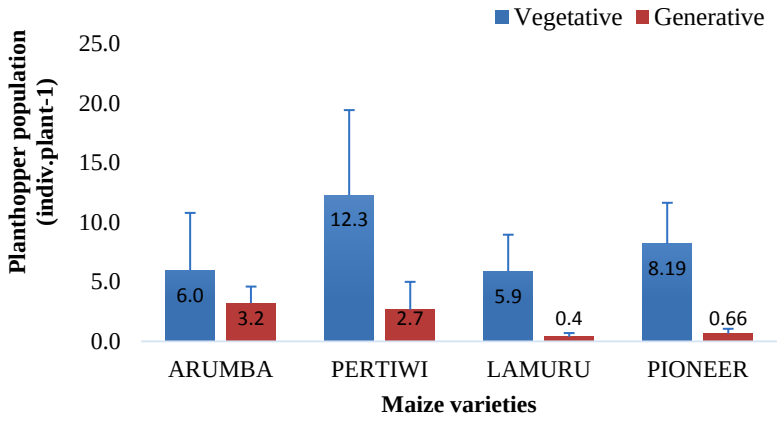

Figure 3. Abundance of the *S. pacificus* at different phase of maize

Differences in the planthopper abundance are also reported by Syahrawati *et al*. [2] noted that *S. pacificus* was more prefer to attack the NT10 variety compare to compared to other tested varieties from the early growth of cor. However, they recorded that *S. pacificus* abundance was higher at the generative phase than the vegetative, a different pattern of the population dynamic of the *S. pacificus* found in this study. The planthoppers' oviposition activities are greater during the vegetative crop stage and greatly decline after flowering in maize and sorghum [3]. As a result, the population of planthoppers tended to be lower during the generative phase. However, it should be noted that there are complex factors interacting in shaping the population density or the outbreak of the maize planthoppers.

The primary variables that may increase the abundance of the planhoppers include continuous cropping, high-yielding cultivars of maize and sorghum, reduced genetic variety in short duration, and the application of high quantities of nitrogenous fertilizers [3]. Furthermore, a study conducted in China was mentioned by Hasibuan *et al*. [4] claim that high-nutrient cultivars, improper use of insecticides, and other environmental factors relating to climate and culture have caused planthopper outbreaks. Therefore in order to manage this invasive species it needs to implement good agriculture practices such as rotation or mix cropping and using a more rational dan environmentally friendly fertilizer and pesticide.

3.2. Phenolic and silica contents of maize leaf

The total phenolic and silica contents were varied among the maize varieties. They were about 6,41 to 7.33 (mgGAE/g) and 32.98 to 36.91 %, respectively. However, the remarkable differences were only detected in the phenolic contents where one of the hybrid varieties (Pertiwi) has the lowest content of the total phenolic compared to the other three varieties (Figure 4).

The differences in the planthopper population among the maize varieties may related to their phenolic contents. This study found the highest planthoppers abundance in the Pertiwi variety which may relate to their lower phenolic content compared to another variety (Figure 4) although this study detected significant differences in the silica content among varieties it has no clear pattern in relation to the planthopper population. This indicates that the planthopper population on maize is may related to the total polyphenol and not silica contents.

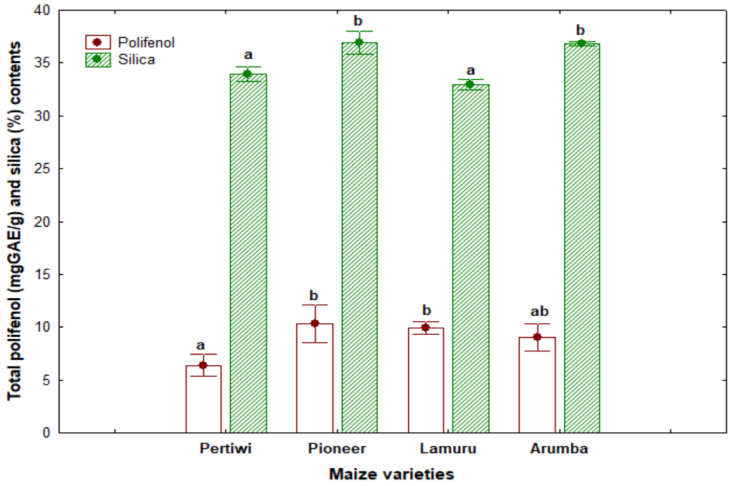

Figure 4. The total poliphenol and silica contents of four maize varieties.

There are some possible mechanisms of the plant hopper resistance against the planthoppers. It included the antixenosis and antibiosis mechanisms. The maize with high phosphorus, potash, and polyphenol content is less preferred by *P. maidis* [3]. While the planthoppers population in rice is negatively correlated with the silica content [8]. Plants use phenolics to resist attacks from herbivores because of their deterrent and toxic effects. The higher concentration of phenolic acids is correlated with the reduced ability of *P. maidis* to locate the phloem tissues on sorghums. These tissues contain a fluid that is rich in sucrose and relatively poor in amino acids and minerals [3]. Therefore, the secondary metabolite contained in each maize variety together with the agronomic practices and climatic factors may be acting as determining factors on the abundance of the planthoppers.

4. Conclusion

The planthoppers attacked the maize in Labuan Toposo, Donggal Regency in Central Sulawesi is the white bellied-planthopper, *Stenocranus pacificus* Kirkaldy (Hemiptera: Delphacidae). The highest population of *S.pacificus* was detected at 4 and 5 WAP and the most preferred variety by them was Pertiwi followed by Pioneer, Arumba, and Lamuru. The abundance of *S. pacificus* in our study area is not high and they are more abundance in the vegetative stage of maize. Differences in their abundance between maize varieties have seemed closely related to the phenolic and not the silica contents.

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