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Research Article

The Feeding Potential of Greater Wax Moth (*Galleria mellonella*) in Different Gauzes of Plastics

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Abstract

Greater wax moth (*Galleria mellonella)*, the honey comb moth, is the member of family pyralidae, considered as the serious pest of the bee industry, is also known for its plastics digesting ability. This research was carried out in two phases in the month of September- October & December- January. The data on change in weight of the plastics using digital balance and area of plastic consumed by the larvae was taken for 30 and 15 consecutive days in winter and summer respectively. From the statistical analysis the results found out; 8.4 mg, 2.4 mg & 1.6mg mean change in weight in the treatment T1, T2, T3 respectively; that the area of plastic consumed by the larvae was higher in plastics of 200 gauze i.e. smaller the gauze of plastic, greater the area consumed. The study revealed the similar change in weight of plastics within the range of 300-500 gauze which was lower than the change in weight of the natural feed, wax. Higher rate of plastic feeding was observed in summer as compared to winter.

Keywords: Plastics; consumption; pollution; control; Greater Wax Moth

Introduction

Greater Wax Moth (*Galleria mellonella*), honey comb moth, a holometabolous insect, belongs to Lepidoptera order, completes its lifecycle through egg, larva, pupa, and adult (William, 2000; Marston, 1976). The moth has 7 instars and completes its life cycle in 6-7 weeks at about 27-30ºC and RH 40-100%. The larva feeds on pollen, honey, wax, cast-off honeybee pupal's skins, creates tunnels in the comb, and leaves masses of webs on the frame.

The greater wax moth (*Galleria mellonella)*, at first, reported in honeybee colonies of Asian honeybee *Apis cerana* and then it was believed to be spread to Northern Africa, Great Britain, some parts of Europe, Northern America and New Zealand (Akratanakul,1987; Paddock, 1918). However, they are cosmopolitan in distribution (Williams, 1997; Shimanuki, 1980). And at early 20th it has been confirmed in 27 African countries. But the presence is highly reported in Asian countries, some of the North American countries, and few Latin American countries

(Hussein, 2000; Carrol, 2006; El-niweiri, 2015; Kebede, 2015; Nielsen & Brister, 1979; Correa-Marques and De Jong, 1998; Kwadha *et al*., 2018). They are further reported in Australia and European countries but the availability varies with the climatic conditions (Bombelli, 2017).

Plastics (malleable, ductile, and impervious in nature) is being used and produced 7.8 billion tons - more than one ton of plastics for every man alive today. As of 2018, about 380 million tons of plastic is produced worldwide each year. From the 1950s up to 2018, an estimated 6.3 billion tons of plastic has been produced worldwide, of which an estimated 9% has been recycled and another 12% has been incinerated (https://www.economist.com/international/2018/03/03/the-known-unknowns-of-plastic-pollution/). Plastics, one of the great contributors of human civilizations have had its dark sides, took too long to get degraded. Half of the plastics we use; we just use them once and throw away. That is why plastics pollution is being the major issue of the 21st century. Microorganisms over 90 genera from bacteria and fungi such as *Bacillus megaterium*, *Pseudomonas sp*., *Azotobacter, Ralstonia eutropha, Halomonas sp*., etc. have been used by various scientists as a means to degrade the plastics biologically. But the degradation rate by these microorganisms recorded till date is 0.13 mg cm^{-2} day^{-1}, which is very slow. Leading the global population to think about some innovative ideas for the degradation of plastics, it would be amazing if entomology led us to the cure and raise us from the ruin of the plastic pollution, wouldn't it? Greater Wax Moth Larva is getting an attention of the world for its plastics digesting ability, in about 12 hours, nearly 100 wax worms kept in a plastic shopping bags reduced the mass of plastic by 92 mg, about 2.2 holes were made per worm per hour (Varshneya *et al*., 2008).

Materials and Methods

The major apparatus that had been used during the whole course of research are same instar larva of *Galleria mellonella*, Plastics of different gauzes (200, 300, 500), Glass Cups, Bee Wax, Weighing Machine weighing minimum of 1 mg and Net.

Collection of Insects

Larva were collected from the nearby village Bethari, Rupandehi – Nepal (27.5135°N, 83.3910°E). The apiary known as PAL APIARY owned by Mr. Setwan Pal provided us with enough larva and bee wax.

Artificial Rearing

In order to get the larva of the same instar the collected larva was further reared artificially in the laboratory condition. The media was prepared with - Water, deionized, parboiled - 100 ml Honey, raw or commercial brand - 150 ml, Glycerin - 50 ml, Bee wax - 3 gm., Cholesterol - 1 gm., Polyvisol Multivitamin supplement - 4 ml, Baby food cereal and Gerber's Hi-Protein - 454 gm.

First of all, the water was heated up to 80°C and honey, glycerin, beeswax, and cholesterol were added while swirling vigorously. When the solution gets cool down to about 50°C the multivitamin content and the nicely pulverized cereals were added to the solution. The collected larvae were put in the pot and provided with the bee wax. When they developed into an adult, they were transferred to the pot containing folded sheet of wax paper held together where moths laid their eggs. When the adult laid eggs, they were removed from there and put in the jar containing the medium (about 1000 larva in the 150gm of the medium). After 7-10 days larvae were in their second instar and they were collected for the experiment to begin.

Experimental Site and Set Up

The study was conducted in Entomology laboratory 27.48013ºN 83.44730ºE, Institute of Agriculture and Animal Science, Tribhuvan University, Paklihawa Campus. The research was conducted under ambient lab condition in two different seasons (Sept-Oct & Jan Feb). Glass bowls of 5cm×2.5cm size were used. Plastics of three different gauzes (200,300 & 500) were brought. Four treatments were made and each was replicated 10 times. The treatments were:

T1: Plastics of 200 gauze

T2: Plastics of 300 gauze

T3: Plastics of 500 gauze

T4: Bee Wax (Natural feed)

Each gauzes of plastic were cut into 10 similar pieces of area $144cm^2$ and weighed separately, and placed in separate glass bowls. For 4th treatment i.e. natural feed, 10gm wax was weighed and placed in each replication. The experiment was conducted in laboratory under homogeneous condition. Ten larvae were confined inside each glass bowls of different treatment and then covered with a covering net. To avoid the risk of ant attack to larvae, the whole experimental setup was placed in safety, the whole setup was kept over a tray and further in another bigger tray full of water.

Data Collection and Statistical Interpretations

The data on holes made by worms on plastics, change in weight of the plastics and change in weight of wax were taken in every 24 hours for 30 consecutive days in winter and 15 days in summer season. The area of holes made on the plastics was measured by using graph paper and the change in weight of plastics and bee wax was measured by using 4-digit digital weighing machine (0.000gram). To correlate the change in weight and area among the treatment a statistical software SPSS is used. The treatments were analyzed using analysis of univariate and the statistical interpretation were undertaken to determine the homogeneity and the mean of the data. Duncans test was carried out ($p<0.005$).

Result and Discussions

Variation in Temperature

As the research was carried out in the two different seasons mean temperature is different but no significant change was seen in consecutive days during the experiment. Temperature ranged from 26.8˚C-30.7˚C in summer & 11.8˚C- 17.2˚C in winter as shown in the Fig. 1 and Fig. 2.

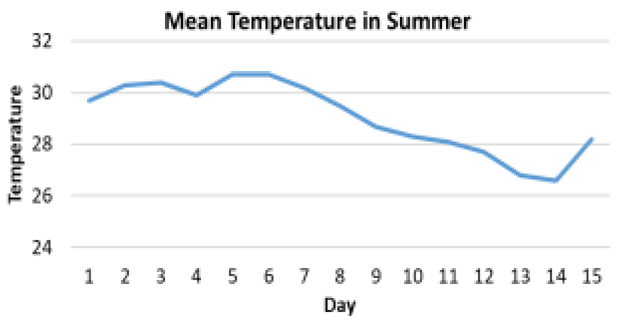

Fig. 1: Mean Temperature in summer

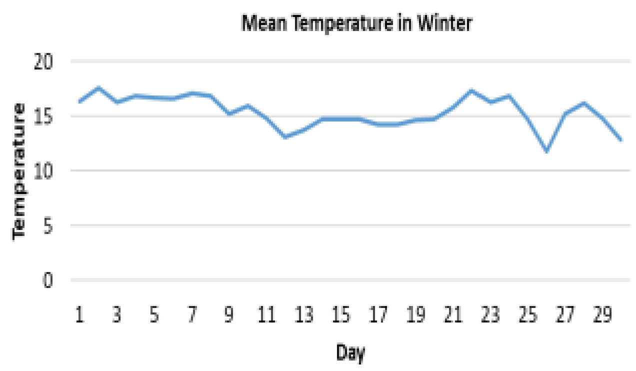

Fig. 2: Mean temperature in winter

Effect of Treatment in Change in Weight

Change in weight in summer:

From the analysis of variance, we found that the change in weight in summer is significantly different among the treatments. (F= 158.208; df =3: Significant value: 0.000) (Table 1). However, further analysis on Duncan's test, resulted that T4 is significantly different from T1, T2 & T3 as shown in the Fig. 3.

During the research period of 15 days in summer, the mean of change in weight was found to be 3.45 mg, 0.87 mg, 0.6 mg &400 mg per day for 200 gauze, 300 gauze, 500 gauze plastic and bee wax respectively.

Change in weight in winter:

We found out that treatment has significant difference on change in weight in winter. (F= 12.329; df= 3: Significant Value: 0.000) (Table 1). During the research period of 30 days in winter, the mean of change in weight was found to be 0.31 mg, 0.27 mg & 0.17 mg per day for 200 gauze, 300 gauze, 500 gauze plastic and bee wax respectively as shown in the Fig. 4.

If we see the rate of consumption in the first day of experiment, 10 larvae in 200 gauze of plastic were found to consume 8.4 mg in 24 hours. In the similar research it was found that 92 mg of plastic degraded by 100 worms in 12 hours.

Effect of Treatment on Area of Plastics Consumed

Change in area of plastics in summer:

From the analysis of Variance, we found out treatment has significant difference on area of plastics consumed. (F=35.961; df= 2: Significant Value: 0.000). During the research period of 15 days in summer, the mean of area of plastic consumed per 10 larvae was found to be 64.47 mm², 15.79 mm²& 2.52 mm² per day for 200 gauze, 300 gauze & 500 gauze respectively as shown in the Table 1 & Fig. 5.

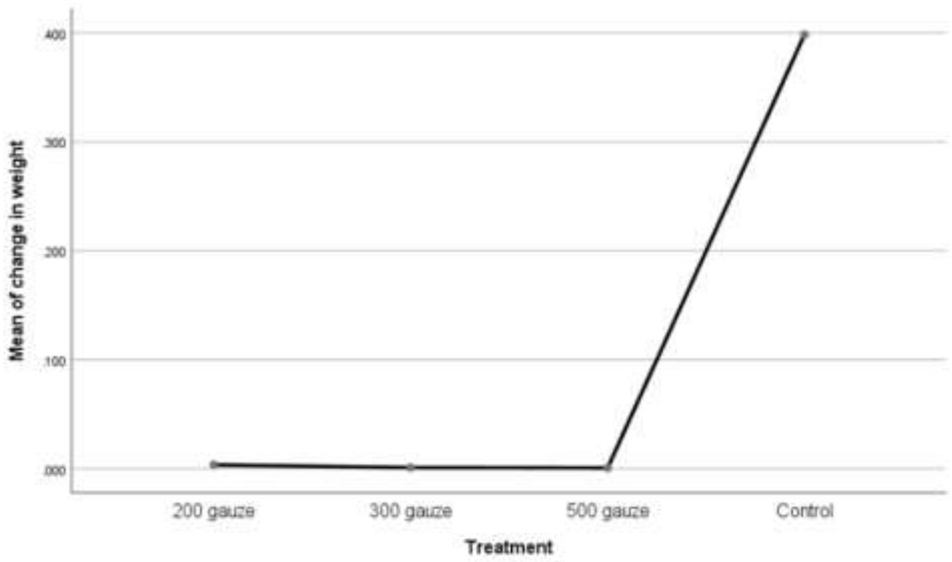

Fig. 3: Mean of Change in Weight vs Treatment in summer

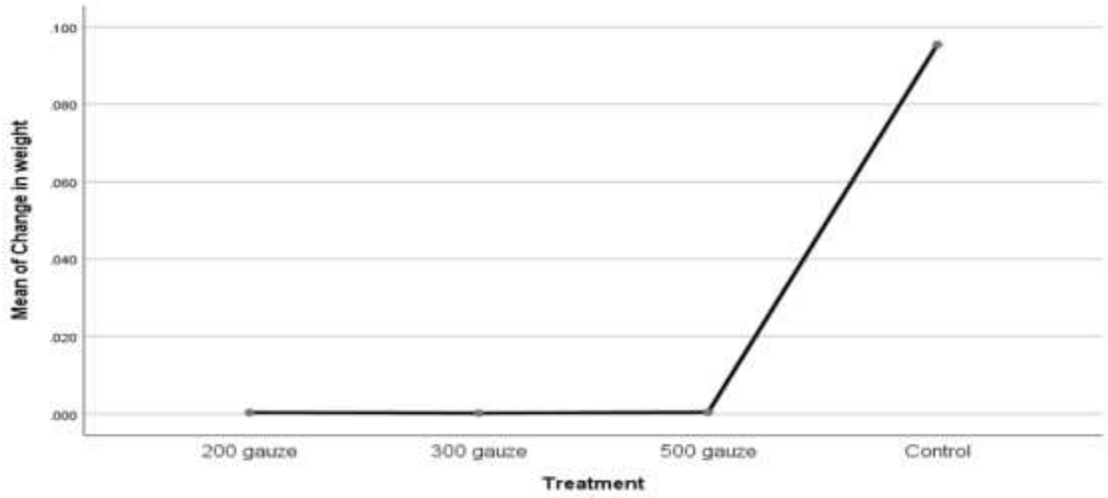

Fig. 4: Mean of Change in Weight vs Treatment in Winter.

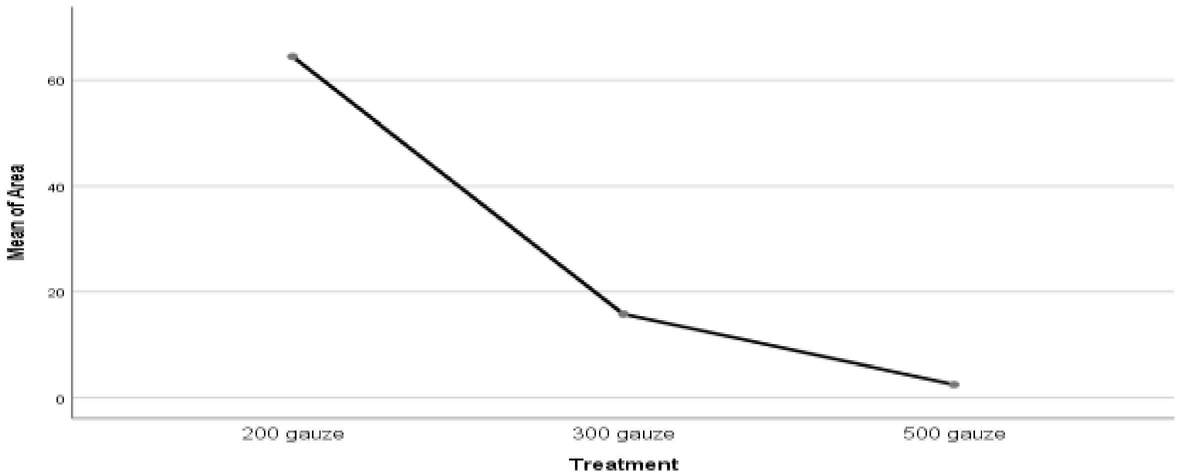

Fig. 5: Mean of Area of Plastics Consumed vs. Treatment in summer

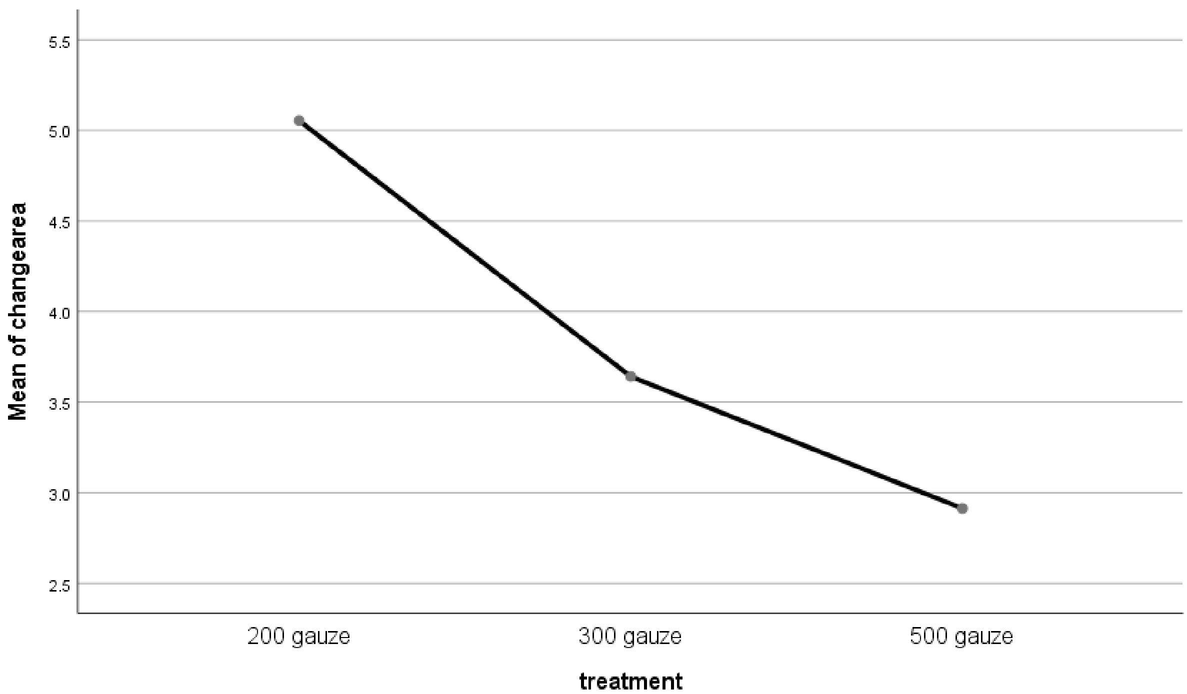

Fig. 6: Mean of Area of Plastics Consumed vs. Treatment in winter

Table 1: Effect of Treatment in Change in Weight and Area in winter and summer

Treatment	Change in Weight		Change in Area	
	In winter	**summer**	**In winter**	**In summer**
T1	0.31±0.005	3.45±0.019	5.05±55.976	64.47±2218.793
T2	0.27±0.005	0.87±0.019	3.95±55.976	15.79±2218.793
T3	0.17±0.005	0.6±0.019	2.97±55.976	2.52±2218.793
T4	.09567±0.005	.398373±0.019		
p-value	*	*	*	*

*Significance of the different treatments at the 0.05 level of significance.

Change in area of plastics in winter:

From the analysis of Variance, we found that treatment has significant difference on area of plastics consumed. (F= 6.138; df= 2; Significant Value: 0.002). During the research period of 30 days in winter, the mean of area of plastics consumed was found to be 5.05 mm², 3.59 mm² & 2.87 mm² per day respectively as shown in the Table 1 & Fig. 6.

Discussion

Our research pointed out that higher rate of feeding is observed in summer season and lower in winter season and mortality and cannibalism is also higher among larva during the summer than in winter. The peak infestation was observed in the hot periods as reported in the literatures.[18][19] The most commonly used polyethylene plastic bags (black bin liners), typically sold in stores, commercial and domestic kitchen purposes are between gauzes of 100 and 200. Since the higher rate of feeding was also observed in the 200 gauze of plastic, the use of wax moth larva for its management can be recommended.

In our research change in weight in T1, T2 & T3 was not significantly different, change in weight of rest of the treatments with respect to the change in weight of T4 was found significantly different. It doesn't mean the holes made on all gauzes of plastics were of similar sizes. It's because even a smaller hole or scrubbing on the plastic of larger gauze causes a significant change in weight of that plastic. However, a bigger hole is required for a significant change in weight in case of plastic of smaller gauze. If we see the rate of consumption in the first day of experiment, 10 larvae in 200 gauze of plastic were found to consume 8.4 mg in 24 hours. Similar research conducted by scientists found that 92 mg of plastic degraded by 100 worms in 12 hours. But during the total experimentation period of 30 days, the mean plastic consumption by 10 larvae in 200, 300, 500 gauzes of plastic was found to be 3.41mg, 0.8mg, and 0.6 mg per day respectively. This might be because of decreasing plastic feeding potential of the larva when used continuously for several days.

Conclusion

Hence, from the research, it was concluded that rate of plastic feeding was significantly higher in summer than in winter. Change in area for 200 gauze of plastic was significantly higher than 300 & 500 gauze i.e. area of plastics consumed by the larva decreases with increase in gauze of the plastic. But the rate of change in weight was similar for three gauzes of plastics. Consumption in winter season is relatively lower than the summer season. Inside the closed environment, in appropriate temperature and life stage of larva, it seems good to use these larvae in order to make them feed upon the plastic refuses. However, the further research is preferred because they may be churning these wastes and digesting through some sophisticated mechanisms inside their gut. So, if we are able to know that mechanism and create such type of environment artificially it could lead us to the way out of this plastic ruins.

Authors' Contribution

All authors contributed equally in all stages of research work and manuscript preparation. Final form of manuscript is approved by all of them.

Conflict of Interest

The author declares that there is no conflict of interest with present publication.

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