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Population Density of *Bemisia tabaci* on Sweet Pepper (*Capsicum annuum*) Varieties in the Greenhouse

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Abstract. We conducted an experiment in a greenhouse at the research station belonging to the Department of Plant Protection / Ministry of Agriculture, in Abu Ghraib area during the spring and autumn season 2022-2023, to study the population density of the whitefly on two varieties of sweet pepper plant (Charisma and Sierra Nevada). The experiment was laid out in a randomized complete block design "RCBD" with three replicates for each variety. The results showed that in spring season the population density of *B. tabaci* eggs and nymphs reached the peak in the last week of May, which were 2.667 and 4.444 individual / leaf, respectively while the population density peak of the adults was in the first week of June, where it reached 3.33 individual / leaf for Charisma variety, while in Sierra Nevada variety the population density of eggs reached its peak at the first week of May 2.889 individual / leaf, while the nymphs reached its peak at the last week of May 4.44 individual / leaf, also the adults reached its peak in the second week of June 2.667 individual / leaf. In autumn season the population density of the eggs, nymphs and adults on Charisma variety reached its peak in the third week of November, where it were 3.556, 2.778 and 3.444 individual / leaf respectively, while the population density of the eggs, nymphs and adults recorded on the Sierra Nevada variety reached its peak in the third week of November with 3.889, 3.778 and 3.778 individual / leaf respectively. These results clearly showed that *B. tabaci* had nearly the same preference to infest the two varieties of sweet pepper, Charisma and Sierra Nevada through the abundance of their stages on the plants.

Keywords. Sweet pepper, Charisma, Sierra Nevada, *B.tabaci*.

1. Introduction

Sweet pepper is considered one of the most important fresh vegetables spread all over the world due to its combination of color, flavor and high nutritional value, as sweet pepper is characterized by its high content of vitamins, antioxidants and important and useful compounds such as Olefins, ascorbic acid, carotenoids, Vitamin E and capsaicinoids [1, 2, 3]. It is a vegetable crop of warm regions which grown in Iraq at open fields during the beginning of spring and at protected agriculture during the beginning of Autumn[4]. that is consumed fresh or cooked, and is commonly used in food seasonings. It is grown throughout the year as a cash crop. Based on the latest statistics of the Central Bureau of Statistics and



information technology, the area of sweet pepper production amounted to 5,297 hectares with a total production of 45,498 tons in Iraq.

In the last few years *B.tabaci* has appeared as a pest threatening the production of sweet pepper in addition of many important crops since it's a multi-family pest known to attack more than 70 crops all over the World [5]. The whitefly is a small soft-bodied insect belonging to the order (Homoptera) of the family (Aleyrodidae) [6]. Peppers infested with whitefly (nymphs and adults) that feed on plant sap, as the whitefly is located on the lower surface of the leaves, which causes leaf deformation, small blade size, dwarfism and yellowing of the upper part of the plant [7, 8]. Nymphs and adult whitefly feed on plant sap, which leads to plant weakness, yellowing and plant death in case of severe infection, and it also provides a favorable environment for the growth of fungi [9]. The most serious harm to whitefly species is represented by their transmission of viral diseases [10]. And it have the ability to resist the action of chemical pesticides, which makes it more dangerous, because they have developed a high degree of resistance against various groups of insecticides Including (organophosphates, carbamates, pyrethroids and chlorinated hydrocarbons) and insect growth regulators, [11] pointed out that the reason for whitefly resistance to pesticides is related to the excessive use of many pesticides, the short generation time of this insect, its high fertility and the rapid movement of adults. Therefore this experiment was conducted to study the Population Density of Bemisia tabaci on Sweet Pepper (*Capsicum annum*) Varieties in the Greenhouse during the Spring and Autumn Season.

2. Materials and Methods

The experiment was conducted in a greenhouse at the research station belonging to the Department of Plant Protection / Ministry of Agriculture, in Abu Ghraib area during the spring and autumn season 2022-2023, to study the population density of *B. tabaci* on two varieties of sweet pepper plant (Charisma and Sierra Nevada). The design of the field experiment was randomized complete block design (RCBD) with three replicates utilizing the statistical analysis program SPSS version 26 to conduct an analysis of variance (ANOVA) on the data. Infested sweet pepper leaves with whiteflies from each tested variety were compared using the least significant difference (LSD) under the probability level of 0.05.

The first date of the appearance of the whitefly insect was determined by sticky yellow traps in addition to periodic inspection of the pepper varieties targeted in the study. Samples were taken weekly and randomly with three replicates for each variety and for three levels of the plant (upper, middle and lower). Each sample was kept when collected in a zip lock bags provided with initial details such as name of the item, the replicate number and the date of collection of the sample. The samples were transferred to the laboratory of plant extracts affiliated to the department of plant protection in Abu Ghraib. The samples were examined by a light microscope (Hamburg) at a magnification of 4x to calculate the number of eggs and nymphs per leaf. The adults were counted on the plants directly in the early morning by turning the leaf slowly to avoid flying while counting. The population density of whitefly stages on each variety was calculated for the spring seasons for the period 9 / 1 / 2022 until 31 / 7 / 2022 and for the autumn season for the period 1 / 9 / 2022 until 1 / 1 / 2023.

3. Results and Discussion

3.1. Population Density of *B. tabaci* on Charisma and Sierra Nevada Pepper Varieties for Spring and Autumn Season

3.1.1. Spring Season

The results of estimating the population density stages of *B. tabaci* on the two pepper varieties in the greenhouse (Table 1) showed that all the stages were present throughout the growing season of the studied pepper varieties (Charisma, Sierra Nevada) in the greenhouse and with varying and fluctuating population densities (Figure 1 and 2). The population density of *B. tabaci* eggs and nymphs (on Charisma variety) reached the peak in the last week of May, which were 2.667 and 4.444 individual / leaf, respectively, when the average temperature was 34.5 °C and relative humidity was 38.10%

inside the greenhouse , while the population density peak of *B. tabaci* adults was in the first week of June, where it reached 3.33 individual / leaf when the average temperature was 39.20 °C and relative humidity was 23.30% inside the greenhouse .

While in Sierra Nevada variety , the population density of *B. tabaci* eggs reached its peak at the first week of May 2.889 individual / leaf , while nymphs of *B. tabaci* reached its peak at the last week of May 4.44 individual / leaf, also *B. tabaci* adults reached its peak the in the second week of June with 2.667 individual / leaf when the temperature was 32.00 °C and the relative humidity was 21.50%, while adults averaged 3 individuals / leaf when the temperature average was 48.50 °C and relative humidity was 23.60% . This may due to the role of temperature and humidity which effect on the population density of whitefly stages [12 and 13]. This corresponds to [8] , who found that the highest rates of whitefly infection were recorded on the eggplant crop during the months of April and May.

Table 1. Population density of different stages of *B. tabaci* on charisma and Sierra Nevada pepper varieties for spring season.

Date	Charisma			Sierra Nevada		
	Egg	Nymph	Adult	Egg	Nymph	Adult
9/1/2022	0	0	0.111	0	0.222	0.222
16/1/2022	0	0.222	0.333	0	0.111	0.222
23/1/2022	0.111	0.222	0.222	0	0	0.222
30/1/2022	0.222	0.333	0.444	0.222	0.333	0.444
6/2/2022	0.444	0.556	0.667	0.556	0.556	0.333
13/2/2022	0.444	0.444	0.444	0.556	0.556	0.556
20/2/2022	0.778	0.667	0.556	0.556	0.111	0.333
27/2/2022	0.444	0	0.222	0.222	0.111	0.222
6/3/2022	0.111	0.222	0.444	0.222	0.444	0.333
13/3/2022	0.222	0.111	0.333	0.333	0.222	0.333
20/3/2022	0.444	0.222	0.444	0.333	0.556	0.556
7/3/2022	0.444	0.444	0.556	0.556	0.333	0.556
3/4/2022	0.444	0.333	0.778	0.444	0.222	0.556
10/4/2022	0.667	0.333	0.667	1	0.556	0.778
17/4/2022	0.556	0.222	0.556	0.667	0.333	0.667
24/4/2022	0.778	1.222	1	0.889	1.111	0.889
1/5/2022	1.556	2.444	1.111	1.333	2.111	0.889
8/5/2022	1.778	2.889	1.444	2.889	3.111	1.111
15/5/2022	2.222	3.222	1.556	2	3.111	1.778
22/5/2022	2.111	3.556	2.333	2	3.444	1.556
29/5/2022	2.667	4.444	2.889	2.444	4.444	2.444
5/6/2022	2.444	3.222	3.333	2.667	2.444	3
12/6/2022	1.889	2.222	2.556	2.111	2.111	2.667
19/6/2022	1.889	1.889	2.222	1.778	1.444	1.778
6/6/2022	1.444	1.444	1.778	1.333	1.333	1.667
3/7/2022	1.222	1	1.222	1.222	1	1.444
10/7/2022	0.889	0.889	0.889	1.111	1	0.778
17/7/2022	0.889	1	1	0.556	0.667	0.667
24/7/2022	0.556	0.444	0.444	0.111	0.333	0.333
31/7/2022	0	0	0	0	0	0
LSD	0.922	1.141	1.019	0.937	1.078	0.991

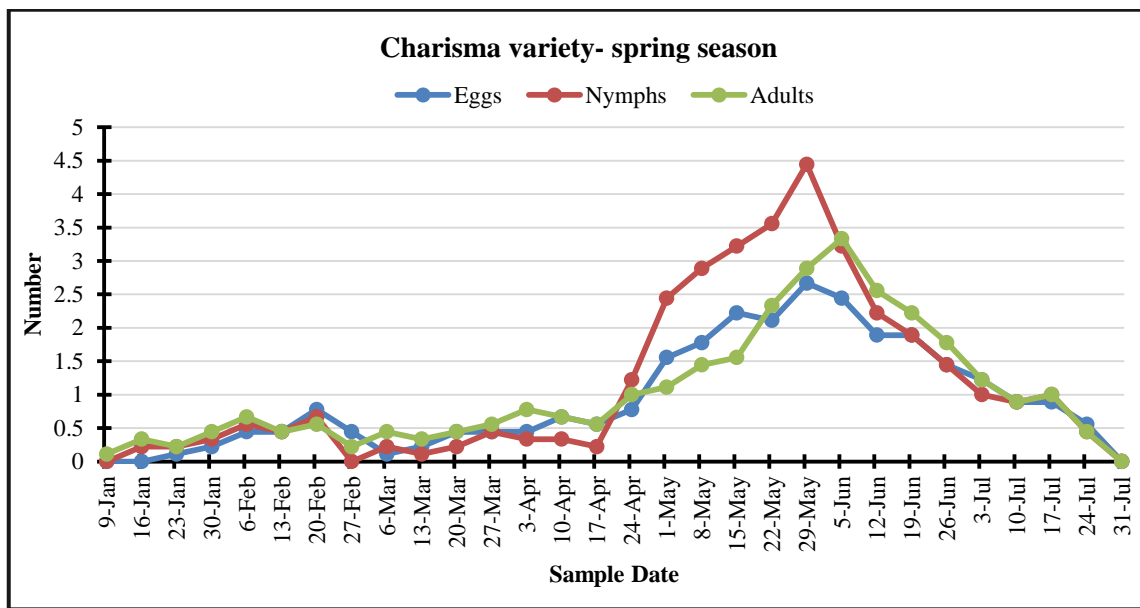


Figure 1. Population density of *B. tabaci* stages (egg, nymph, adult) on charisma variety.

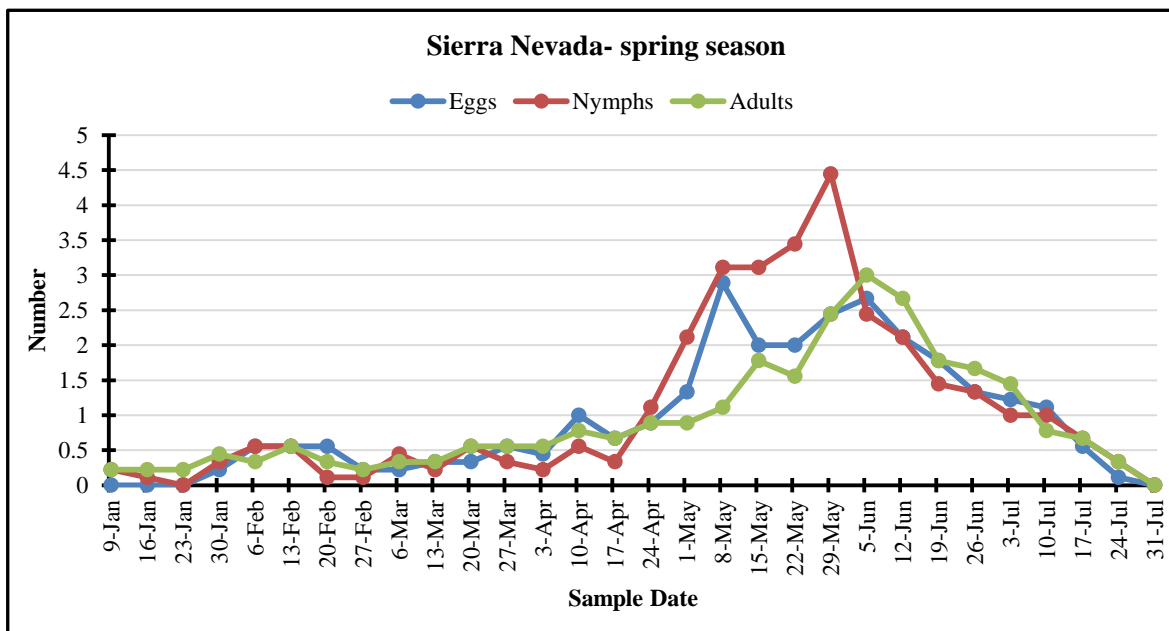


Figure 2. Population density of *B. tabaci* stages (eggs, nymph, adult) on Sierra Nevada variety.

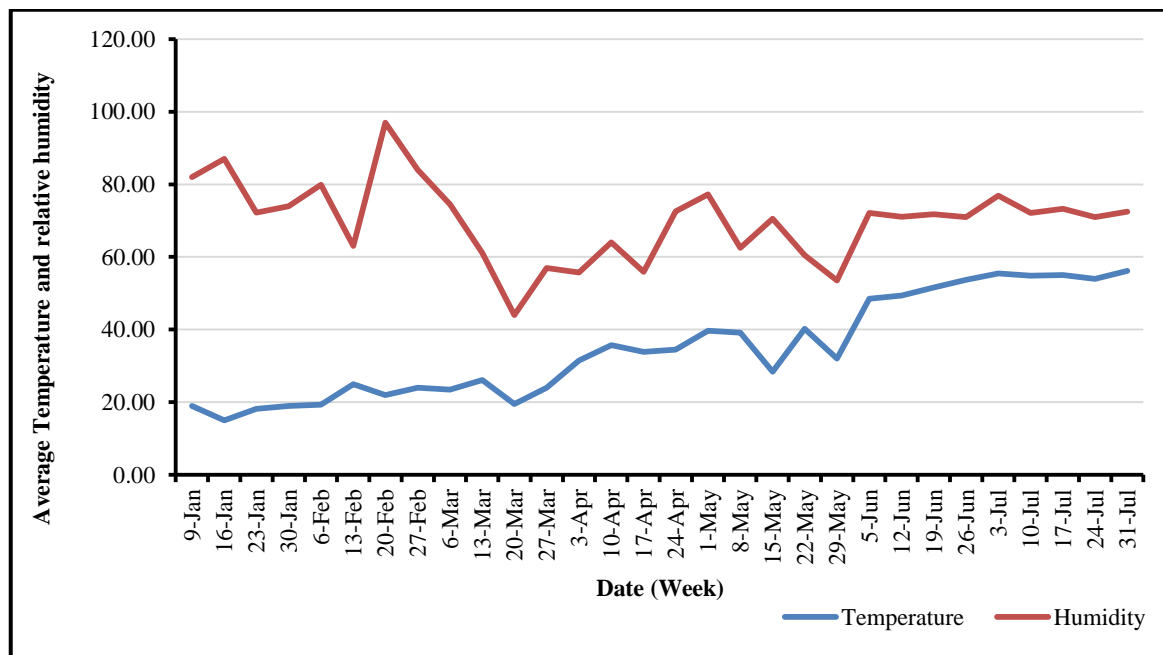


Figure 3. Average temperature and relative humidity in the Greenhouse of sweet pepper crop.

The results of the statistical analysis of the average insect numbers in Table.1 showed that there was no significant difference between the insect numbers on the studied plant varieties, as the numbers were nearly similar throughout the growing season for both varieties, the high population density of *B. tabaci* is associated with high temperatures and humidity inside the greenhouse, which leads to increased evaporation and transpiration processes in plants and laterly to the reproduction of the whitefly, as this insect prefers high humidity and hot conditions.

3.1.2. Autumn Season

The results of estimating the population density of *B. tabaci* stages on the two sweet pepper varieties in greenhouse (Table 2) showed that all the stages were present during the growing season of the studied sweet pepper varieties (charisma, Sierra Nevada) in the greenhouse and with varying and fluctuating population densities (Figure 4 and 5) for autumn season. One peak of population density was recorded in Charisma variety which began to rise gradually from the last week of October to reach its peak in the third week of November, where the population density of the eggs, nymphs and adults were 3.556, 2.778 and 3.444 individual/ leaf respectively. Also there was one peak of *B. tabaci* stages population density recorded on the Sierra Nevada variety which began to rise gradually from the second week of October to reach its peak in the third week of November for eggs, nymphs and adults which were 3.889, 3.778 and 3.778 individual / leaf respectively, when the temperature was 11c and relative humidity (85%). And this may due to the reasons mentioned above.

The results of the statistical analysis of the average insect numbers in Table 2 showed that there was no significant difference between the insect numbers on the studied plant varieties, as the numbers were similar throughout the growing season for both varieties, the high population density of the whitefly is associated with high air humidity and high temperatures inside the greenhouse, which leads to increased evaporation and transpiration processes in plants, which leads to the reproduction of the whitefly, as this insect prefers high humidity and hot conditions.

Table 2. Population density of *B. tabaci* stages on charisma and Sierra Nevada sweet pepper) varieties for the autumn season.

Date	Charisma			Sierra Nevada		
	Egg	Nymph	Adult	Egg	Nymph	Adult
4/9/2022	0	0	0	0	0	0
11/9/2022	0.222	0.444	0.333	0.111	0	0.222
18/9/2022	0.333	0.778	0.444	0.444	0.333	0.667
25/9/2022	0.444	0.778	0.667	0.667	0.556	0.444
2/10/2022	0.778	0.889	0.556	0.778	0.556	0.667
9/10/2022	0.667	1	0.889	0.556	0.889	0.667
16/10/2022	1.222	1.222	1.111	1	1.111	1
23/10/2022	1.778	1.333	1.556	1.444	0.889	1.333
30/10/2022	2	2.667	2.333	2.111	2.667	2.889
6/11/2022	3	2.444	3.222	2.778	2.444	2.889
13/11/2022	3.333	2.778	4	3.778	2.778	3.667
20/11/2022	3.556	2.778	3.444	3.889	3.778	3.778
27/11/2022	2.444	1.889	3	2.667	2.222	2.667
4/12/2022	2	1.444	2.222	2	1.444	2.222
11/12/2022	1.333	0.889	1.444	1.333	0.667	1.333
18/12/2022	0.889	0.778	0.778	0.778	0.444	0.889
25/12/2022	0.333	0.556	0.556	0.333	0.333	0.333
1/1/2023	0	0.222	0	0	0.111	0
LSD	1.352	1.272	1.475	1.370	1.179	1.426

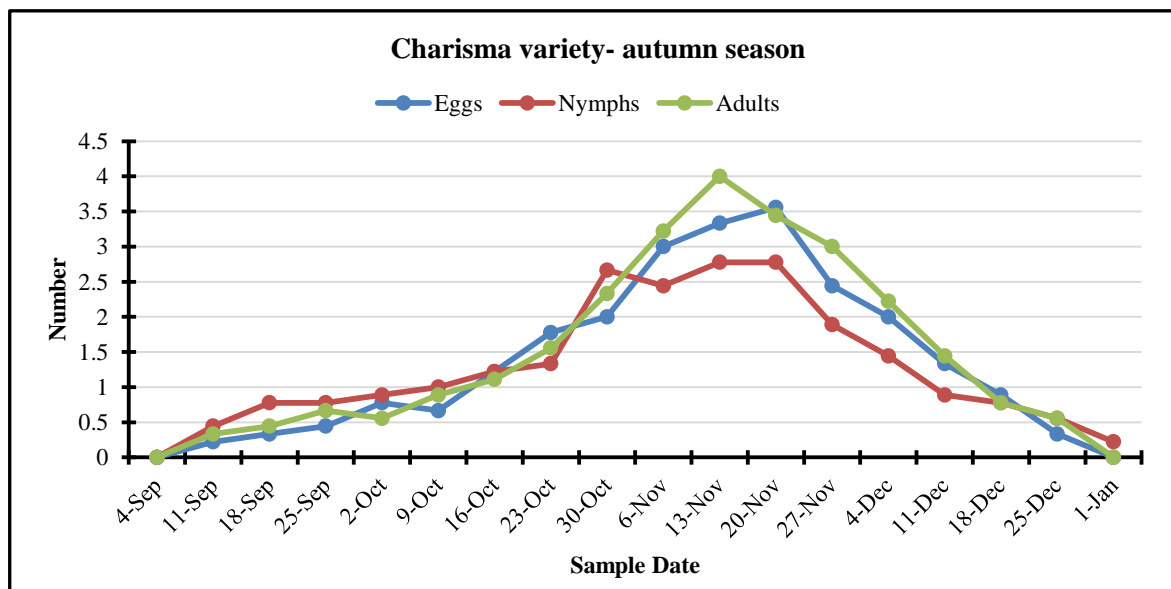


Figure 4. Population density of *B. tabaci* stages (eggs, nymph, adult) for the Sierra Nevada variety.

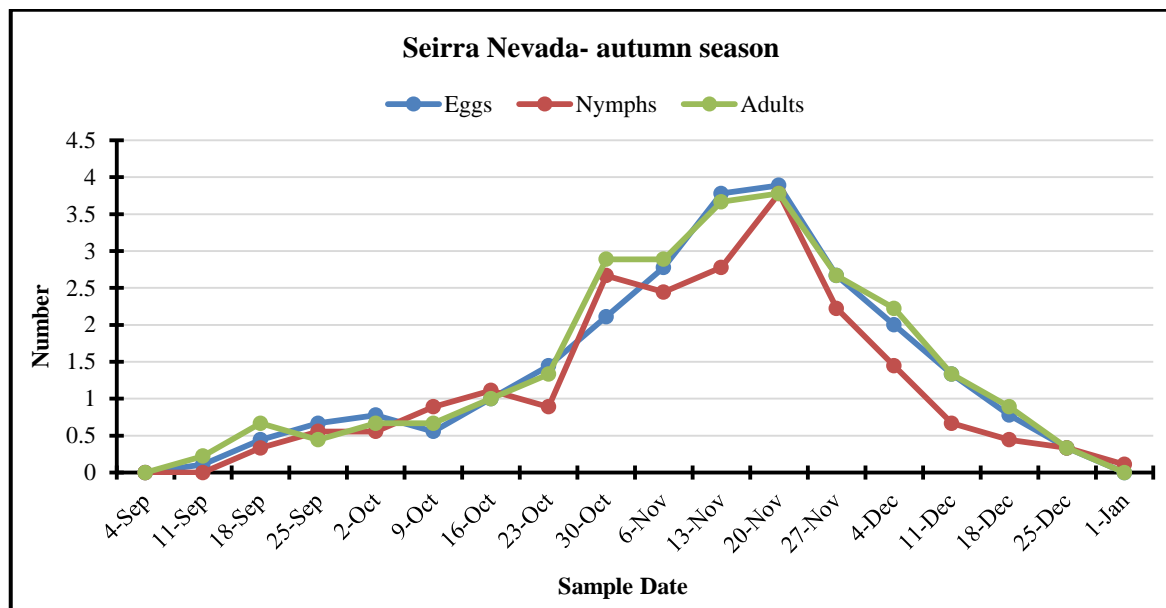


Figure 5. Population density of *B. tabaci* stages (eggs, nymph, adult) for the Sierra Nevada variety.

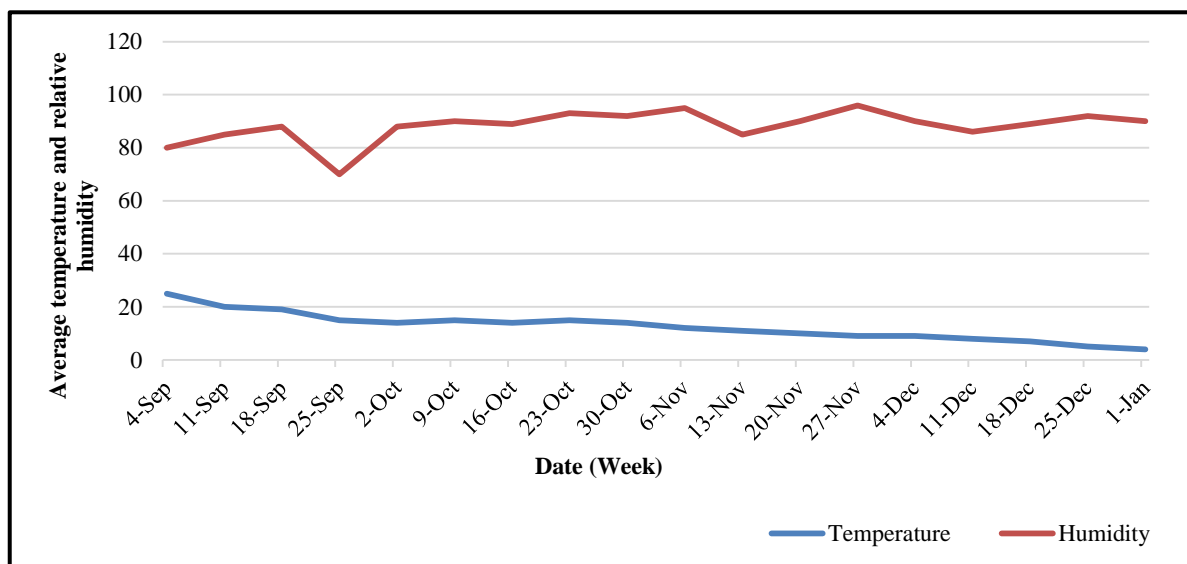


Figure 6. Average temperature and relative humidity in the greenhouse of sweet pepper crop.

Conclusions

From these results, we conclude that temperature and humidity has an effect on the population density of whitefly *B. tabaci*. Since its population density increases with increasing of temperature and humidity to a certain limit. There was nearly a similarly preference for *B. tabaci* to infect both of Charisma and Sierra Nevada sweet paper varieties through the presence of their different stages on the leaves of the plants.

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