THE SPIRALLING WHITEFLY, *Aleurodicus dispersus* Russell (HEMIPTERA: ALEYRODIDAE): A PHILIPPINE PERSPECTIVE

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Abstract— Agriculture is among the most crucial sector in almost all countries around the world. It provides both income and employment opportunities among people ensuring food security and sustainability. However, an insect pest called spiralling whitefly, *Aleurodicus dispersus* Russell (Hemiptera:Aleyrodidae) threatens the agricultural industry. This pest is native to Caribbean Region and Central America and was first reported and described in Florida in 1965. From there on, it logistically spreads and invades many countries around the world. The spiralling whitefly is an intensively polyphagous pest with a wide range of host plants. It affects the plants by directly feeding on leaves competing with nutrients to the host. Indirect effects were also observed, such as producing honeydew and waxy substances that affect the host plants' overall physiological ability. Management strategies against the pest include releasing insect predators and parasitoids, removing infested leaves, installing light and sticky traps, selecting possible resistant crop varieties, using naturally occurring insecticides, and some synthetic control tactics. However, in the Philippines, very few studies have been conducted concerning the biology, ecology, and management of this polyphagous pest. Considering that the country is looking for a sustainable, healthier, and environmentally friendly pest management approach, research efforts should therefore give considerable attention to mitigate and prevent the possible impacts of this polyphagous insect pest in the future of the Philippine agricultural sector.

***Keywords*— Invasive pest, pest management, Philippines, polyphagous pest, spiralling whitefly**

INTRODUCTION

Spiralling whitefly, *Aleurodicus dispersus* Russell (Hemiptera: Aleyrodidae) is one of the most economically important insect pests in many horticultural and ornamental crops around the world (Kajita et al., 1991; Srinivasa, 2000; Oliviera et al., 2001; Chand et al., 2019). This pest is endemic in the Central America and Caribbean Region (Russell, 1965; Martin, 1987; Waterhouse and Norris, 1987). It was regarded as a highly polyphagous insect pest due to its extensive host range attacking many important agricultural and ornamental crops (Srinivasa, 2000; Stansly and Natwick, 2010). It was introduced in Canary Island and became an economically important insect pest in 1962 and was reported in Hawaii subsequently in 1978 (Paulson and Kumashiro, 1985). In 1981, the pest was reported in American Samoa and Guam (Firman, 1982), and a year after, the pest invaded the Philippines (Waterhouse and Norris, 1989).

The spiralling whitefly is an intensive polyphagous insect pest that attacks a wide range of host plants belonging to 295 genera and about 90 families of fruits, vegetables, and ornamental plants (Srinivasa, 2000; Gundappa et al., 2013). It damages the plant in two different ways. Directly, it feeds into the plant by inserting its stylet into the leaf tissues sucking up liquid nutrients therein, resulting in leaf drop off (Rashid et al., 2003). Indirectly, the pest secretes waxy substances on the leaf surfaces, which initiate the growth of sooty mold fungus (Purich et al., 1982; Chin et al., 2007). The pest is also vector plant viruses, affecting agricultural production (Nasruddin & Stocks, 2014). Yield reduction was recorded in Guava due to several months of continuous infestation reaching up to 80% (Wen et al., 1995) and in Cassava up to 53% (Geetha, 2000) in Taiwan and India, respectively.

Spiralling whitefly's intensive and logistic spread across many countries is mainly because of the ineffectiveness of synthetic control measures and inefficient non-chemical control tactics (Mani and Krishnamoorthy, 2002). Therefore, this insect pest presents a significant risk in the production and movement of agricultural products across nations (Lambkin, 1998). Since chemical control is impractical and uneconomic, alternative management approaches such as physical, cultural, and biological methods are continuously explored in countries where the pest has become economically significant (Waterhouse and Norris, 1987).

In the Philippines, since the first discovery of the pest in 1982 (Waterhouse and Norris, 1989), minimal attention and effort have been carried out concerning its status, biology, ecology, and management. Therefore, this paper critically analyzed the history and status of the pest in the world, including its management. This was done by examining various sources and published literatures both international and local about the spiralling whitefly. Despite the limited publications about spiralling whitefly in the Philippines, this paper aims to offer a better understanding of the biology and ecology of the pest. The paper also highlights our efforts in terms of its management, preventing this pest from becoming a serious threat in the Philippine agricultural sector.

Origin, Distribution and History of Introduction

Spiralling whitefly is native in Central America and Caribbean Islands but reported first in Florida in 1957 (Russell, 1965). Since then, the pest has successfully spread into many parts of the world, including South America, Africa, Australia, and some Pacific countries (Paulson and Kumashiro, 1985; Waterhouse and Norris, 1987; Akinlosotu et al., 1993). It was reported in Cook Island, Kiribati, Papua New Guinea, Majuro, and Fiji (Waterhouse and Norris, 1987). In Asian countries, on the other hand, it was recorded in India at Kerala in 1993 (Palaniswami et al., 1995), and later to the rest of the Indian Peninsula (David & Regu, 1995). Unfortunately, there is no sufficient evidence yet to explain its mode of introduction in India, but it was hypothesized that the pest possibly came from Sri Lanka or Maldives (Raman et al., 2002). In Southeast Asia, through intensive field surveys and field observations in Java, Indonesia, the spiralling whitefly was recorded attacking 22 species belonging to 14 families of ornamental plants, fruit trees, and annual crops (Kajita et al., 1991; Yuliani et al., 2005).

Meanwhile, in the Philippines, the spiralling whitefly was first recorded in 1982 by Waterhouse and Norris (1989). The insect was reported as an emerging pest in 1987 in the province of Laguna and was believed to be introduced in the country through strong winds and typhoons (Medina, 1987). In the past few years, through an intensive survey, the pest was reported in the Island of Mindanao, Philippines, particularly in the SOCSARGEN region, and was observed attacking banana plants (Aguilar et al., 2014). Since then, there have been no subsequent studies on the status and distribution of spiralling whiteflies in the Philippines.

Taxonomy, Biology and Ecology of Spiralling Whitefly

The spiralling whitefly was first reported and described in Florida, USA, in 1957 by Russell (1965). The placement of this whitefly species is under the subfamily Aleurodicinae, which is among the three subfamilies under the family Aleyrodidae (Mound and Halsey, 1978). The spiralling whitefly was just among the 100 estimated species under this family (Russell, 1965). To distinguish this species from the other whiteflies, Russell (1965) further described the spiralling whitefly based on the pupal stage. The spiralling whitefly has compound and distinctive pores during this development stage, which is different from the other whitefly species. However, this would be a laborious way of identification and requires microscopic examination. Therefore, detailed taxonomic keys were provided based on some important characteristics of adults and puparia to differentiate spiralling whitefly from the other closely related species (Martin, 1987). On the other hand, no single attempt has been made concerning the taxonomic status of spiralling whiteflies in the Philippines.

Visually, this insect can be characterized by a small white-colored sucking insect closely related to mealybugs and aphids (Chin et al., 2007). The pest’s life cycle consists of eggs, four stages of a nymph, and the adult (Chand et al., 2019). Eggs are yellow and elliptical, measuring about 0.3 mm long and singly laid underneath the leaves (Reddy, 2015). The eggs are laid with a short stalk or pedicel inserted into the tissues of the plant host during the process of oviposition (Waterhouse and Norris, 1989). It can be characterized by irregularly spiralling deposits of flocculent waxy structure. The first larval stage of the insect is called crawler and is mobile; however, can only travel short distances in search of feeding locations (Martin, 1987). The succeeding immature (2nd and 3rd) stages have an oval disc shape; about 0.5 to 0.65 mm long, soft-bodied instars, and can be observed as stationary while feeding on a fixed location. Waxy cottony secretions are more visible in these stages than in the 4th instar (Russell, 1965).

On the other hand, the pre-imago or the 4th instar stage is enclosed in a puparium that is about 1.6 mm long and has glass-like rods wax along the side of the body. The imago looks like a minute white-colored moth with a body length of about 2 mm in length (Martin, 1987; Banjo, 2010). The wings of the adults are plain white but may appear pale yellow with dark spots on the forewings (Chin et al., 2007). Spiralling whiteflies' developmental biology was intensively studied in Nigeria on different cassava genotypes. The incubation period of eggs takes about 6-10 days; the first nymph takes 3-7 days, the second instar takes 4-7 days, the third instar takes 4-7 days, and the fourth instar takes 6-10 days (Banjo et al., 2003). In the Philippines, parthenogenesis was reported as the mode of reproduction by the pest. However, the average number of eggs laid by the mated and unmated males was similar at 67.7 eggs per adult female. Meanwhile, the percent hatchability of the pest in the Philippines reaches up to 88.3 percent (Medina, 1987).

Like any other tropical insect species, temperature and the amount of rainfall were the major climatic factors directly affecting the developmental period of spiralling whitefly regardless of the type of host (Banjo and Banjo, 2003). Lower temperature and heavy to occasional rainfall led to the partial reduction of the Whitefly population (Mani, 2010). Meanwhile, temperatures between 40-45 and 35-40 °C increased the mortality rates of immature and adults, respectively, while temperatures below 10 °C also resulted in higher mortality of the pest (Cherry, 1979; Waterhouse and Norris, 1987). In India, the pest was present throughout the year, with a peak population in March to June but gradually decreased between October to January (Mani & Krishnamoorthy, 2000; Gopi et al., 2001). Meanwhile, in Nigeria, moderate rainfall amount together with a high temperature in the month between April and May, which is also the start of the rainy season after the prolonged drought in December to January, definitely favors the population of spiralling whitefly to increase (Banjo and Banjo, 2003). However, in June and July, which is the wet season in Nigeria, the pest population gradually decreases because many of the eggs are washed out by intense rain with heavy winds (Banjo and Latunde Dada, 1999; Banjo et al., 2003; Asiwe et al., 2002). In the Philippines, the pest population dynamics was reported to be highly correlated with relative humidity, number of rainy days, and amount of rainfall but showed no correlation with temperature. Moreover, the number of natural enemies increases as the population of whitefly increases indicating a probable functional response (Medina, 1987). However, there is no available data regarding the seasonal abundance of the insect pest in the Philippines throughout the year.

Economic Importance

The spiralling whitefly's high reproductive capacity and dispersal rate in most of the invaded countries pose a significant threat to the agricultural industry around the world (Pacific Pest and Pathogen, 2016). The pest becomes economically crucial in two distinct ways. First, it directly feeds on the plant tissues posing a competition with the host for nutrients. The saps are composed of essential carbohydrates and other vital nutrients that are supposed to be utilized by the biochemical processes of the plants. As a result, plants compete with the insect pest causing premature leaf drop and decreasing the overall productivity of the host (Bryne et al., 1990). Secondly, the production of honeydew stimulates the growth of sooty molds, which affects the photosynthesis of the host plant (Puritch et al., 1982; Kumashiro et al., 1983). The growth of the fungus hinders the absorption of light, movement of water and gas exchange, leading to wilting symptoms of the leaves (Reddy, 2015). These two ultimately lead to the reduction of the yield from the infested crop.

Generally, almost all species of whiteflies can transmit plant diseases, specifically viral pathogens. Spiralling whitefly was reported to transmit Cassava Brown Streak Disease in Nigeria efficiently (Mware et al., 2009) and Pepper Yellow Leaf Curl Disease in Indonesia (Nasruddin and Stocks, 2014). The transmission of these diseases by the pest is believed to be in a persistent manner, just like aphids, mainly when there is enough time to acquire the viral inoculum (Costa, 1969). In the Philippines, it was documented that the pest attacks 40 plants species belonging to 14 families. Specific plants preferred by the pest include *Psidium guajava*, *Euphorbia pulcherrima*, *Capsicum annuum*, and *Musa spp.* (Quimio and Cayetano, 1985; Medina, 1987).

Management Approaches

Spiralling whitefly was not believed an important insect pest from its native origin in Caribbean Region and Central America because the insect is assumed to be regulated by its natural enemies (Prathapan, 1996). However, whitefly management has been a great challenge today to most countries where the pest became economically crucial due to its polyphagous nature and wide host range (Chand et al., 2019). Thus, it was highly recommended that whiteflies be treated by integrating natural regulators, improving the functional response of natural enemies, and area-wide management programs (Chandel et al., 2010).

1.1. Biological Control Method

Biological control was considered one of the most important and safest management tactics and has been an effective component of integrated pest management worldwide (Chand et al., 2019). Since spiralling whitefly is an exotic insect pest in most countries, the introduction of biological control agents is necessary to have a better and sustainable management approach (Lopez et al., 1997). Introduction of natural enemies like aphelinids and coccinellids from the Caribbean Region to Hawaii and some of the Pacific countries showed promising results against the spiralling whitefly (Kumashiro et al., 1983; Paulson and Kumashiro, 1985; Waterhouse & Norris, 1989). Two aphelinid wasps *Encarsia haitensis* and *Encarsia guadaloupe vigigani* were also studied in Nigeria and Ghana against the pest (Neuenschwender, 1994). When the presence of spiralling whitefly was first observed in Benin, Africa, the wasps *E. haitiensis* and *E. guadeloupae* were reported to control the pest population in guava (D'Almeida et al., 1998). Successful control for spiralling whitefly was also reported in Australia when *E. haitiensis* was introduced in Queensland (Lambkin, 1998). Similarly, three aphelinid wasp species were introduced in Japan, namely *Eretmocerus mundus*, *Eretmocerus eremicus*, and *Encarsia formosa* against the pest (Sugiyama et al., 2011). The efficiency of these aphenlinid wasp species to parasitize spiralling whitefly nymphs was studied in India and reached 33.88 - 100% in different host plants (Beevi et al., 1999; Srinivasa et al., 1999; Beevi & Lyla, 2001). On the other hand, more than 40 native predators were reported against the spiralling whitefly in India, most of them are generalist, and only a few are species-specific (Ramani et al., 2002). In Southern Pacific mainly, pirate bugs, lacewings, big-eyed bugs, many coccinellid beetles, and a mite species were the common predators of spiralling whitefly (Messelink et al., 2008; Chand et al., 2019). Additionally, *Stenthonus spp.*, a species of small dark beetle, was reported in India to predate the nymph and pupa of the pest (Banjo, 2004). Meanwhile, entomopathogens have also appeared as a potential biological control agent against spiralling whitefly. Entomopathogenic fungi such as *Isaria farinosa* (formerly *Paecilomyces farinosus*), *B. bassiana*, *M. anisopliae*, *L. lecanii*, and *P. fumosoroseus* were found to be effective in reducing the population of the pest up to 100% in laboratory and field conditions (Mani et al., 2000; Boopathi et al., 2013; Boopathi et al., 2015a; Boopathi et al., 2015b). In the Philippines, 13 natural enemies were reported to regulate the population of spiralling whitefly in the province of Laguna. Among these, ten were considered predators; 8 of these were beetles, and 2 were chrysopids, while the remaining 3 were hymenopteran parasitoids. The significant predators that showed a high predation rate were *Chrysopa splendida*, *Chrysopa basalii*, and *Clambus spp.* (Medina, 1987). However, there is a dearth of published reports on entomopathogens as biological control agents against the spiralling whitefly in the Philippines.

1.2. Cultural/Physical Method

The cultural pest management method is one of the classical techniques to manage insect pest population that affects agricultural industry (Hill, 1987). It is defined as the purposeful modification of crop production techniques to reduce the pest population or the damage caused by the pest. This method includes modifying the environment where the crop is established and enforcing the correct agronomic practices (Schellhorn et al., 2000). In combating the spiralling whitefly using the cultural method, the selection of plant varieties that are somewhat resistant against the pest was promising as a cultural management method. It was reported that some cassava genotypes in India showed compensatory ability even there is a high infestation of the whitefly (Banjo et al., 2004). Further, removing low-lying weeds during the wet season prevents the re-infestation of the pest since, during the wet season, infestation re-occurs when the environment is favorable (Banjo and Latunde-Dada, 1999). Use of clean planting materials and removal of infested leaves to rid the immobile immature and pupal stages may also be an environmentally friendly approach; however, it does not completely remove the presence of the pest but at least reduce their population (Geetha, 2000; Chand et al., 2019). On the other hand, installation of yellow sticky traps, light traps covered with Vaseline coating, and fluorescent light with castor oil effectively attract the adult population of the pest and can be placed both in greenhouse and field conditions (Srinivasan and Mohanasundaram, 1997; Mariam, 1999; Geetha, 2000; Barbedo, 2014). Unfortunately, there were no published articles on using this pest management method against spiralling whitefly in the Philippines.

1.3. Chemical Method

In countries where natural enemies and cultural management methods are not possible, a resort to chemical control is necessary to manage spiralling whitefly and is one of the options for most farmers. It is also recommended that when the pest population becomes severe, synthetic control may be used to prevent significant economic losses due to the attack of the pest (Asiwe et al., 2002). Commonly, synthetic insecticides such as Dimethoate 30 EC, Chlorpyriphos 20EC, Cypermethrin 10EC, Thiamethoxam 25WG, Diazinone 60EC, Chlorpyrifos 48EC, and Malathion 57EC were used against spiralling whitefly (Roy et al., 2014; Reddy, 2015; Khan, 2017; Khalil et al., 2019). Similarly, chemicals such as buprofezin, imidacloprid, pyridaben, and spiromesifen also showed promising results (Bi et al., 2002; Toscano and Bi, 2007). Insecticidal soap and detergents, on the other hand, have been reported to effectively control the spiralling whitefly and other insect pests in many countries (Puritch et al., 1982; Waterhouse and Norris, 1989; Butler et al., 1993; Laprade and Cerdas, 1998; Hall & Richardson, 2013; Boopathi et al., 2014). In the Philippines, there is a limited report concerning the application of chemical insecticides against the spiralling whitefly. It was stated that Chlorpyrifos, diazinon, malathion, and methomyl were the synthetic insecticides used against the pest infesting guava in Laguna, Philippines (Quimio and Cayetano, 1985). However, chemical control against the pest was uneconomic and impractical since it destroyed the abundance of natural enemies like insect parasitoids and predators in the field (Kajita et al., 1991).

1.4. Botanicals

Botanical insecticides have been considered to represent an alternative to chemical insecticides in protecting crops. Some major contributing factors for exploring such alternatives are health and environmental issues of using synthetic chemicals, uneconomic, impractical, and several reports of pest developing resistance (Kajita et al., 1991; Oliveira et al., 2001; Aktar et al., 2009; Chand et al., 2019). With these issues in mind, essential oils and plant-derived extracts were recently explored against a variety of insect pests that affect crops (Singh et al., 2012; Yang, 2010). It was reported that the mode of action of these biopesticides is mainly through contact action. These natural insecticides disrupt the natural functions of the cell, hinder the respiration process by blocking the entry point of air and inhibit growth and development (Bogran et al., 2006; Fogang et al., 2012; Subbalakhmi et al., 2012). Neem (*A. indica*) extract diluted in ethanol and acetone applied topically resulted in 100% mortality of spiralling whitefly (Alim et al., 2017). Neem oil has

Table 1. Summary on different management approaches against the spiralling whitefly.

Country/s	Method of Pest Management	Specific Management Technique	References
Hawaii	Biological	Introduction of Insect predators and Parasitoids	Kumashiro et al. (1983) Paulson and Kumashiro (1995) Waterhouse and Norris (1989)
Carribean Region	Biological	Native Parasitoids and Predators	Waterhouse and Norris (1989)
Nigeria	Biological	Introduction of insect parasitoids	Neuenschwender (1994)
Ghana	Biological	Introduction of insect parasitoids	Neuenschwender (1994)
Benin	Biological	Parasitoids	D’Almeida et al. (1998)
Australia	Biological	Utilization of insect parasitoids	Lambkin (1998)
Japan	Biological	Introduction of insect parasitoids	Sugiyama et al. (2011)
India	Biological, Cultural, Chemical and Botanical	Insect predators and Parasitoids, entomopathogens, removal of low lying weeds, application of synthetic chemicals, insecticidal soap and neem.	Beevi et al. (1999) Srinivasa et al. (1999) Mani et al. (2000) Beevi and Lyla (2001) Ramani et al. (2002) Boopathi et al. (2013) Boopathi, et al. (2015a) Boopathi, et al. (2015b) Khan (2017)
Philippines	Chemical and Biological	Application of synthetic insecticides and utilization of insect predators and parasitoids.	Quimio and Cayetano (1985) Medina (1987)
Southern Pacific	Biological and botanicals	Use of insect parasitoids, predators and medicinal plant extracts	Messelink et al. (2008) Chand et al. (2019) Chand et al. (2016)
Indonesia	Biological	Utilization of insect predators	Kajita et al. (1991)
Bangladesh	Chemical and bitanicals	Application of synthetic chemicals and plant extracts.	Khalil et al. (2019) Alim et al. (2017)
Costa Rica	Chemical	Application of diluted soap and detergents.	Laprades and Cerdas (1998)

also been effective against the pest in several countries (Ramani et al., 2002). Meanwhile, essential oils of some medicinal plants in the South Pacific, namely *Cananga odorata*, *Cymbopogon citratus*, *Murraya koenigii*, *Ocimum tenuiflorum* and *Euodia hortensis* showed excellent repellent and fumigant effects (Chand et al., 2016). There was a study in Bangladesh exploring eight species of plants extracted in ethanol and acetone against the pest (Alim et al., 2017). Unfortunately, there is still no published report in the Philippines until this date regarding the utilization of botanical insecticides against the spiralling whitefly.

Quarantine Regulations

Even if there are management strategies for spiralling whitefly in many countries globally, quarantine is still one of the most critical strategies for countries which the pest has not invaded until this date. Quarantine restrictions are significant in regulating the movement of infested plant materials together with insect pests (Karuppuchamy and Venugopal, 2016). The movement of plants and produce across borders requires specific regulations and inspection to ensure the products are free from insect infestation (Chin et al., 2007). In Queensland, plants should be inspected not more than 48 hours after arrival in the facility. Both sides of plant leaves must be inspected thoroughly by an authorized plant inspector. If accepted, the inspector will issue the authorization for the plants to enter the country. However, if the spiralling whitefly is detected, the plants will be automatically rejected, immediately removed from the area, treated with insecticides, and eventually discarded (Queensland Government, 2002). In the Philippines, a presidential decree 1433; otherwise known as the Plant Quarantine Decree, was enacted in 1978 that provides power to the Bureau of Plant Industry (BPI) in promulgating regulatory procedures to prevent the introduction, incursion, establishment, and the possible spread of different pests and diseases during movement of agricultural products across boundaries. The decree further provides plant quarantine rules and regulations that adhere to the UN's International Plant Protection Convention (IPCC) (Ani, 2017).

CONCLUSION AND RESEARCH PROSPECTS

The spiralling whitefly is indeed a serious insect pest of several crops in many countries around the world. The pest becomes a significant concern of most farmers due to its intensive host range. This is because the pest feeds directly on the leaves, removing nutrients from plants. The production of waxy substances and honeydew also cause indirect damage by interfering with photosynthesis. Many scientists reported the development of spiralling whitefly to be highly correlated with agrometeorological factors such as relative humidity, temperature, and rainfall. One of the concrete bases in any pest management is the data on the population dynamics of the concerned pest. Knowledge of these factors provides the exact time for a control measure to be applied. However, there is a dearth of researches concerning seasonal fluctuations of spiralling whitefly throughout the year in the Philippines, suggesting that more efforts on pest monitoring and detection are vital. Meanwhile, it was reported that this pest is a vector of numerous plant viruses that could be a potential for a disease outbreak in many crops. Thus, future research should also focus on the virus-vector interaction, including the pest's efficiency in transmitting such plant viruses.

As to the management of the pest, chemical control is still the option of many farmers. However, numerous records of biological control agents such as predators, parasitoids, and entomopathogenic fungi were all effective against the spiralling whitefly. Moreover, the bioefficacy of botanical insecticides against the pest was also intensively explored in recent years. In the Philippines, however, only predators, parasitoids, and chemical control were studied. These limitations open the opportunity for future studies to explore entomopathogenic fungi and other entomopathogens as potential biological control agents against the spiralling whitefly. In addition, utilizing botanical insecticides against the spiralling whitefly is strongly advocated since there are dearth published efforts in the Philippines concerning natural insecticides for this insect pest. On the other hand, cultural methods have also been reported as a contributory factor for effective management against the pest. The use of this method must also be carried out in the country to utilize farm resources efficiently. Additionally, more recent evaluation on the efficiency of predators and parasitoids and the efficacy of newer synthetic insecticides with new mode of action is also recommended.

Due to environmental concerns and health issues, the non-chemical approaches as significant components of the integrated pest management program for spiralling whitefly must be given utmost priority in future works to have safer food products, a healthier environment, and prevent pest resistance. Although there are no reports of the spiralling whitefly outbreak in the Philippines since its first discovery in 1982, still it is important to monitor its occurrence and status to quickly respond to the pest before the outbreak scenario. Considering that this pest has a wide host range, it is undeniable that it would significantly affect Philippine Agriculture if given favorable conditions. Hence, mitigation and constant monitoring of its status are paramount to protecting the countries' agricultural industry.

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