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Effect of Several Vegetable Combinations on The Population of *Bemisia tabaci* (Homoptera: Aleyrodidae) Under Glasshouse Conditions

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Abstract: The whitefly *Bemisia tabaci* (Gennadius) has become one of the most important agricultural pests and virus vectors of agricultural and ornamental crops in Malaysia. The objective of this research was to study the effect of combinations among four different vegetable plants; chilli *Capsicum annuum*, brinjal *Solanum melongena,* tomato *Solanum lycopersicum* and okra *Abelmoschus esculentus* on population abundance of *B. tabaci* under glasshouse conditions. The results showed that most of the total mean numbers of adults, eggs and nymphs of whitefly were significantly higher ($P< 0.05$) on brinjal compared with other crops and the lowest mean number of whitefly stages was on chilli. This indicates that mixed crops will lower pest population and could indirectly reduce disease incidence transmitted by the pests.

Key words: *Capsicum annuum* · *Solanum melongena* · *Solanum lycopersicum* · *Abelmoschus esculentus* · Host Plant Preference

INTRODUCTION

The Silver leaf Whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae), is a serious pest of vegetables and ornamental crops in much of the tropical and subtropical of the world [1]. It is a polyphagous pest species that feed exclusively from the phloem, this feeding weakens the plant and causes it's early wilting and reduces the plant growth rate and yield, during its feeding excreted honeydew that covers leaf foliage, which fosters the growth of sooty mold and reduces photosynthesis [2,3]. In addition, it transmits plant pathogenic viruses which can cause heavy losses in crops [4]. The whitefly was first recorded in Malaysia in 1935, it had been observed in Malaysian lowlands on chilli, *Copsicum annuum*, soybean, *Glycine max* and okra, *Abelmoschus esculentus* [5]. In the mid 1980s, it was seen on papayas, guavas, mangos and cocoa. Syed *at el*. [6] reported that *B. tabaci* has been found in several places in Peninsular Malaysia on vegetables like the angled loofah, *Luffa acutangula*, brinjal, *Solanum melongena*, cucumber, *Cucumis sativus*, French bean, *Phaseolus vulgaris*, long bean, *Vigna sesquipedalis* and okra, *A. esculentus*. *B. tabaci* is considered one of the most important pests of vegetables in Malaysia, where causing heavy losses in the crop by direct feeding and transmitting geminiviruses. However adults, eggs and nymphs of *B. tabaci* are located on the underside of leaves where they are protected from overtop applications of insecticides [7, 8]. Therefore, chemical control of whiteflies is expensive and not always effective. In addition, control of whiteflies with chemical pesticides is often problematic due to the wide occurrence of resistance in whiteflies to conventional pesticides [9], furthermore the adverse effect of pesticides on the natural enemies of whitefly [10]. Understanding insect responses to vegetational diversity had received a considerable attention since the 1960's when a general trend for decreased pest pressure in polycultures compared to monocultures emerged [11]. Accordingly we need to understand the behaviour of whitefly such as host plant selection, which can be used as a trap for whitefly. The objective of this study was to evaluate the effect of vegetable combinations on the density of whitefly.

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MATERIALS AND METHODS

Study Site: The study was carried out in a glasshouse environment at Malaysian Agricultural Research and Development Institute (MARDI) Serdang, Selangor, in the period from October 2009 to July 2010. Experiments were conducted in cages of dimensions 1.5×3.0 m and 2.0 m in height, covered by insect proof screen at all sides and top, at 30-36°C, 80% relative humidity.

Whitefly Rearing: The insects used in those studies were reared on tobacco plants for one month before commencing of the experiments inside cages of dimensions 0.5×1.20 m and 1.20 m in height covered by insect proof screen.

Crops Used in the Study: The plants used in this study, chilli, (*C. annuum* MC11), brinjal, (*S. melongena* MTe1), tomato (*S. lycopersicum,* MT1) and okra, (*A. esculentus*, MKBE1) and were obtained from MARDI Station, JalanKebunKlang. Seeds were planted in pots with soil (2:1:1 for clay, sand & natural fertilizer). After sowing, the seeds were placed under net covers in separate isolated compartments of the glasshouse to reduce infestation by insects. After the plants reached 3-5 leaf stages, they were transferred to experiment cages. Seven combinations treatments were tested (chilli with tomato), (chilli with okra), (chilli with brinjal), (tomato with okra), (tomato with brinjal), (okra with brinjal) and (chilli, tomato, okra and brinjal). Each treatment consisting of 4 rows spaced 10 cm apart with a 20 cm distance between rows (Each row contains 8 plants), where were arranged into Completely Randomized Design (CRD) with 3 replicates. 400 adults of whitefly were released per replicate [7].

Data Collection: After one day of infestation, adults of whitefly density were randomly counted daily on 3 plants per replicate on the underside surface of the leaf for one month period [12]. Sampling of whitefly stages (eggs and nymphs) was taken every 4 days in 1 cm² by using a stamp made on apaxial surface, which was placed between the central and left lateral leaf veins. The number of eggs and nymphs was observed by stereoscopic microscope at 40X magnification.

Statistical Analysis: *T* test was used to analyse the data of population abundance of white fly between treatments which contains two plants, while one way ANOVA was used for all plants in the same treatment. Means were separated using Fisher`s test at $P < 0.05$ (Minitab Statistical Package Vol. 15).

RESULTS

The data presented in Figure 1 showed that the cumulative distribution of various life stages of *B. tabaci,* which were very clearly different among the brinjal and chill. The mean number of whitefly adults ($t_{0.05}$, 1335=23.29, P<0.05) and the mean number of eggs ($t_{0.05}$, 168=8.09, P < 0.05) were significantly higher on brinjal. Similarly, the mean numbers of whitefly nymph on brinjal was significantly higher ($t_{0.05}$, 253=4.66, P <0.05) compared with chilli plant.

The results also indicated that mean number of whitefly adults, nymph and eggs was found to be different among okra and brinjal. The three life stages of whitefly were accumulated inbrinjal compared with okra plant, showed that adults ($t_{0.05}$, 1350= -3.48, P < 0.001), eggs ($t_{0.05}$, 216=7.00, P < 0.05) and nymphs ($t_{0.05}$, 223=5.15, P < 0.05) (Figure. 2). Generally, the number of whitefly adults, nymph and eggs was highest on the brinjal than okra plant.

The present results in Figure 3, showed that the total mean number of whitefly stages was significantly different among brinjal and tomato.The highest mean number of whitefly stages were observed in brinjal, adults ($t_{0.05}$, 1628=17.90, P< 0.05), eggs(t 0.05, 179=6.92, P< 0.05) and nymphs ($t_{0.05}$, 285=4.71, P<0.05) compared to tomato.

The total Mean number of whitefly stages in Figure 4, was significantly different among chilli and tomato. The highest mean number of whitefly stages was recorded in tomato plant which differ significantly from the chilli plant, adults ($t_{0.05}$, 1527=20.87, P <0.05), eggs ($t_{0.05}$, 203=8.16, P < 0.05) and nymphs ($t_{0.05}$, 294=3.26, P < 0.05).

The present study also indicated that the number of adults of whitefly ($t_{0.05}$, 321 = -1.25, P = 0.211) was not significantly different between okra and tomato. However, the number of whitefly eggs and nymph was not significantly different among okra and tomato, eggs ($t_{0.05}$, 321 = -1.25, P = 0.211) and nymphs ($t_{0.05}$, 311 = -1.09, P = 0.278) (Figure 5).

There were a significant difference between okra and chilli, where the higher mean number of whitefly stages was found on okra compared to chilli; adults ($t_{0.05}$, 1248 = -27.34, P < 0.05), eggs($t_{0.05}$, 200 = -8.84, P < 0.05) and nymphs ($t_{0.05}$, 273 = -3.71, P <0.05) (Figure 6).

When given a choice test (the four plants in the experimental arena), significantly more *B. tabaci* adults were found feeding on brinjal, okra, tomato than chilli respectively ($F_{0.05}$ (3,4856) = 383.05 P< 0.05).In contrast, the mean number of eggs (F0.05 (3,644) = 49.43 P< 0.05)

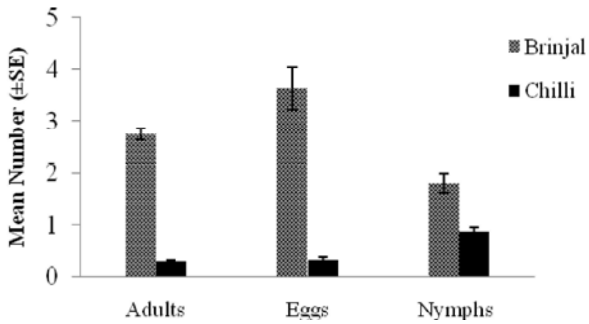

Fig. 1: Mean population density of various life stages of *tabaci* on brinjal and chilli

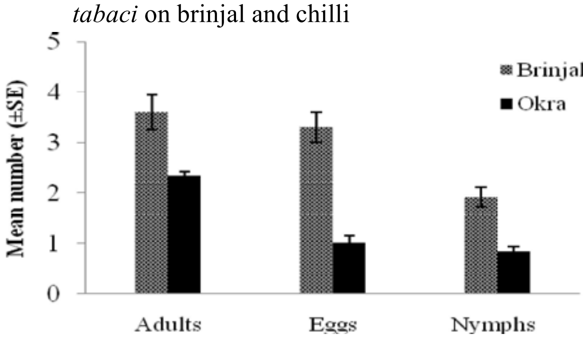

Fig. 2: Mean population density of various life stages of *Bemisia Tabaci* on brinjal and okra

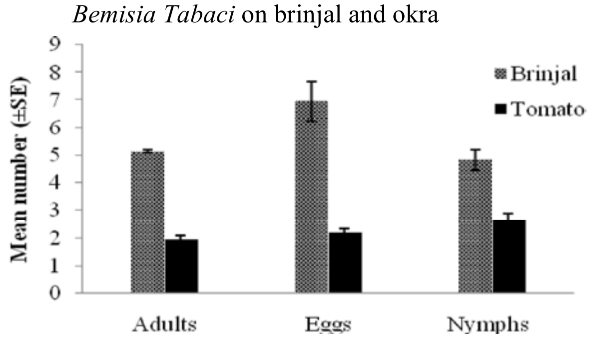

Fig. 3: Mean population density of various life stages of *Bemisia tabaci* on brinjal and tomato

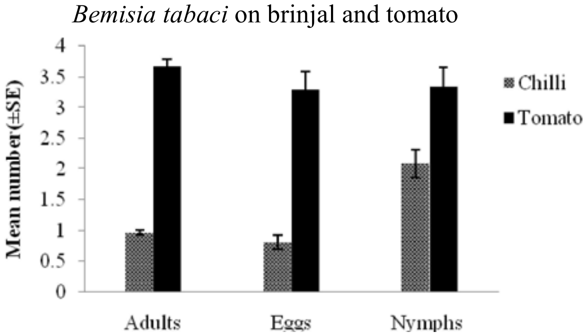

Fig. 4: Mean population density of various life stages of *Bemisia tabaci* on chilli and tomato

and nymphs (F0.05 (3,644) = 34.63 $P < 0.05$) was higher on brinjal but slightly similar on okra and tomato, while that on chilli was lower (Figure 7).

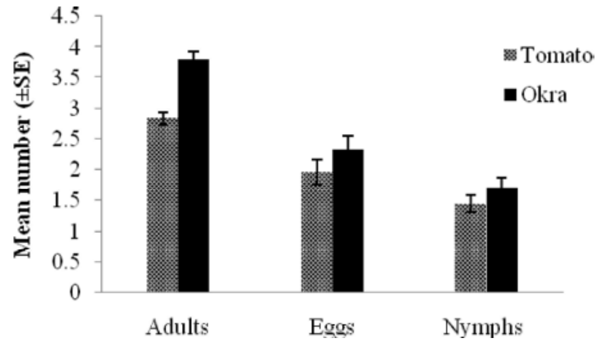

Fig. 5: Mean population density of various life stages of *Bemisia tabaci* on tomato and okra

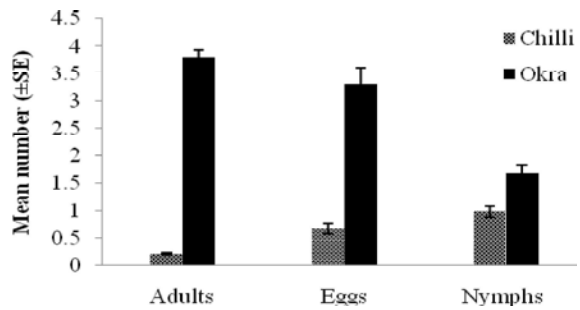

Fig. 6: Mean population density of various life stages of *Bemisia tabaci* on chilli and okra

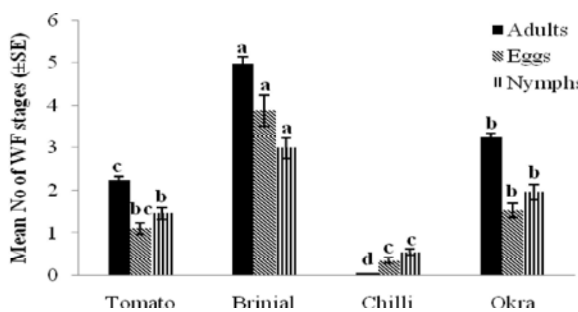

Fig. 7: The mean (± SE) number of adult, eggs and nymphs of *B. tabaci* on several vegetables. Means in the same shape column with same letter are not significantly different at $P < 0.05$ (Tukey)

DISCUSSION

Although there were several previous studies focusing on the influence of intercrops on the attack of whitefly on vegetables crops, but there were few reports about the preference rate. In general all the combination systems showed various associations between whitefly stages and plant species throughout the sampling period. The lowest number of whitefly adults was observed on chilli when combined with brinjal. Statistical analysis of those differences showed that the nymphal density counts in brinjal were significantly higher compared to those of okra and tomato. Similarly, higher numbers of eggs were found in brinjal than okra and tomato, while chilli had the lowest number. On other hand, the results revealed that there was no significantly different between tomato and okra in the mean number of whitefly stages, when they were in the same experimental arena. The significant differences seen in the host plants might be correlated with a significant difference in the components of host plant quality (such as carbon, nitrogen and defensive metabolites) Awmack and Leather [13] and Leite *at el*. [14], who indicated that these components in the plant play an important role on the development. Furthermore Kakimoto K. *at el*. [15] found that the survival and reproduction of whitefly depends on presence of these components and their concentrions in the plant. Moreover, the presence of the trichomes on brinjal might play an important role in whitefly preferences, the same results have been reported by Butler and Henneberry [16] and Butler *et al.* [17]. They concluded that the high leaf trichomes density on cotton, *Gossypium hirsutum* L. cultivars was related to high *B. tabaci* density compared with the smooth leaf cultivars. Similarly, *B. tabaci* adult females were also found to be feeding and laying eggs more on soybean (*G. max* L.) with trichome covering the leaves more than the garden bean (*P. vulgaris* L) that has less trichomes [18].

Other factor, which considered being an important as or even more than trichomes density is the type of trichomes, brinjal has a higher density of non- glandular type of trichomes, while tomato has glandular trichomes, this could be the main reason forthe higher whitefly population (adults, eggs and nymph) on brinjal than tomato. Snyder *at el*. [19] found that the types of trichome were responsible for the whitefly preference for oviposition. Leaves of chilli may have been unsuitable for feeding or ovipostion in the presence of other plants. The higher densities of *B. tabaci* (eggs, nymphs and adults) found in brinjal compared with other plants, clearly demonstrates that brinjal acted as a good feed source to all whitefly stages.

The different population rate of whitefly on the four host plants in this study suggested that the effectiveness of using biological control agents could be used to control this pest, where brinjal appears to be the most suitable host plant for *B. tabaci*, therefore, it could be used as a trap plant. Moreover, chilli should be intercropping with those plants for reducing the densities of *B. tabaci* and its transmitting of plant viruses to the main crop. To better understand the differences occurring in host pants preference. It would be interesting to investigate the chemical components and the nutritional profile of the plants on the behaviour response of whitefly.

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