SNAIL FARMING IN NET-COVERED GREENHOUSES: A COMPARISON BETWEEN SEMI-NATURAL AND ARTIFICIAL CONDITIONS

Apostolou K.[1], Pappas – Zois E.[1], Flessas A.[1], Neofitou C.[1], Katsoulas N.[2], Kittas C.[2], Hatziioannou M.[1]

[1]Department of Ichthyology & Aquatic Environment, School of Agricultural Sciences, University of Thessaly, Fytoko Street, 38 445, Nea Ionia Magnesia, Greece

[2]Agriculture Crop Production and Rural Environment, School of Agricultural Sciences, University of Thessaly, Fytoko Street, 38 445, Nea Ionia Magnesia, Greece

Abstract

The suitable climatic conditions for rearing snails (Cornu aspersum and Helix lucorum) were investigated in a net greenhouse (Volos Greece). Temperature and Relative Humidity were evaluated during light and darkness for the period of a month. In addition, snails' growth was recorded. In October 2011, with the fog system in operation, the temperature inside the net – house was recorded to be lower than outside (14,38°C - 16,9°C). The Relative Humidity was in a very good level regarding the interior (85,13%). The next year (October 2012) in semi natural conditions, air temperature was higher inside (21,43°C), although the relative humidity was significantly lower (53,3%).

Key words: *snail climatic conditions, net-covered greenhouse, fog cooling system, relative humidity*

1. INTRODUCTION

Snails are considered as food, that is consumed by millions of people worldwide (Jess & Marks 1998, Milinsk *et al.* 2006). Snail farming (Heliciculture) takes place in open spaces (fields), under totally controlled conditions or net-covered green houses. In France, Italy, Spain, and Australia also, extensive and intensive methods have developed in snail farming (Elmslie 1989, Iglesias et al. 1996). In closed farms, the number of snails is protected by predators and the production is higher in relation to open farms. However, the net-covered greenhouses established in our country so far for snail fattening, do not employ temperature and relative air humidity control systems (Hatziioannou et al 2014). A system of this kind could be that of cooling by evaporation, spraying water in the net-covered greenhouse both with high and low pressure. Cooling systems with artificial fog have been tested and operate successfully for temperature and humidity control of greenhouses (Arbel et al. 1999, Katsoulas et al. 2007) and also net-covered snail farms (Katsoulas et al. 2013, Apostolou et al 2014).

The aim of this experiment was to determine whether it is possible to maintain climatic conditions appropriate for snail farming during autumn in a net-covered green house in Central Greece (Volos, Thessaly). The climate in Greece is typical Mediterranean, with the cold and rainy season lasting from mid-October to late March and the hot and dry season from April to October. More specifically, the average temperature in Volos is 16, 9°C, while the average rainfall is estimated at 500 – 600 mm. October was chosen due to the fact that it is the last month of the reproduction period for Central and Northern Greece, since conditions are still favourable for snail growth, although this period is characterized by temperature fluctuations. The air temperature and relative air humidity fluctuations inside the net-covered green house during day and night time were compared to those in the external environment. Furthermore, the climatic conditions in the two kinds of management concerning the operation (October 2011) or not (October 2012) of the cooling system were compared.

2. METHODS

The experimental plant of breeding snails of the Laboratory of Ichthyology – Hydrobiology of the Department of Ichthyology and Aquatic Environment, University of Thessaly, is a net-covered greenhouse of 300 m^2, which constitutes a type of modified arched greenhouse. The net-covered greenhouse was constructed with a steel frame (7 m width, 2.5 height), covered with a shading net, with a coverage of 90%. In perimeter, there is coverage by means of a plate, 80 cm in height and 20 cm in depth, which prevents the entry of rodents and reptiles. The maintenance of the required humidity of October 2011 is achieved by the cooling system, of high and low pressure in spraying water. The high pressure system (*AIR PETRI*) sprays droplets of water (some tens μm in size and 60 bar in pressure), thus allowing the creation of fog, until their total evaporation. During the experiment during October 2011, the system operated by means of an electronic sensor, which was activated during the day (from 9 am until 9 pm) and for 55 sec / min, when the relative air humidity was lower than 90%. The low pressure system, on the other hand (*NETAFIM*), sprays droplets of water (200 μm in size and 3 bar in pressure), which mainly fall to the ground and evaporate depending on the environmental conditions. During the experiment in October, 2011, the system operated in an everyday basis (from 10 am until 7 pm) for 2 sec / min. Cooling systems were not used in the experiment of the following year (October 2012).

For the recording of the abiotic conditions the following were used: a sensor for temperature and air humidity (*E + E America*), a waterproof logger for temperature and relative humidity (*ONSET America*) with measuring range from 0.5 m / s to 40 m / s, a solar radiation sensor (*DECAGON, America)* and a sensor for wind speed (*THIES CLIMA Germany).* The temperature range in the territory was from -40°C to 70°C, with 0.2 °C accuracy. The relative humidity ranged from 0 – 100 % with a measurement accuracy of 2.5 %. Measurements were recorded every 10 minutes, from sensors inside and outside of the net-covered greenhouse, while software compatible with the meteorological stations of HOBO Warre BHW-PC was used for procession. Finally, water supply in both cooling systems was recorded with the aid of a hydrometer.

3. RESULTS

Figures 1 and 2 show the air temperature alteration inside the farm for the first period of research (October 2011). During the coldest nights, there were no significant differences between night and day temperatures. The most significant difference was recorded on 12 / 10, when the highest temperature was 23.5^{o}C during the day and 17.0^{o}C during the night. Finally, only in two cases (14/ 10 and 16 /10) the highest temperature was greater during the day than during the night. Air temperature fluctuations in Volos, during the same period of time, is demonstrated in Figures 3 and 4. No important deviations were recorded between day and night. In fact, greater difference was recorded in 19 / 10 and was 6.6^{o}C (20.5^{o}C – 13.9^{o}C). In two cases, the highest temperature during the day was lower than the highest temperature during the night (14/10 and 27/10).

The average day temperature in the net-covered greenhouse in October 2011 was 16^{o}C, while the average night temperature was 13^{o}C. Temperatures of the environment went 18 ^{o}C and 14 ^{o}C, respectively. The highest air temperature during the day inside and outside the net-covered greenhouse (Figures 1, 3) were slightly different, especially after 7/10, thus the cooling system was operated. On the other hand, the lowest air temperature during the day was at all times lower than the one on the inside. The average temperature during the night inside and outside the net-covered greenhouse did not show any differences, except for the two cases where the temperature inside the net-covered greenhouse was significantly lower that the outside temperature (on 8/10: 5.1 ^{o}C and on 14/10: 2.5^{o}C) (Figures 2, 4). The lowest temperature during the night showed no difference for the inside and the outside of the net-covered greenhouse.

As far as the relative air humidity is concerned (Figures 5, 6) in the net-covered greenhouse in October 2011, no differences between day and night were recorded, mainly due to the use of cooling systems.

Inside the net-covered, and for the same time period, significant deviations were observed, both in maximum and minimum value of relative air humidity.

This in logical, since from this time, the watering inside the net-covered greenhouse began and the outside humidity was low (23% on 19/10), thus ideal conditions were achieved. The alterations in relative humidity (Figure 6) during the night inside the net-covered greenhouse was 33% (97% - 64%). Regarding the fluctuation of relative air humidity (Figure 7) in Volos in October, 2011, slight differences were recorded between night and day, with some measurements presenting significant deviations (14 /10 with the highest humidity during the day 64.7% and 92.3% at night).

The cooling systems inside the net-covered greenhouse did not operate in October, 2012, so farming took place in semi-natural conditions. The maximum value of temperature during the day was 33^{o}C on 3/10 and 30 ^{o}C during the night on 5/10 (Figures 9 and 10). The minimum value of temperature during the day and night is the same, 10 ^{o}C (Figures 9, 10). During the same time, in Volos, the highest temperature during the day was 31.4 ^{o}C (Figures 11, 12), while during the night it was recorded to be 22 ^{o}C. The minimum temperature during the day was 26 ^{o}C, while 22 ^{o}C during the night. The difference of the maximum air temperature (day – night) in October 2012 is very small (0.6 ^{o}C), while the difference of the minimum temperature was 2 ^{o}C (Figures 11, 12).

During the day, the lowest humidity was recorded at 32%, while during the night it was 25% (Figures 13, 14). The maximum value for humidity inside the net-covered greenhouse is almost the same with the humidity of the environment (Figures 15, 16). As far as the minimum value of humidity during the day is concerned, it was higher than the minimum value of humidity during the night (42% and 30% respectively) (Figures 15, 16).

In October 2012, during the night, higher temperatures were recorded inside the net-covered greenhouse (Figures 10, 12), compared to the environment. Generally, the minimum values of humidity are much greater than those of the outside (Figures 13, 15). During the night (Figures 14, 16) the humidity was higher inside the net-covered greenhouse than at the outside.

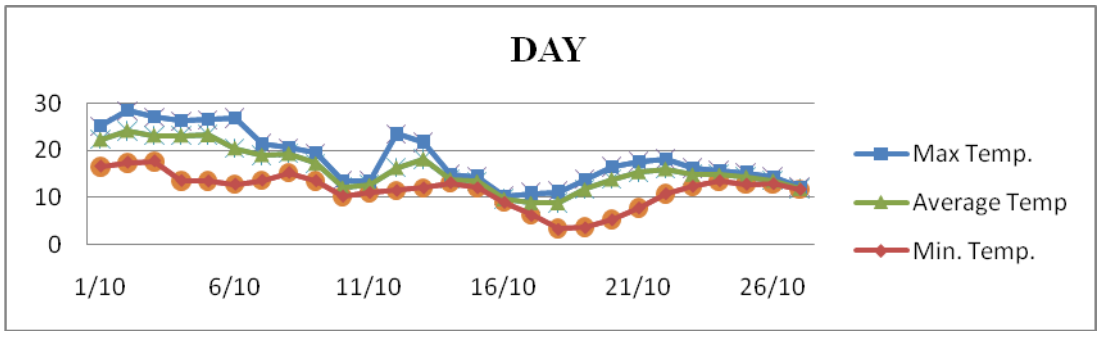


Figure 1. Temperature (^{o}C) inside the net – covered greenhouse in October 2011.

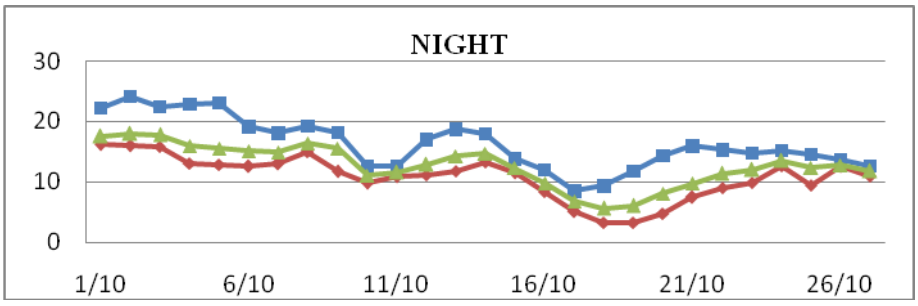


Figure 2. Temperature (^{o}C) inside the net – covered greenhouse in October 2011.

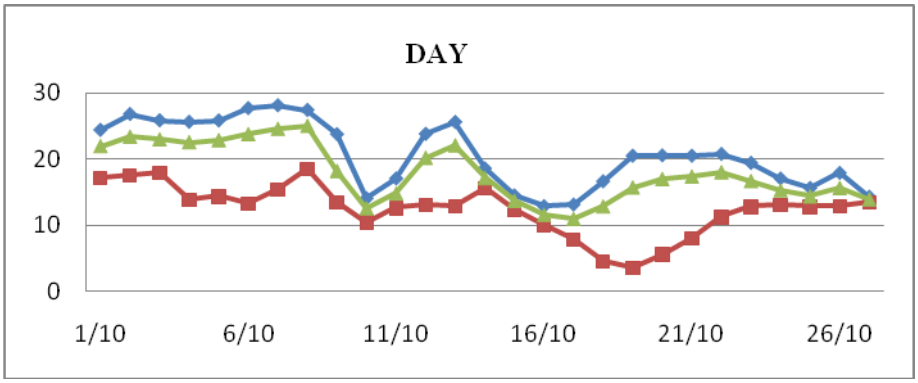


Figure 3. Environmental temperature (°C) in October 2011.

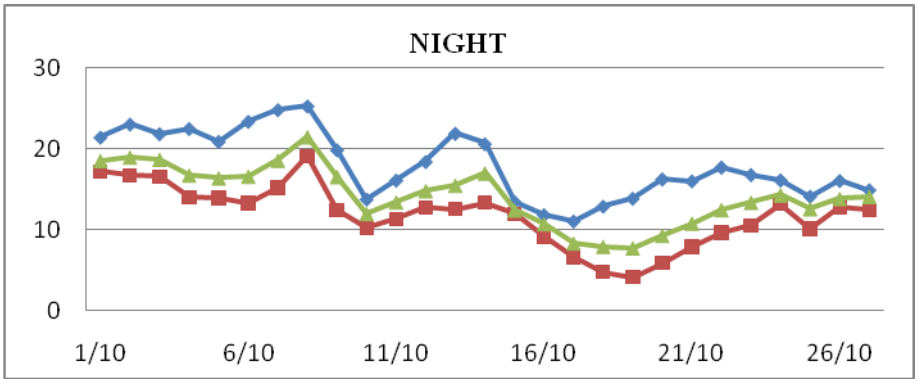


Figure 4. Environmental temperature (°C) in October 2011.

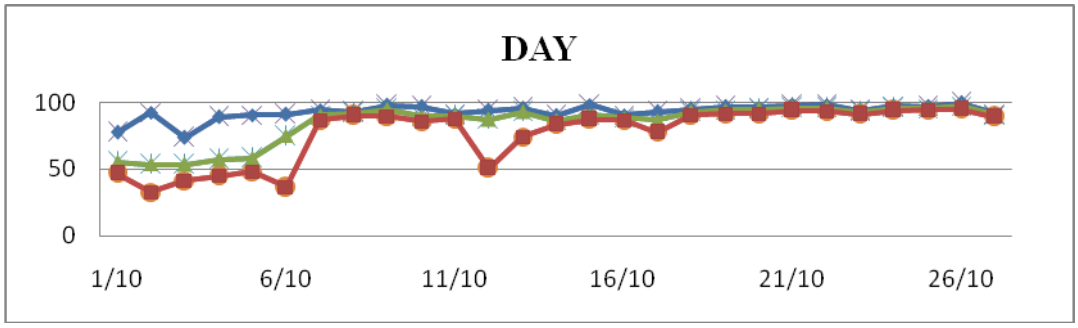


Figure 5. Relative Humidity (%) of net – covered greenhouse in October 2011

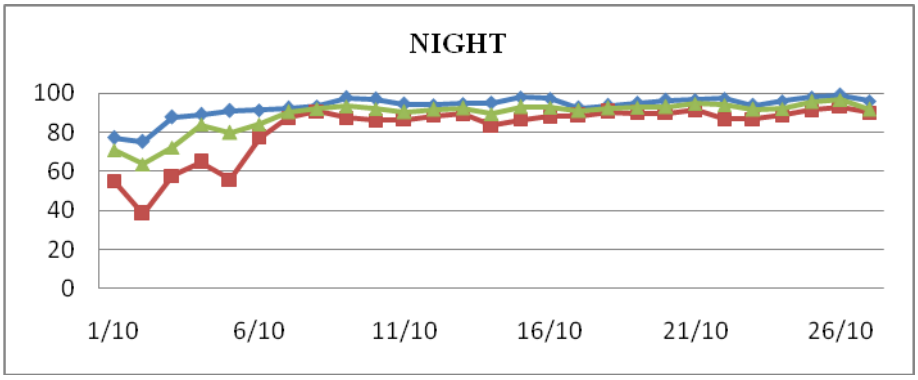


Figure 6. Relative Humidity (%) of net – covered greenhouse in October 2011.

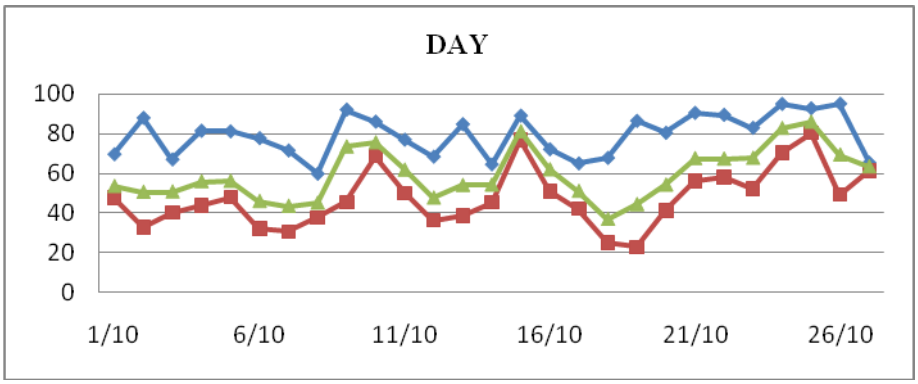


Figure 7. Environmental Relative Humidity (%) in October 2011.

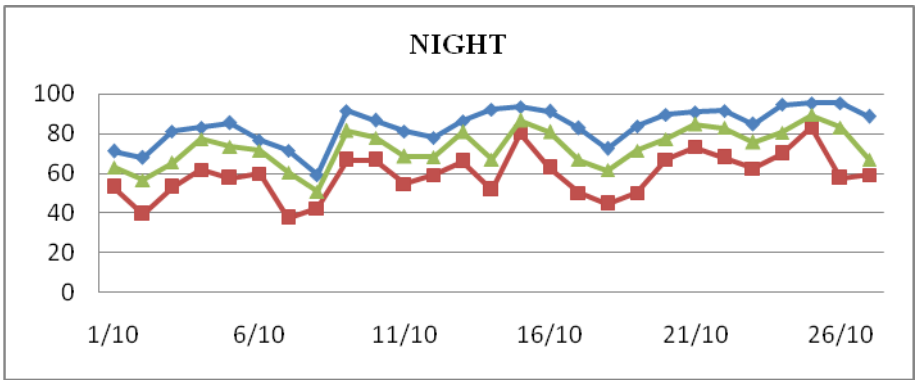


Figure 8. Environmental Relative Humidity (%) in October 2011.

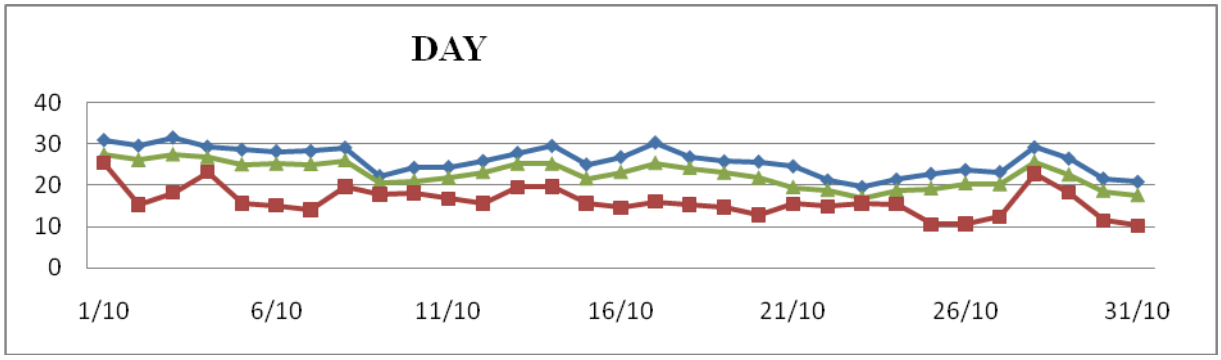


Figure 9. Temperature (°C) inside the net – covered greenhouse in October 2012.

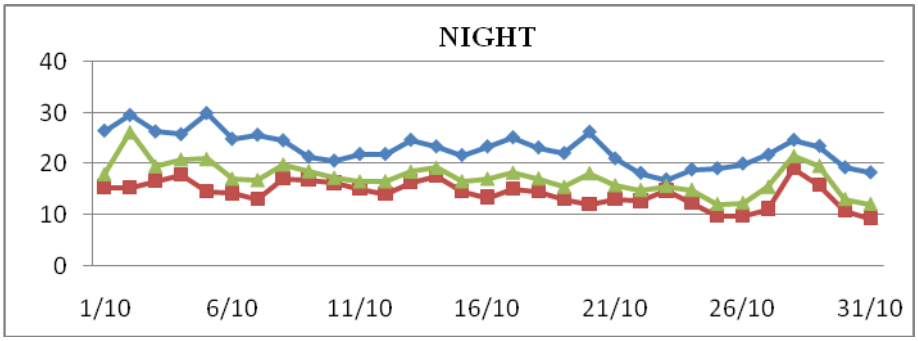


Figure 10. Temperature (°C) inside the net – covered greenhouse in October 2012.

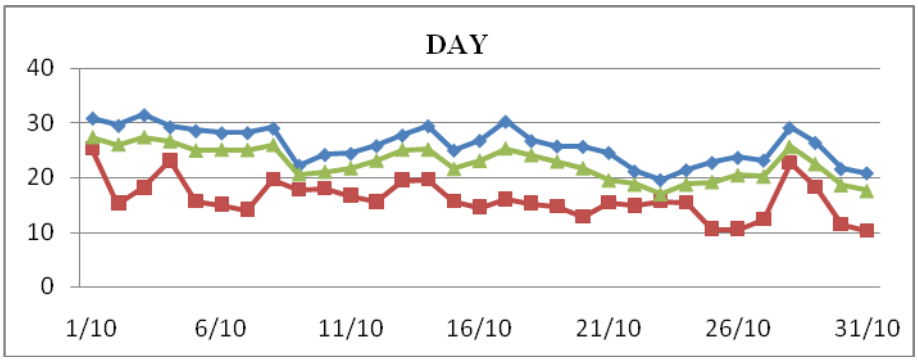


Figure 11. Environmental temperature (°C) in October 2012.

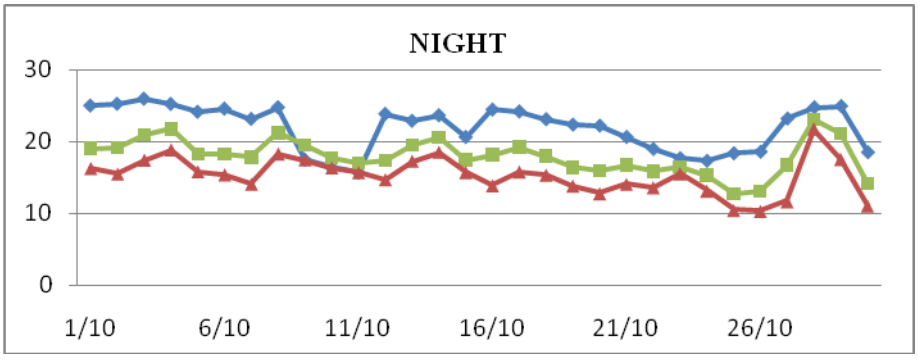


Figure 12. Environmental temperature (°C) in October 2012.

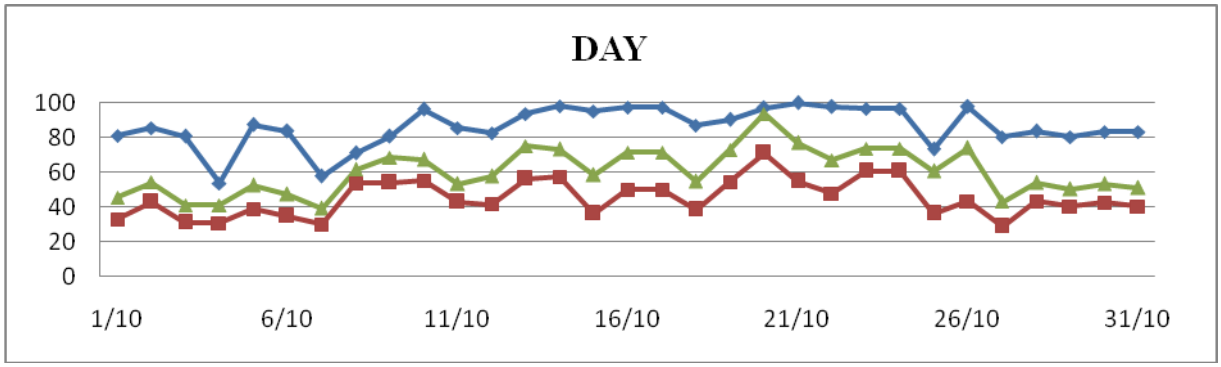


Figure 13. Relative Humidity (%) of net – covered greenhouse in October 2012.

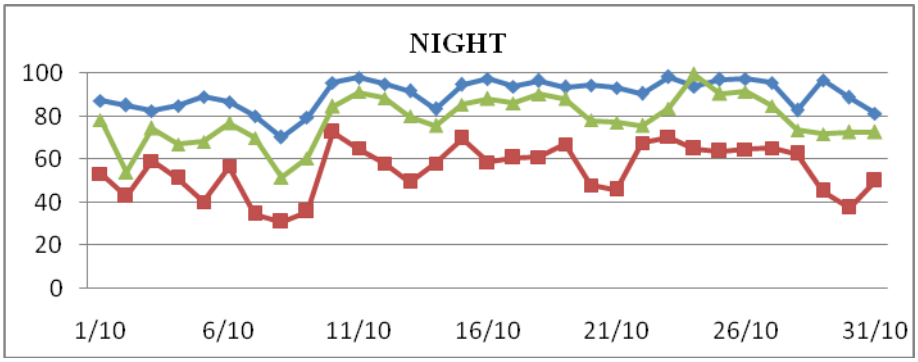


Figure 14. Relative Humidity (%) of net – covered greenhouse in October 2012.

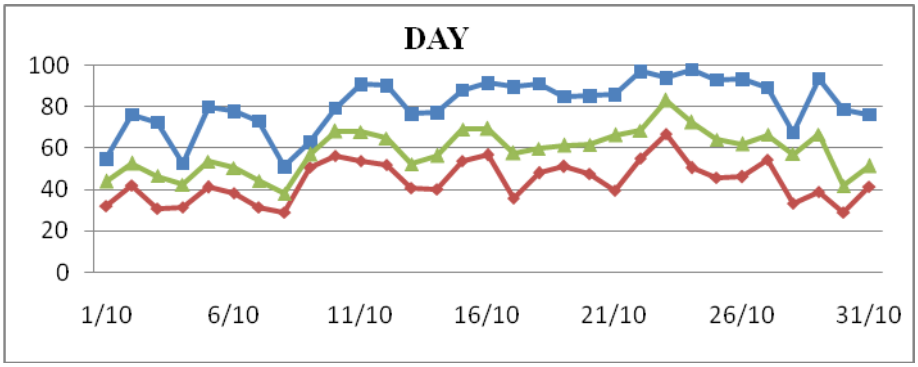


Figure 15. Environmental Relative Humidity (%) in October 2012.

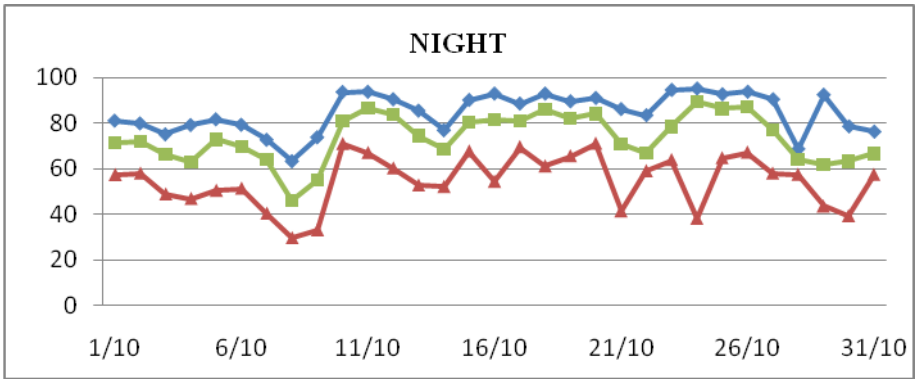


Figure 16. Environmental Relative Humidity (%) in October 2012.

4. DISCUSSION

The use of the cooling system in October 2011 was proved to decrease temperature inside the installation, mainly during the days when the temperature outside was low. On the contrary, under semi-natural conditions, the temperature inside and outside the net-covered greenhouse during both years, was maintained in good levels, due to the cooling system, in 2011, and the climatic conditions (rainfall) in 2012. During the dry seasons in 2012 days, when humidity levels were below 50 %, were recorded.

According to Arbel et al. (1999) and Katsoulas et al. (2007), the cooling systems with artificial fog have been tested and operate successfully for temperature and relative humidity control in greenhouses. The results of this particular research demonstrate that the micro-climate inside the net-covered greenhouse for snail farming was influenced by climatic conditions and cooling systems. The operation of the cooling system during autumn decreases temperature inside the net-covered greenhouse, harming the growth of snails. In the same net-covered greenhouse, with the aid of the cooling systems, temperatures during the hot season is maintained in levels lower that 25ºC, even when the outside temperature was higher than 30ºC (Katsoulas et al. 2013, Apostolou et al. 2014).

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