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CONTROL OF GREENHOUSE WHITEFLIES THAT ARE VECTORS OF PLANT VIRUSES USING NOISE IN FORM OF ACOUSTIC SOUND IN EGERTON UNIVERSITY, NJORO KENYA.

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ABSTRACT

White flies are vectors of plant pathogenic microorganisms which lead to low yields all over the world. Although there are a wide range of chemicals being used today to control white flies, the flies have developed resistance to them. Tomato seedlings were raised in nurseries in triplicate. Seven modified green houses were made using two cartons that were cat to give supporting frames that gave support to polythene papers. Twelve tomato seedlings were placed in each modified greenhouse. Two hundred white flies were introduced into each modified green house. A noisy radio was placed in six of the modified greenhouse while the seventh greenhouse acted as a control. The number of eggs lied and those that subsequently hatched were determined for 2 months. The data obtained was analyzed using Statistical Package for Social Sciences (SPSS) version 25 software. There was no significant difference in the germination percent between the plots (F=0.250803859 P=0.782154004). There was a significant difference between the number of eggs laid in the experimental greenhouses and the control greenhouse (P=0.040140971). There was a significant difference between the number of eggs that hatched in the experimental greenhouses and the control greenhouse (P=0.017298).Tomato seedlings were raised in the nursery for 6 weeks. Acoustic vibrations produced by the radio affected the number of eggs laid by the white flies and subsequently their hatching. Use of Acoustic noise as a way of controlling whiteflies is highly recommended to both small scale and large scale farmers all over the world.

Key words; Acoustic; Greenhouse; Noise; Vectors; Viruses; Whiteflies.

Introduction

White flies are small moth like, soft bodied, winged insects closely related to aphids and mealybugs (Mazzoni *et al*., 2010). They are have a global distribution. White flies mainly transmit diseases in vegetables (Polston and Capobianco, 2013). Their activity is high during the day since they are poikilothermic (Su *et al*., 2015). They are capable of overwintering and producing throughout the year in warmer climates (Maluta *et al*., 2014).

White flies injure plant by sucking plant juices causing yellowing of leaves which leads to premature leaf fall. When too many, they cause entire plant death (Navas-Castillo *et al*., 2011). Indirect damage to the affected plants is mostly caused by adult whiteflies which transmit viruses through their mouths from a diseased plants to healthy ones. They also excrete a honeydew substance which makes the plants look black and dirty (Samarra *et al.,* 2009).

However, the biggest damage occur when the white flies get into the greenhouse (Witgall *et al*., 2010). They suck plant juices and in turn produce whiteflies honeydew which is as a result of whiteflies feeding on the plans for quit along time (Halevy *et al*., 2009). The honeydew encourage fungal growth leading to fungal diseases (Janssen *et al*., 2017a). This reduces the rate of photosynthesis leading to reduced yields. The plants looks stunted, suffer from wilting and turn yellow (Bragard *et al*., 2013).

The control of whitefly control is difficult and complex, as whiteflies rapidly develop resistance to chemical pesticides (Bale *et al*., 2008). In addition, most chemicals are poisonous or harmful to human health if consumed. Some insecticides used kill the natural predators of whiteflies which are very important in biological control (Ericksson *et al*., 2012). Chen *et al*. (2014) proposed washing of plants after spaying them with insecticides before releasing predators or parasitoids in biological control of white flies (Legarrea *et al.,* 2015).

The availability of chemicals for the control of white flies is also a big concern (Vennila, 2013). Most farmers may lack the ability of buying the chemicals needed for the control of white flies (Zchori-Fein *et al*., 2005). As a remedy to this problem, some physical control methods such as use of vacuums and yellow tapes have been investigated (Mauck *et al*., 2012). This study aimed at determining the effects of high acoustic noise in form of acoustic sound on the reproduction and hatching of eggs in greenhouse whiteflies.

Materials and methods

Study area

This study was carried out in Egerton university main campus, Njoro, Kenya. Egerton University is located at coordinates 0° 23' south, 35° 35' and altitude of 2000m above sea level. The temperatures range between 17-22°C. The area receives an average annual rainfall of about 1000mm (Waithaka *et al*., 2016).

Making of the modified green houses

Seven medium sized carton boxes (Width-300mm, Height-600mm, and Length-300mm) were used in making the frame for placing transparent papers. All the sides except the bottom side were cut leaving 5cm frame (Wenninger *et al*., 2009). The cut surfaces plus the frame were covered with greenhouse polythene papers. The polythene papers were fixed on the frames using pins. Tiny holes were made on the polythene covers for ventilation. Doors were made on the front sides.

Raising the tomato seedlings

Five plots measuring 1x1m were prepared in 3 replicates. Tomatoes (*Solanum lycopersicum*) were bought from Njokerio shopping centre near Egerton University. Two hundred seeds were sown in each plot. The number of seeds that germinated were determined. The germination percent was calculated using the formula below (Soler and Lenteren, 2004).

$$Germination\ percent = \frac{x}{200} x\ 100$$

The seedlings were raised in nursery bed for a period of 6 weeks.

Introducing tomatoes in the modified green houses

Eighty four seedlings were transplanted on 84 polythene sleeves. Twelve seedlings were separately placed each of the seven modified green house. The soils in the sleeves were amended using well rotten cow manure. Water was added in the sleeves taking care not to cause waterlogging (Rubinstein and Czosnek, 2004). Dry leaves were placed at the base of the seedlings to reduce water loss through evaporation (Bleeker *et al*., 2009). Watering of the seedlings was carried out when need arose.

Introduction of whiteflies into the modified green houses

White flies were captured from Egerton University greenhouses using a sweep net. The capturing of whiteflies took place at 7:30am when the flies were less active (Hanafi, 2003). Two hundred whiteflies were placed in each modified greenhouse (Mauck *et al*., 2010).

Introduction of the noise into the modified green houses

A noisy radio that produced acoustic noise was placed in six modified greenhouses (Ingwell *et al*., 2012). The remaining one greenhouses acted as the control (Janssen *et al*., 2017b).

Determination of the number of whiteflies

Time was allowed for the white flies to lay the eggs (Blanc and Michalakis, 2016). The eggs were counted daily. The number of hatched eggs was determined starting from the second week up to 8th week.

Data analysis

The data obtained was analyzed using Statistical Package for Social Sciences (SPSS) version 25.0 software. Results on germination percentage of tomato seeds were compared using one way ANOVA. However, the results on number of eggs laid and those that hatched were analyzed using t-test. All statistical results with $p \leq 0.05$ were considered statistically significant.

Results

Germinated of tomato seeds

The germination percentage of tomatoes in plot 1 ranged from 86±0.3 to 88±0.1, 2 (85±0.2-87±0.1), 3 (84±0.2-83±0.2), 4 (83±0.3-

80±0.1) and 5 (81±0.3-78±0.3) (Table 1). There was no significant difference in the germination percent between the plots (F=0.250803859 P=0.782154004).

Table 1: Germination percentage of tomato seeds

Plot Number	Replicates		
	1	**2**	**3**
1	88±0.1	86±0.3	87±0.1
2	85±0.2	87±0.1	86±0.2
3	83±0.2	84±0.2	81±0.2
4	80±0.1	83±0.3	82±0.1
5	78±0.3	81±0.3	80±0.1

Number of eggs lied by the whiteflies (week 3)

There were no eggs that were laid by the whiteflies on day one (Table 2). However, the number of eggs laid on the tomatoes in the experimental greenhouses varied from 12±0.3 in day 2 to 312±0.1 in day 7. In the control greenhouse, the number of eggs varied from 34±0.2 in day 2 to 1022±0.3 in day 7. There was a significant difference between the number of eggs laid in the experimental greenhouses and the control greenhouse (P=0.040140971).

Table 2: Number of eggs laid on the tomato plants in the experimental and control greenhouse.

Day	Experimental greenhouse	Control greenhouse
1	0±0.00	0±0.00
2	12±0.3	34±0.2
3	76±0.2	124±0.1
4	132±0.2	421±0.1
5	207±0.1	699±0.3
6	241±0.2	725±0.2
7	312±0.1	1022±0.3

Number of hatched eggs of greenhouse whiteflies (week 4)

There were no eggs that hatched in day one (Figure 1). However, the number of eggs that hatched among the experimental greenhouses varied from 4±0.3 in day 2 to 63±0.2 in day 7. In the control greenhouse, the number of eggs varied from 34±0.3 in day 2 to 1009±0.3 in day 7. There was a significant difference between the number of eggs that hatched in the experimental greenhouses and the control greenhouse (P=0.017298).

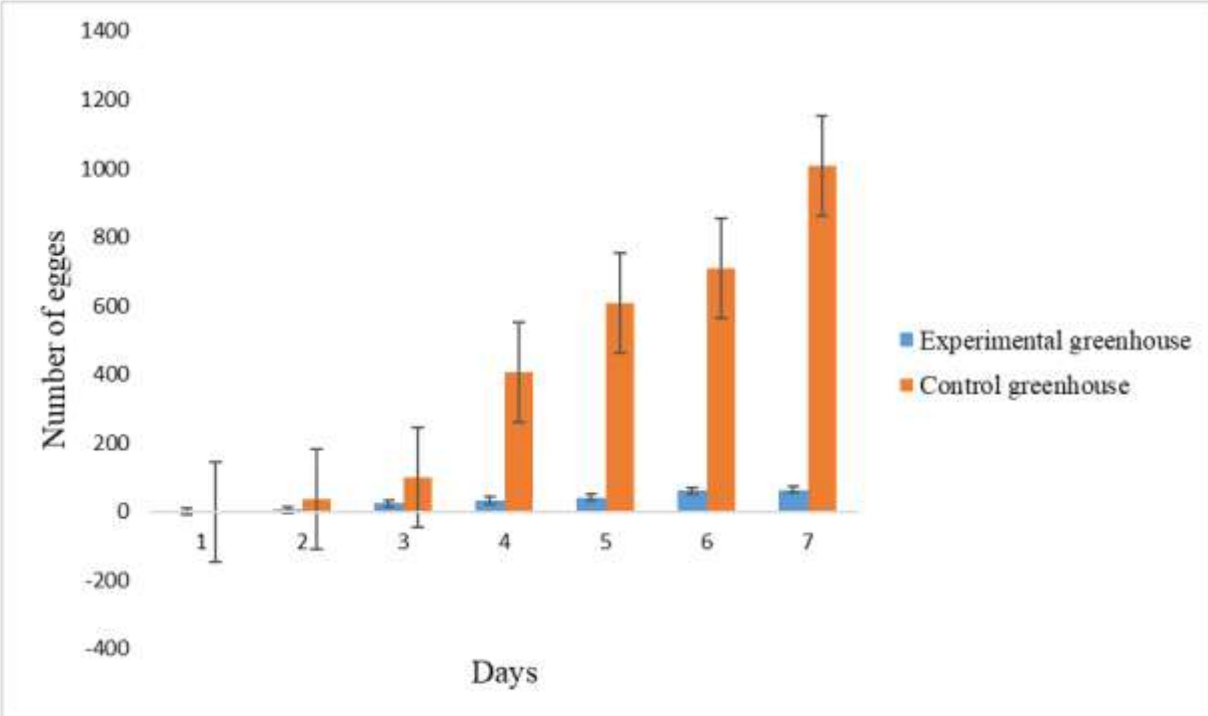

Figure 1: Number of eggs that hatched in the experimental and control greenhouse

Discussion

Tomatoes do well in the normal room temperatures or slightly above like those in the greenhouse during a hot day (Juarez *et al*., 2019). Although there was there was no significant difference in the germination percent between the plots, germination in plot 1 was higher than the other plots. This may have been caused by differences in soil fertility of the plots (Hanafi and El-Fadl, 2012). In addition, the soil physico-chemical characteristics greatly affects the germination in tomato seeds (Fereres and Moreno, 2009). The results of the present study differed with the results of a previous study by Kanmiya (2016). Differences in the genetic constitution of the plants from which the seeds were obtained could be a contributing factor (Moreno-Delafuente *et al*., 2013). In addition, the stage at which the seeds were harvested from the mother plant greatly contributed to their germination capacity (Togni *et al*., 2010).

In the first day of the experiment, no eggs had been laid by the white flies. This may be attributed to the time required by the whiteflies to familiarize with their new environment (Fontes *et al*., 2010). In addition, the whiteflies may have been too young to lay eggs (Pilkington *et al*., 2010). There was a gradual increase in the number of eggs from the second day in both the experimental and the control setups. However, the number of eggs in the control set up was higher than in the experimental set up. This may have probably resulted from a lot of noise in the environment which was a nuisance to the whiteflies (Horowitz and Ishaaya, 2014). The highest number of eggs were laid on the seventh day. In both the experiments, not all the white flies lied eggs. This is because some whiteflies had already laid their eggs before they were captured (Eriksson *et al*., 2011). Similar results were reported by Mankin (2012). These could be attributed white the white flies belonging to the same species (Li *et al*., 2014).

In the first day, no egg had hatched. However, the number of eggs that hatched increased from the second day. There was a significant difference between the number of eggs that hatched in the experimental greenhouses and the control greenhouse. This concurred with a previous study on Mazzoni *et al*. (2009). Similarity in the experimental set up could have contributed to the observed results (Rodriguez *et al*., 2019).

Conclusions

Tomato seedlings were raised in the nursery for 6 weeks. Acoustic vibrations produced by the radio affected the number of eggs laid by the white flies and subsequently their hatching.

Recommendation

Use of Acoustic noise as a way of controlling whiteflies is highly recommended to both small scale and large scale farmers all over the world.

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