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Importance of *Bemisia tabaci* Forecasting Technology: A Review

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Abstract

Bemisia tabaci has a wide range of host plants. Due to its short-distance solid migratory ability, there is a phenomenon of migration and damage among plants in different seasons. Through the study of the population growth and decline rules of *B. tabaci* on different host plants and the prediction and forecast technology explores its sustainable prevention control technology. This article mainly discusses the research progress of *B. tabaci* forecasting, realizing the timely prevention and control of *B. tabaci* and comprehensive regional management, which can effectively reduce the population base of *B. tabaci* and reduce the number of pesticides used, which has a protective effect on the ecological environment.

Keywords

Bemisia tabaci, Field Investigation, Yellow Sticky Board, Prediction and Forecast, Prevention and Cure

1. Introduction

B. tabaci (Gennadius) was first discovered on Greek tobacco in 1889. It is widely distributed on all continents except Antarctica. It is an essential pest in tropical, subtropical, and adjacent temperate regions [1] [2]. As a polyphagous pest, *B. tabaci* has a wide variety of hosts and a wide range of damage. It mainly damages cotton, soybeans, vegetables, flowers, and garden plants. Adults and nymphs of *B. tabaci* can suck plant sap and cause abnormal plant physiology [2]. At the same time, they can secrete honeydew to induce coal pollution disease. *B. tabaci* can also spread many plant viruses, affect plant growth, and cause plant death in

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severe cases [3] [4] [5]. The earliest record of *B. tabaci* in China was in 1949, mainly distributed in Hainan, Guangdong, Fujian, Guangxi, Yunnan, Shanghai, Zhejiang, Jiangxi, Sichuan, Shaanxi, Taiwan, and other regions south of the Yangtze River Basin [6] [7]. The scope and extent of the harm of *B. tabaci* in China have increased year by year, causing considerable losses to agricultural production [8] [9] [10] [11]. Current research shows that *B. tabaci* is a compound species that contain multiple cryptic species, in which *B. tabaci* B and Q cryptic species are two more invasive species [12] [13]. Since the 1990s, with the introduction and rapid spread of B-type and Q-type *B. tabaci*, it has become one of the main pests and invasive organisms on vegetables and other crops in China [14] [15] [16] [17].

B. Tabaci have different developmental rates, mortality and fecundity on different facility vegetable crops. Different biotypes of *B. tabaci* also have preferences for the crops they feed on and lay eggs [17]. Studies have shown that the growth, development, and population expansion of *B. tabaci* are closely related to environmental temperature conditions [18]. Temperature is a crucial factor affecting the population growth and decline of *B. tabaci*. Below 20˚C and above 30˚C are not conducive to the growth, development, and reproduction of *B. tabaci*. Due to the low temperature in winter, the development process of *B. tabaci* is slower, and there are still more nymphs in early spring [19]. Other studies have shown that the population number of *B. tabaci* fluctuates up and down under the synergistic effect of the internal factors of the population and the external factors of climate, and it mainly changes in a bimodal curve throughout the year, which is divided into summer peak period (July-August) and autumn peak period (September-October) [20] [21]. As the temperature rises, the development process of *B. tabaci* accelerates, and the pupae on the plant's lower leaves emerge one after another into adults. Because adults of *B. tabaci* have intense tenderness, the adults, after eclosion, transfer to the middle and upper leaves of plants to lay eggs and reproduce [22] [23]. The factors that affect the growth and decline of *B. tabaci* population include population base, temperature, humidity, rainfall and host plants [18] [19] [20] [22].

2. Field Investigation of *Bemisia tabaci*

Because there are significant differences in drug resistance among the cryptic species of *B. tabaci*, monitoring the composition of the cryptic species of *B. tabaci* in the field is very important for controlling *B. tabaci* [7] [24]. The field survey of *B. tabaci* generally uses the visual method to calculate the number of its insect population [25]. According to the occurrence of *B. tabaci*, we select 1 - 2 representative fields or greenhouses and use diagonal 5-point sampling. We record 2 - 4 strains at each point by the size of the insect population and investigate the number of insect strains and adults in each of the upper, middle, and lower leaves of each plant. During the investigation, we gently turned the leaves, calculated and counted the population density of *B. tabaci*, and comprehensively analyzed to determine the best time for *B. tabaci* control [26] [27] [28] [29].

3. Yellow Sticky Board

Because adults of *B. tabaci* have a strong tropism for yellow [30] [31], the standard method to control *B. tabaci* is yellow board trapping, which is also suitable for investigating the occurrence dynamics of *B. tabaci* [32] [33]. In each field or shed room, we use the 5-point placement method and insert a yellow board of 20 cm × 30 cm at each point. The height of the yellow board is that the lower end of the yellow board is slightly higher than the top of the host plant; we replace the yellow plate every ten days. The number of male and female adults on each yellow board is recorded in detail to monitor the occurrence of *B. tabaci* adults in the field. There are three plots for each crop, and five yellow boards are placed on each plot, totaling 15 plots [34]. In order to improve the forecasting and continuous pest control level of *B. tabaci*, the researchers systematically monitored *B. tabaci* on vegetable crops in greenhouses for four consecutive years (2009-2012) by using the yellow board trapping method. The occurrence of *B. tabaci* was different on vegetable crops in different facilities, the largest on cucumber, the second on eggplant and tomato, and the least on pepper [35] [36].

4. Prediction and Forecast of *Bemisia tabaci*

In the process of field prediction and forecasting of *B. tabaci*, it is necessary to comprehensively analyze and predict the occurrence trend to inhibit the spread of *B. tabaci* according to the development progress of each insect state the number of insects [37] [38] and the number of natural enemies in the field [38] [39] [40], combined with the growth of field crops and the recent weather forecast [41] [42]. It has become a significant problem to be solved urgently in current agricultural production [43] [44]. *B. tabaci* can damage facility vegetables every year, and there is obvious overlapping of generations. When the temperature is suitable and the host is abundant, *B. tabaci* is prone to occur, especially in the hot and dry season [6].

4.1. Prediction of Occurrence Period

According to the field investigation of *B. tabaci*, determine the beginning, peak, and end of the nymphs or adults. On this basis, using the existing calendar research data, referring to the climatic conditions at that time, plus the predicted duration of the insect state, the occurrence time of a certain period of *B. tabaci* is predicted to carry out prevention and cure in time [45] [46] [47] [48]. Prediction criteria for occurrence period of *B. tabaci*: the initial peak period is when the cumulative development progress reaches 16%, the peak period is when it reaches 50%, and the final peak period is when it reaches 84% [49]. In the process of growth and development, each insect needs to absorb a certain amount of heat from the outside to complete a particular stage of development, and the total heat required by insects at each developmental stage is a constant (Effective Accumulated Temperature Law) [18] [49] [50] [51] [52] [53]. When the developmental starting temperature and effective accumulated temperature of a certain instar or insect stage of *B. tabaci* are measured, the generation number of *B. tabaci* can be predicted by the accumulated temperature formula based on the developmental state of *B. tabaci* and the recent temperature forecast [49] [54] [55] [56] [57]. The formula for calculating the developmental duration is as follows:

$$N = \frac{k}{t - t_0}$$

In the formula, N is the developmental period; k is the effective accumulated temperature; t is the average temperature; t_0 is the temperature at the development point.

4.2. Prediction of Occurrence Quantity

The population growth and decline of *B. tabaci* are affected by various environmental factors. We need to identify dominant factors from complex environmental factors and use the dynamics of these factors as predictors of *B. tabaci* population density [58] [59] [60] [61] [62]. Then we combined the occurrence over the years to conduct a comprehensive analysis to predict the occurrence of *B. tabaci* on a specific host plant [10] [38] [40] [63] [64].

4.3. Control Index of *Bemisia tabaci*

Based on the prediction of the occurrence period and amount of *B. tabaci*, and according to the growth status of crops, further research to predict whether the sensitive period of a particular crop to be harmed by *B. tabaci* is consistent with the most significant number of insects and the damage period. So we can infer the degree of occurrence of pests or the size of losses to determine the prevention period and method [65] [66] [67].

For the control index and occurrence degree of *B. tabaci*, we usually refer to "Prediction, Forecast, and Control of Major Crop Diseases and Insect Pests" [28]. The classification standard of *B. tabaci* is determined as follows: the number of first-level single leaf insects is less than 10; the number of second-level single leaf insects is 10 - 30; the number of third-level single leaf insects is 30 - 50; the number of fourth-level single leaf insects is more than 50 (Unit Quantity: head) [68] [69].

5. Conclusions

Monitoring the occurrence of *B. tabaci* and timely and accurate trend forecasts can effectively control and reduce hazards. Strengthen the monitoring of *B. tabaci* infestation, based on early prevention and control, to control the base of insect sources and cut off the transmission route as the key measures. The prevention and control of *B. tabaci* should adhere to the concept of "green plant protection," rationally apply relevant green prevention and control technologies and ecological engineering technologies, and reduce the use of chemical pesticides, to ensure the ecological environment and the safe production of vegetables and tobacco. The green and environmental protection control methods of *B. tabaci* include: using modern molecular biology to cultivate new anti-virus varieties. When the crops were planted, yellow sticky boards were hung in the field to trap *B. tabaci* adults and monitor their occurrence dynamics. Planting non-hobby host plants in the greenhouse has a better repelling effect on *B. tabaci*. The release of natural enemies plays an important role in controlling the population of *B. tabaci*. The use of a large number of insecticides leads to the drug resistance of *B. tabaci*. We choose high-efficiency and low toxicity chemical pesticides in a reasonable and timely manner. *B. tabaci* young instar nymphs (before the third instar) are thin wax layer, poor drug resistance, and easier to control. When carrying out green prevention and control, it is necessary to adopt measures to local conditions and take effective prevention and control measures in combination with the local production level at that time.

Predicting the occurrence trend of *B. tabaci* is an essential basis for effectively controlling *B. tabaci* and reducing the degree of damage, and it is a vital prerequisite for ensuring the safety of agricultural production. The statistical establishment of the prediction model for the peak occurrence period and occurrence amount of *B. tabaci* on different crops has guiding significance for scientific and practical control of *B. tabaci* in agricultural production.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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