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# Screening and evaluation of maize varieties for resistance to *Spodoptera frugiperda*

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**ABSTRACT**
Maize is one of the staple food crops in the world, but the entry of *Spodoptera frugiperda* pests has reduced national maize production. Most farmers control these pests by using pesticides that cause harm to human health and the environment, so that other environmentally friendly control alternatives are needed, namely the use of resistant varieties. This study aims to obtain maize varieties that are resistant to *Spodoptera frugiperda* attacks. This study used a one-factor Randomized Block Design (RBD), namely maize varieties, consisting of five varieties, namely: Bisi 2, Bisi 18, Pertiwi 3, Pioneer 32, and NK 212. Each variety was repeated five times. Based on the results of observations of vegetative and generative growth parameters, it was obtained that the NK 212 variety had the best growth and production compared to other varieties. Meanwhile, the results of observations of *Spodoptera frugiperda* attacks showed that Pioneer 32 was a resistant variety with the lowest attack intensity. Although the NK 212 variety showed the best growth and yield, the Pioneer 32 variety proved to be more resistant to pest attacks. Therefore, variety selection must consider the balance between pest resistance and potential production results.
**Keywords:** maize, resistant varieties, screening, *Spodoptera Frugiperda*

## 1. Introduction

Maize is one of the food crops that is a staple food in the world after rice and wheat [1]. In addition to being used as a food ingredient, maize also has the potential to be used as a feed ingredient and industrial material with high selling value because maize is a source of carbohydrates, fiber, and a number of other important nutrients [2]. The need for maize increases every year because more than 55% of domestic maize needs are used for feed, and 30% for food consumption, the rest for other needs and seeds [3].

Fulfillment of these needs has become difficult since the entry of a new pest, namely *Spodoptera frugiperda* (JE Smith) (Lepidoptera: Noctuidae), in Indonesia, also known as the armyworm, first entered Lampung [4]. Then *S. frugiperda* spread to West Java, West Sumatra, and was found in almost all regions in Indonesia [5-6]. *S. frugiperda* has become a global concern and is known as a pest that causes significant yield losses with economic impacts [7]. Crop losses due to *S. frugiperda* invasion vary between countries. Maize losses in Brazil range from around 34% [8], in Zimbabwe 12% [9], in Kenya more than 30% [10], in India 33% [11], in the United States 5–20% [12], and in Zambia 35% [13].

Most farmers control *S. frugiperda* by using pesticides, but this control is considered to have disadvantages for human health and the environment [14]. The spread of this pest is very fast, so other efforts are needed, one of which is the use of maize varieties that are resistant to pest attacks, including armyworms [15]. The use of pest-resistant varieties requires relatively low costs, a fairly high success rate, does not cause environmental pollution, and is easy to apply by farmers in the field. According to Pajrin et al [16], the use of resistant varieties is more profitable because their resistance properties are more stable, economical, and do not cause side effects in the form of poisoning and environmental pollution.

Research on the effect of *S. frugiperda* attacks on several maize varieties has been widely reported. Deden et al. [17] reported that the type of variety affects the preference for laying egg clusters, the intensity of damage, and the intensity of *S. frugiperda* attacks on sweet maize plants, where the intensity of attacks on the Sweet Boy variety was 9.14%, the Sweet Lady 8.19%, and the Super Sweet 7.34%. Furthermore, Sholihat et al. [15] reported that the Bisi 2 maize variety tended to experience the most severe damage compared to other varieties, namely 49.13%, followed by the Srikandi Kuning variety (38.06%), Nasa 29 (28.99%), Bisma (28.90%), Lamuru (38.58%), and the lowest in the Sukmaraga variety (27.51%). However, there are no varieties that are resistant to *S. frugiperda* attacks. Based on this, it is necessary to conduct a study on plant responses to *S. frugiperda* attacks in an effort to use screening techniques to obtain resistant varieties. This study aims to obtain maize varieties that are resistant to *S. frugiperda* attacks.

## 2. Materials and Methods

### *2.1. Place and Time*

This study was conducted at the greenhouse of the Faculty of Agriculture, Universitas Sumatera Utara, at an altitude of 25 meters above sea level, from September to December 2025.

### *2.2. Materials and Tools*

The materials used in this study were five varieties of maize (Bisi 2, Bisi 18, Pertiwi 3, Pioneer 32, and NK 212), armyworms (*Spodoptera frugiperda*), polybags, topsoil, sand, Urea fertilizer, KCl fertilizer, TSP fertilizer, bamboo, tile cloth, nails, plastic rope, wire, labels, plastic labels, and other supporting materials. The ools used in this study were hoes, watering cans, meters, rulers, scales, cameras, pens/markers, and other supporting tools.

### *2.3. Methods*

This study used a one-factor Randomized Block Design (RBD), namely maize varieties, consisting of five (5) varieties: Bisi 2 (V1), Bisi 18 (V2), Pertiwi 3 (V3), Pioneer 32 (V4), and NK 212 (V5). Each variety was repeated five times. Each experimental unit of each maize variety consisted of three polybags per replication.

Planting was carried out in polybags using loosened soil media, then put into 35 cm x 40 cm polybags. Maize seeds (10 g of each variety) were first soaked in clean water in order to obtain good seeds. Soaking was carried out for 1 x 24 hours, then the water was drained and dried. Each variety was planted with as many as 2 seeds per polybag, so that there were 30 seeds per treatment, and then the seeds were planted at a depth of 2.0 cm.

Plant maintenance was carried out according to plant conditions. Fertilization is carried out using Urea (6.5 g/polybag), TSP (3.3 g/polybag), and KCl (1.7 g/polybag) fertilizers when the seedlings are 7 days old after planting.

The parameters observed included vegetative growth, namely plant height, number of leaves, and stem diameter observed at 7 weeks after planting (WAP), and generative growth, namely height of the cob, weight of cob with husk, weight of cob without husk, cob length, and cob diameter observed at harvest time at different times for each variety.

### *2.4. Rearing of Spodoptera frugiperda*

Maintenance and propagation of *S. frugiperda* is carried out in the greenhouse by taking S. frugiperda larvae from the field and placing them in jars. Maize plants are used as host plants (feed for *Spodoptera frugiperda*) planted in planting media (polybags filled with soil) measuring 35 cm x 40 cm. After the larvae become imago, the imago are then released on plants that have been prepared to produce eggs and larvae on the plants. For the second generation, the larvae that have been obtained from the rearing results are then placed in jars until they become imago so that the imago are directly invested in 1-month-old plants.

*2.5. Investment of Spodoptera frugiperda*
*S. frugiperda* used in this study is the second generation of rearing results. Obtained by taking 5 male moths and 5 female moths from *S. frugiperda*, then the male and female moths are placed on maize plants.

*2.6. Data Analysis*
The observation data were analyzed using the F test. If the maize variety treatment on the armyworm inventory had a significant effect, then it was continued with the Tukey test at 5% [18].

## 3. Results and Discussion

*3.1. Vegetative Growth of Maize*
Vegetative growth is one of the important phases in the life cycle of maize plants, because at this stage the plant forms basic structures such as roots, stems, and leaves that greatly determine the plant's ability to absorb nutrients and support generative growth. In this study, five maize varieties were tested to determine the differences in their vegetative growth characteristics. Each variety has a different genetic potential, which can affect the growth rate, plant height, number of leaves, and stem diameter formed during the vegetative period (Table 1).

**Table 1.** Vegetative growth of five varieties of maize

| Variety | Parameter | | |
|---|---|---|---|
| | **Plant Height (cm)** | **Number of Leaves (leaves)** | **Stem Diameter (cm)** |
| Bisi 2 | 139.64 | 8.89$^{ab}$ | 1.46 |
| Bisi 18 | 131.18 | 9.11$^{ab}$ | 1.46 |
| Pertiwi 3 | 130.06 | 7.44$^{c}$ | 1.39 |
| Pioneer 32 | 131.02 | 8.22$^{bc}$ | 1.32 |
| NK 212 | 138.80 | 9.89$^{a}$ | 1.49 |

Note: Numbers followed by different letters in the same column and row indicate significant differences according to Tukey's test at $\alpha = 5\%$.

The results of the analysis of variance showed that the variety treatment had no significant effect on the height of the maize plant. The maize plant variety Bisi 2 had the highest plant height. If sorted by plant height from highest to lowest, namely Bisi 2, NK 212, Bisi 18, Pioneer 32, and Pertiwi 3 (Table 1). The plant height between each variety is different, indicating that plant height is one of the plant characteristics influenced by genetic factors, where the difference is caused by differences in the speed of cell division, multiplication, and enlargement [19]. According to Sitompul and Guritno [20], differences in genetic composition are one of the causes of diversity in plant appearance. Next, Genetic variety is crucial because it improves a species' chances of survival [21].

Varietal treatment significantly affected the number of leaves, where the largest number of leaves was found in the NK212 variety, which was not significantly different from Bisi 18 and Bisi 2, but significantly different from Pioneer 32 and Pertiwi 3 (Table 1). The number of leaves is related to the ability of plants to carry out photosynthesis, which takes place in the leaves of the plant. According to Gardner et al. [19], the more leaves on a plant, the more light is absorbed by the plant for the photosynthesis process, so it greatly influences the growth and development of the plant.

Varieties had no significant effect on maize stem diameter, but the largest stem diameter was found in the NK 212 variety, followed by Bisi 2, Bisi 18, Pertiwi 3, and Pioneer 32 (Table 1). The results of this study differ from the study by Khairiyah et al. [22], who found that varieties had a significant effect on stem diameter parameters only at 21 and 28 DAP, while at 35 and 42 DAP the varieties had no significant effect. Marliah et al. [23] stated that plants with different varieties planted in the same environmental conditions showed different results.

*3.2. Generative Growth of Maize*
Generative growth is a crucial phase in the life cycle of maize plants, because at this stage, the reproductive organs are formed, which directly determine the potential final harvest results. Each maize variety has different generative growth characteristics, including height of the cob, weight of the cob with husk, weight of the cob

without husk, cob length, and cob diameter (Table 2). These differences are influenced by genetic factors and the variety's response to the environmental conditions in which it grows.

**Table 2.** Generative growth of five varieties of maize

| Variety | Parameter | | | | |
|---|---|---|---|---|---|
| | **Height of the Cob** | **Weight of cob with husk** | **Weight of cob without husk** | **Cob Length** | **Cob Diameter** |
| Bisi 2 | 87.89 | 152.78$^{ab}$ | 136.11$^{ab}$ | 13.47 | 4.16 |
| Bisi 18 | 85.00 | 125.78$^{ab}$ | 113.44$^{ab}$ | 11.33 | 4.10 |
| Pertiwi 3 | 80.22 | 126.78$^{ab}$ | 104.33$^{ab}$ | 11.10 | 4.11 |
| Pioneer 32 | 74.00 | 91.89$^{b}$ | 78.78$^{b}$ | 10.02 | 3.21 |
| NK 212 | 82.10 | 194.44$^{a}$ | 174.44$^{a}$ | 14.86 | 4.29 |

Note: Numbers followed by different letters in the same column and row indicate significant differences according to Tukey's test at $\alpha = 5\%$.

The results of the analysis of variance showed that the variety treatment had no significant effect on the height of the maize cob. The position of the cob on the Bisi 2 maize plant was the highest compared to other varieties, while the lowest was the Pioneer 32 variety. This shows that there is an influence of genetic factors and the growing environment, where to obtain optimal sunlight in the photosynthesis process, plants tend to elongate the stem segments so that plant height and cob height increase in the Bisi 2 variety. Plant height and cob height are correlated, namely the higher the plant, the higher the cob height depending on its genetic properties [24].

In contrast to the height of the cob, the variety treatment significantly affected the weight of maize cobs with and without husks. Based on Table 2, it can be seen that the NK 212 variety has the highest weight of cobs with husks compared to other varieties, where the NK 212 variety is not significantly different from Bisi 2, Bisi 18, and Pertiwi 3, but significantly different from Pioneer 32. According to Maryamah [25], the weight of cobs with husks is a yield variable that is used as a description of the yield per plant and can be used as a reference for yields in a certain area. Furthermore, the NK 212 variety also has the highest weight of cobs without husks compared to other varieties, where the NK 212 variety is not significantly different from Bisi 2, Bisi 18, and Pertiwi 3, but significantly different from Pioneer 32. According to Prakoso et al. [26], the weight parameter without husks can be used to see the total results of photosynthesis in producing carbohydrates.

The variety has no significant effect on the length of the maize cob. The NK 212 variety has the longest cob compared to other varieties, while the shortest is in the Pioneer 32 variety. The growth and production of sweet maize are influenced by genetic factors and also the environment in which the maize is cultivated. The length of the cob and the diameter of the cob are related to the yield of a variety. If the average cob length of a variety is longer than that of other varieties, then the variety has the potential to have a higher yield than other varieties [27].

In addition, the results of the analysis of variance also showed that the variety treatment had no significant effect on the diameter of the maize cob. The NK 212 variety also had the highest cob diameter compared to other varieties, while the lowest was the Pioneer 32 variety. It is suspected that the NK 212 variety has the ability to grow and develop well so that it can produce a larger cob diameter. Good plant growth and in accordance with the nature and character of a variety indicate that the variety is able to adapt to the characteristics of a particular region, and vice versa if plant growth is hampered and does not match the nature and character of the variety, it indicates that the variety does not have good adaptability so that the variety is less suitable for development in the region [28].

### *3.3. Intensity of Spodoptera frugiperda Attacks*

The results of the analysis of variance showed that the variety treatment had no significant effect on the intensity of *S. frugiperda* attacks at the ages of 1, 3, 5, and 7 days after inoculation (DAI). The percentage of *S. frugiperda* attack intensity was quite high in all tested varieties, reaching 50%, but the highest average attack intensity was found in the Bisi 18 variety (Table 3). Table 3 shows that the intensity of *S. frugiperda* attacks varies between corn varieties and between observation times. Differences in attack intensity between varieties indicate variations in genetic resistance to *S. frugiperda*. The NK 212 and Bisi 18 varieties appear to be more susceptible, as indicated by high leaf damage rates from the onset of infestation, while Pioneer 32 and Pertiwi 3 show a better response with lower attack rates. This is in line with findings that plant susceptibility to pest attacks is influenced by variety, plant age, and environmental conditions [29].

**Table 3.** Intensity of *Spodoptera frugiperda* attacks on five maize varieties

| Variety | Attack Intensity (%) | | | |
|---|---|---|---|---|
| | 1 DAI | 3 DAI | 5 DAI | 7 DAI |
| Bisi 2 | 52.24 | 52.20 | 52.43 | 48.70 |
| Bisi 18 | 50.36 | 55.96 | 54.82 | 52.83 |
| Pertiwi 3 | 46.18 | 49.26 | 49.27 | 44.82 |
| Pioneer 32 | 44.63 | 43.71 | 43.89 | 44.44 |
| NK 212 | 55.49 | 54.03 | 51.36 | 47.42 |

The high percentage of attacks on all varieties at the beginning of observation was most likely influenced by the young age of the plants, where the leaf tissue was still soft and easily eaten by larvae. This condition supports the growth of *S. frugiperda* larvae, which are known to be the main pests in the early vegetative phase of corn plants. Previous studies have also reported that young vegetative stages are more susceptible to attack than older stages due to low levels of defense metabolites [30]. In addition to plant age, differences in variety resistance can be influenced by plant morphology and physiology, such as leaf thickness, lignin content, and secondary metabolite compounds [31].

### *3.4. Mortality of Spodoptera frugiperda*

The results of the analysis of variance showed that the variety treatment had a significant effect on the mortality of *S. frugiperda*. Mortality of *S. frugiperda* in the Bisi 2 variety was the highest compared to other varieties, while the lowest was in the Bisi 18 variety. The percentage of mortality of *S. frugiperda* in Bisi 2 variety was not significantly different from Pertiwi 3, Pioneer 32, and NK 212, but was significantly different from Bisi 18 (Table 4).

**Table 4.** Mortality of *Spodoptera frugiperda* on five maize varieties

| Variety | Pest Mortality (%) |
|---|---|
| Bisi 2 | $86.33^{a}$ |
| Bisi 18 | $71.53^{b}$ |
| Pertiwi 3 | $74.00^{ab}$ |
| Pioneer 32 | $75.23^{ab}$ |
| NK 212 | $78.97^{ab}$ |

Note: Numbers followed by different letters in the same column and row indicate significant differences according to Tukey's test at $\alpha = 5\%$.

Previous studies by Yang et al. [32] also support these findings, that maize varieties have different levels of susceptibility to *S. frugiperda*, depending on their specific resistance characteristics. The difference in mortality rates is closely related to the larvae's ability to eat leaves. High mortality rates are caused by the larvae's unwillingness to consume existing leaves. This is caused by various things, such as leaf morphology that is difficult to consume, and the presence of secondary metabolite compounds that act as repellent allelochemicals that affect growth and survival [33].

In addition, some maize varieties may contain antinutritional compounds or defensive proteins (e.g., protease inhibitors, phenolic compounds, or alkaloids) that reduce the digestibility and palatability of leaves, leading to nutritional stress and eventual death of the larvae [34]. These plant defense mechanisms play a crucial role in determining the level of resistance of a variety against *S. frugiperda*. The interaction between these chemical and physical traits significantly influences pest mortality, feeding rate, and development duration [35]. Therefore, varietal resistance can serve as a sustainable alternative for pest control by naturally limiting pest populations without relying heavily on chemical pesticides.

### *3.5. Symptoms of Spodoptera frugiperda Attack*

*Spodoptera frugiperda* attacks the growth of maize plants from the vegetative to generative phases. *S. frugiperda* attacks on maize plants include the shoots, growing points, or young leaves, and leaves that have opened. The shoots of the plants that are attacked on leaves that have not fully opened appear to have holes and lots of dirt like powder, while on leaves that have fully opened, many parts of the leaves are seen to have holes and damage from the larvae's movements (Figure 1).

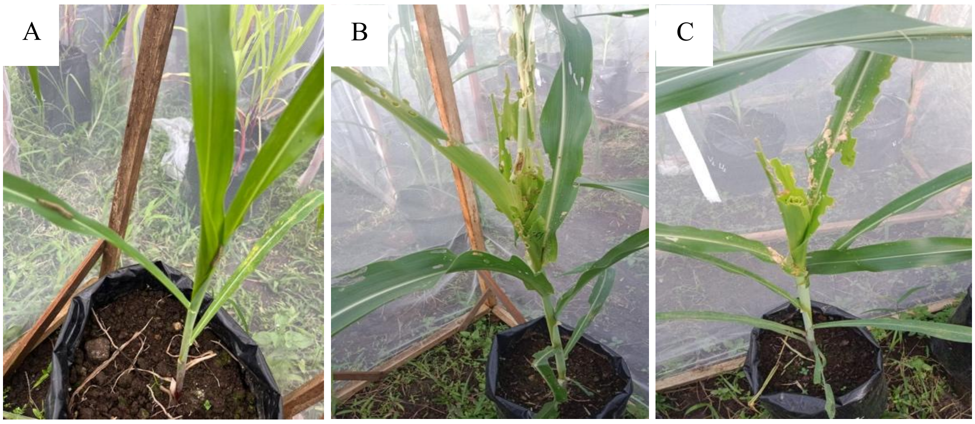


**Figure 1.** Symptoms of plant damage due to *Spodoptera frugiperda* attacks, A. Plants with leaves damaged by larval feeding; B. Middle leaves with "windowing" symptoms; C. The tips of the leaves are with frass and severe damage to the growing tips.

*S. frugiperda* is a polyphagous pest with a high annual migratory rate [36]. The rapid local expansion of *S. frugiperda* is primarily due to natural long-distance movement [37]. In addition, there are various factors that influence the growth and development of *S. frugiperda*, consisting of biotic and abiotic factors. Biotic factors that influence are the type of variety, the availability of feed, and the presence of natural enemies. Abiotic factors that influence are weather (climate, temperature, humidity), cultivation methods, and pest control measures [38].

One important strategy in dealing with *S. frugiperda* attacks is the use of maize varieties that are resistant to this pest. Adaptation of resistant varieties is a biological mechanism of plants to reduce the level of damage through various forms of defense, both physical and chemical [39]. This resistance can be in the form of larvae's dislike of plants (antixenosis), inhibition of larval development or survival (antibiosis), or the ability of plants to recover after being attacked (tolerance) [40].

Resistant varieties exhibit certain characteristics that make it difficult for *S. frugiperda* to thrive, such as rough, thick, or densely trichome-containing leaf surfaces, which interfere with the movement and feeding activity of larvae. Besides, according to [41], the content of secondary metabolites such as flavonoids, phenols, and terpenoids in some varieties can also be toxic or act as natural repellents for larvae, thereby reducing the level of consumption and growth rate of insects.

Previous studies have shown that varieties with lower leaf nutrient content and complex leaf anatomical structures tend to be more resistant to *S. frugiperda* attack [42]. In addition, genetic plant breeding to improve pest resistance traits has become an important part of high-yielding variety development programs, including through transgenic technologies such as the use of *Bacillus thuringiensis* (Bt) genes, which can produce specific insecticidal proteins against lepidoptera larvae [43].

The development and widespread use of resistant varieties can significantly reduce the intensity of *S. frugiperda* infestation. This not only reduces dependence on chemical insecticides but also supports a sustainable agricultural system through an integrated pest management (IPM) approach. Therefore, selection and testing of variety resistance to *S. frugiperda* should be one of the main components in maize development programs in endemic areas.

## 4. Conclusion

The study concluded that NK 212 had the best vegetative and generative growth performance, indicating its potential for high productivity. However, Pioneer 32 demonstrated the highest resistance to Spodoptera frugiperda based on the lowest intensity of attack. Therefore, both varieties are recommended for further field evaluation in diverse agroecosystems to ensure stability of performance and resistance.

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