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Impact of Abiotic Factors on the Foraging Activity of the Major Insect Pollinators on Mango in Tarai Region of Uttarakhand

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Abstract: *Environment plays an important role in pollinator's activity. Flight activity in* A. mellifera *was significantly influenced by temperature, relative humidity and sunshine. Maximum temperature exerted a significant positive correlation with the foraging activity of* A. dorsata, A. mellifera *and* A. c. indica *which indicate that maximum temperature fell within the optimal range (21.0 to 33.5°C) for their activity. However, minimum temperature exerted significant positive correlation with the activity of only* A. dorsata *and* A. c. indica. *It reveals that the* A. dorsata *and* A. c. indica *are able to forage with optimal range of maximum and minimum remperature. It was also observed that maximum temperature exerted significant negative correlation with the foraging activity of syrphids and non apis bees, means their activity is decreased with increasing temperature. Although, rain fall exerted significant negative correlation with all foragers showed their activity is decreased during rainy day.*

Key Words: *A. dorsata, A. mellifera, A. c. indica, syrphids and non apis bees etc.*

INTRODUCTION

Several Agricultural and horticultural crops are needed pollinating agent, like insects, birds, wind etc. Among pollinating insects, syrphids, honey bees and non apis bees have proved as boon for efficient and effective pollination in most of the crops. They are affected directly or indirectly by the environment around them. Among different aspects the environment plays an important role in pollinator's activity. Flight activity in *A. mellifera* was significantly influenced by temperature, relative humidity and sunshine. Reduced activity of pollinators due to low temperature during flowering contributed to the formation of 5.44 percent parthenocarpic seedless fruits in mango **(Thimmapaiah and Singh, 1983).**

The low light intensity and low temperature probably discouraged foraging **(Tanda, 1984). Khader (1989)** also observed in mango fruit setting of a cluster of abnormal seedless at the tip of the panicle called "JHUMKA" in Lucknow area. Most of these fruits contained aborted and shriveled embryos and dropped in less than two weeks. Failure of pollination due to adverse climatic conditions in February-March was considered as a major factor responsible for this. **Pande *et al.* (1991)** noticed that the foraging activities of honeybees were maximum at higher atmospheric temperature and low relative humidity.

Abrol (1992) and Corbet *et al.* (1993) indicated that several environmental factors viz., temperature, humidity, light, solar radiation, time of the day and nectar flow regulate flight activity of bees. Initiation of flight was influenced by dual threshold of temperature and light intensity and cessation was controlled by reduction of light intensity for bee

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species. Bee visitation was more intensive during late morning than early afternoon. Strength of wind was the most important factor in determining honeybee visitation. The number of pollinators/ panicle/minute increased as the average temperature increased to 19.5° C but decreased with further increase in temperature and with rains **(Singh *et al.*, 1997)**. **Singh and Devi (1998)** worked out a positive correlation of initiation and cessation of foraging activity with temperature whereas, relative humidity had positive correlation with cessation of foraging in *A. cerana.* According to **Abrol (1998)** the activity of both bees species, *A. cerana* and *A. mellifera* was negatively correlated with relative humidity and positively with light intensity, solar radiation, nectar sugar concentration and temperature. Ambient temperature and light intensity affected flight activity positively and relative humidity negatively. The meteorological factors were responsible for 33.5 per cent of variation in number of bees leaving the hive and 27 per cent of the variation in bees returning to hive in *A. mellifera.* **Abrol (2000)** observed that the diurnal activity showed significant negative correlation with temperature and significant positive correlation with humidity. Among different aspects, the environment plays very important role in bee foraging. Flight activity in case of *A. mellifera* was significantly influenced by temperature, relative humidity and sunshine. Foraging was also affected by wind speed, which varied from 0.2 to 22.89 km/ h than by air temperature and relative humidity. Keeping in view the importance of insect pollinators, a comprehensive study was undertaken to determine impact of abiotic factors on the foraging activity of the major insect pollinators

MATERIAL AND METHODS

The visitation of insect pollinators were observed visually during the blooming period to record the influence of abiotic factors on the forager's activity. The data on Temperature, Relative Humidity and Rain fall were obtained from the Department of Agrometerology and were correlated with the insect pollinators activity. The experiments were conducted at Horticulture Research Center, Pattharchatta and Apiary, Department of Entomology, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar, Uttarakhand, for two years 2011 and 2012.

RESULTS AND DISCUSSION

The abundance of different insect pollinators/ visitors was correlated with weather parameters such as Maximum and Minimum temperature, Relative humidity and total rainfall and result have been presented in the table 1 – 4 and Fig 2 & 3. It was apparent that when all the weather factors acted together, exerted their influence differently on different foragers during the year 2011 and 2012. The multiple correlation coefficient (r) against maximum temperature (21.0-33.5^{o}C), minimum temperature (7.9-20.0^{o}C), % relative humidity I hour (73-91%), II hour (22-60%) and total rainfall (00.0-9.2 mm.) was computed to be-for -0.064*, -0.055, 0.823, -0.040 and -0.442*, respectively for Syrphid flies, 0.239*, 0.190*, 0.513, -0.271 and -0.265* for *A. dorsata,* 0.240*, 0.282*, 0.468, -0.410 and -0.153* for *A. mellifera*, 0.035*, 0.024*, 0.649, -0.025 and -0.364* for *A. cerana indica* and -0.456*, -0.386, 0.977, 0.311 and -0.574* for Non apis bees (Table 1) during the year 2011.

Observations revealed that maximum temperature exerted a significant positive correlation with the foraging activity of *A. dorsata, A. mellifera* and *A. c. indica* which indicate that maximum temperature fell within the optimal range (21.0 to 33.5^{o}C) for their activity. However, minimum temperature exerted significant positive correlation with the activity of only *A. dorsata* and *A. c. indica*. It reveals that the *A. dorsata* and *A. c. indica* are able to forage with optimal range of maximum and minimum remperature. It was also observed that maximum temperature exerted significant negative correlation with the foraging activity of syrphids and non apis bees, means their activity is decreased with increasing temperature. Although, rain fall exerted significant negative correlation with all foragers showed their activity is decreased during rainy day. While, relative humidity showed no significant effect for any foragers.

The combined effects of all the parameters had been summarized in Table 2. It was apparent that when all the weather factors acted together, exerted

their influence differently on different foragers. The coefficient of determination (R^2) was computed to be 0.004, 0.057, 0.058, 0.001 and 0.208 against Syrphid flies, *A. dorsata*, *A. mellifera*, *A. c. indica* and Non apis bees controlling 0.40, 5.70, 5.80, 0.10 and 20.80 per cent visitors foraging activity alone, respectively.

Similarly, from the Table 3 the impact of weather variables significantly affected the visitation intensities of the honeybee, *A. mellifera*, *A. dorsata*, *A. cerana indica,* Non- Apis Bees and Syrphid flies during the blooming period of the mango in the year 2012. The multiple correlation

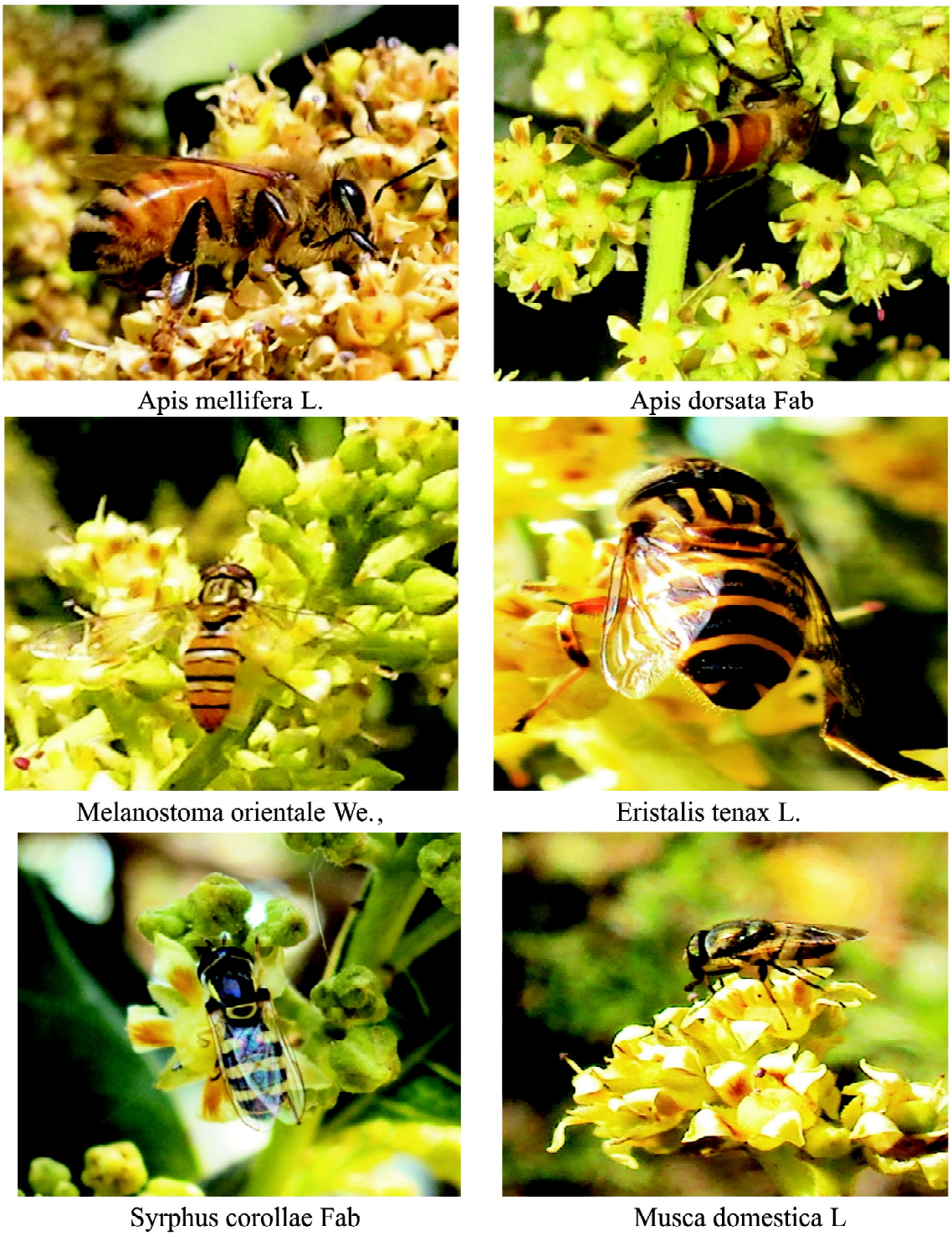

Figure 1: Major insects pollinator visiting on mango flowers during blooming period

coefficient (r) against maximum temperature (27.5-35.7°C), minimum temperature (11.0-18.7°C), % relative humidity I hour (72-90%), II hour (30-49%) and total rainfall (00.0-007.4mm) was computed to be:-0.288*, -0.477, 0.711, 0.092 and -0.412* for Syrphid flies, 0.326*, 0.151*, 0.238, -0.131 and -0.451* for *A. dorsata*, -0.057*, -0.197, 0.591, -0.149 and -0.304* for *A. mellifera*, 0.195*, 0.0004*, 0.328, -0.114 and -0.466* for *A. cerana indica,* -0.074*, -0.243, 0.596, 0.080 and -0.362* for Non apis bees.

Results revealed that maximum temperature exerted a significant positive correlation with the foraging activity of *A. dorsata* and *A. c. indica* which indicate that maximum temperature fell within the optimal range (27.5 to 35.7°C) for their activity. However, minimum temperature exerted significant positive correlation with the activity of only *A. dorsata* and *A. c. indica*. It reveals that the *A. dorsata* and *A. c. indica* are able to forage with optimal range of maximum and minimum temperature. It was also observed that maximum temperature exerted significant negative correlation with the foraging activity of syrphids, *A. mellifera* and non apis bees, means their activity is decreased with increasing temperature. Although, rain fall exerted significant negative correlation with all foragers showed their activity is decreased during rainy day. While, relative humidity showed no significant effect for any foragers. Similarly **Pande *et al.* (1991)** noticed that the foraging activities of honeybees were maximum at higher atmosphere temperature and low relative humidity. The above findings were supported by the experimental findings of **Singh *et al.* (1997)** who reported that the number of pollinators/panicle/minute increased as the average temperature increased to 19.5° C but decreased with further increase in temperature and with rains.

Table 1
Correlation co-efficient matrix (r) between insect pollinators on mango and weather parameters during the year 2011

Weather parameter	*Insect pollinators (r)*				
	Y_1	Y_2	Y_3	Y_4	Y_5
X_1	-0.064*	0.239*	0.240*	0.035*	-0.456*
X_2	-0.055	0.190*	0.282*	0.024*	-0.386
X_3	0.823	0.513	0.468	0.649	0.977
X_4	-0.040	-0.271	-0.410	-0.025	0.311
X_5	-0.442*	-0.265*	-0.153*	-0.364*	-0.574*

X1 - Maximum Temperature °C X2 - Minimum Temperature °C X3 - % Relative Humidity I hr.
X4 - % Relative Humidity II hr. X5 - Total rainfall (mm)
Y1 - Syrphid flies Y2 - *Apis dorsata* Y3 - *Apis mellifera*
Y4 - *Apis cerana indica* Y5 - Non apis bees

Table 2
Multiple regression equation between dependent and independent variables during the year 2011

Insect pollinators visited	*Multiple equation*	*Coefficient of determination (R^2)*
Y_1	29.585 - 0.039X1 - 0.031X2 + 0.939X3 - 0.686X4 - 0.222X5	0.004*
Y_2	28.354 + 0.371X1 + 0.275X2 + 1.496X3 - 1.174X4 - 0.341X5	0.057*
Y_3	27.618 + 0.134X1 + 0.146X2 + 0.492X3 - 0.638X4 - 0.071X5	0.058
Y_4	29.145+0.147X1+0.095X2+4.992X3-0.289X4-1.236X5	0.001
Y_5	33.374-1.646X1-1.297X2+6.619X3+3.116X4-1.713X5	0.208*

X1 - Maximum Temperature °C X2 - Minimum Temperature °C X3 - % Relative Humidity I hr.
X4 - % Relative Humidity II hr. X5 - Total rainfall (mm)
Y1 - Syrphid flies Y2 - *Apis dorsata* Y3 - *Apis mellifera*
Y4 - *Apis cerana indica* Y5 - Non apis bees

The combined effects of all the parameters had been summarized in Table 4. It was apparent that when all the weather factors acted together, exerted their influence differently on different foragers. The coefficient of determination (R^2) was computed to be 0.083, 0.106, 0.003, 0.038 and 0.005 against Syrphid flies, *Apis dorsata*, *Apis mellifera*, *Apis cerana indica* and Non apis bees controlling 8.30, 10.60, 0.30, 3.80 and 0.50 per cent visitors foraging activity alone, respectively.

Table 3
Correlation co-efficient matrix (r) between insect pollinators on mango and weather parameters during the year 2012

Weather parameter	*Insect pollinators (r)*				
	Y_1	Y_2	Y_3	Y_4	Y_5
X_1	-0.288*	0.326*	-0.057*	0.195*	-0.074*
X_2	-0.477	0.151*	-0.197	0.0004*	-0.243
X_3	0.711	0.238	0.591	0.328	0.596
X_4	0.092	-0.131	0.149	-0.114	0.080
X_5	-0.412*	-0.451*	-0.304*	-0.466*	-0.362*

X1 - Maximum Temperature °C X2 - Minimum Temperature °C X3 - % Relative Humidity I hr.
X4 - % Relative Humidity II hr. X5 - Total rainfall (mm)
Y1 - Syrphid flies Y2 - *Apis dorsata* Y3 - *Apis mellifera*
Y4 - *Apis cerana indica* Y5 - Non apis bees

Table 4
Multiple regression equation between dependent and independent variables during the year 2012

Insect pollinators visited	*Multiple equation*	*Coefficient of determination (R^2)*
Y_1	33.302-0.097X1-0.161X2+0.566X3+0.070X4-0.139X5	0.083*
Y_2	31.343+0.563X1+0.262X2+0.973X3-0.518X4-0.781X5	0.106*
Y_3	32.535-0.027X1-0.094X2+0.665X3+0.162X4-0.145X5	0.003
Y_4	31.870+0.772X1-0.001X2+3.061X3-1.027X4-1.846X5	0.038
Y_5	32.554-0.184X1-0.601X2+3.478X3+0.450X4-0.897X5	0.005*

X1 - Maximum Temperature °C X2 - Minimum Temperature °C X3 - % Relative Humidity I hr.
X4 - % Relative Humidity II hr. X5 - Total rainfall (mm)
Y1 - Syrphid flies Y2 - *Apis dorsata* Y3 - *Apis mellifera*
Y4 - *Apis cerana indica* Y5 - Non apis bees

CONCLUSION

Observations revealed that maximum temperature exerted a significant positive correlation with the foraging activity of *A. dorsata, A. mellifera* and *A. c. indica* which indicate that maximum temperature fell within the optimal range (21.0 to 33.5°C) for their activity. However, minimum temperature exerted significant positive correlation with the activity of only *A. dorsata* and *A. c. indica*. It reveals that the *A. dorsata* and *A. c. indica* are able to forage with optimal range of maximum and minimum remperature. It was also observed that maximum temperature exerted significant negative correlation with the foraging activity of syrphids and non apis bees, means their activity is decreased with increasing temperature. Although, rain fall exerted significant negative correlation with all foragers showed their activity is decreased during rainy day. While, relative humidity showed no significant effect for any foragers.

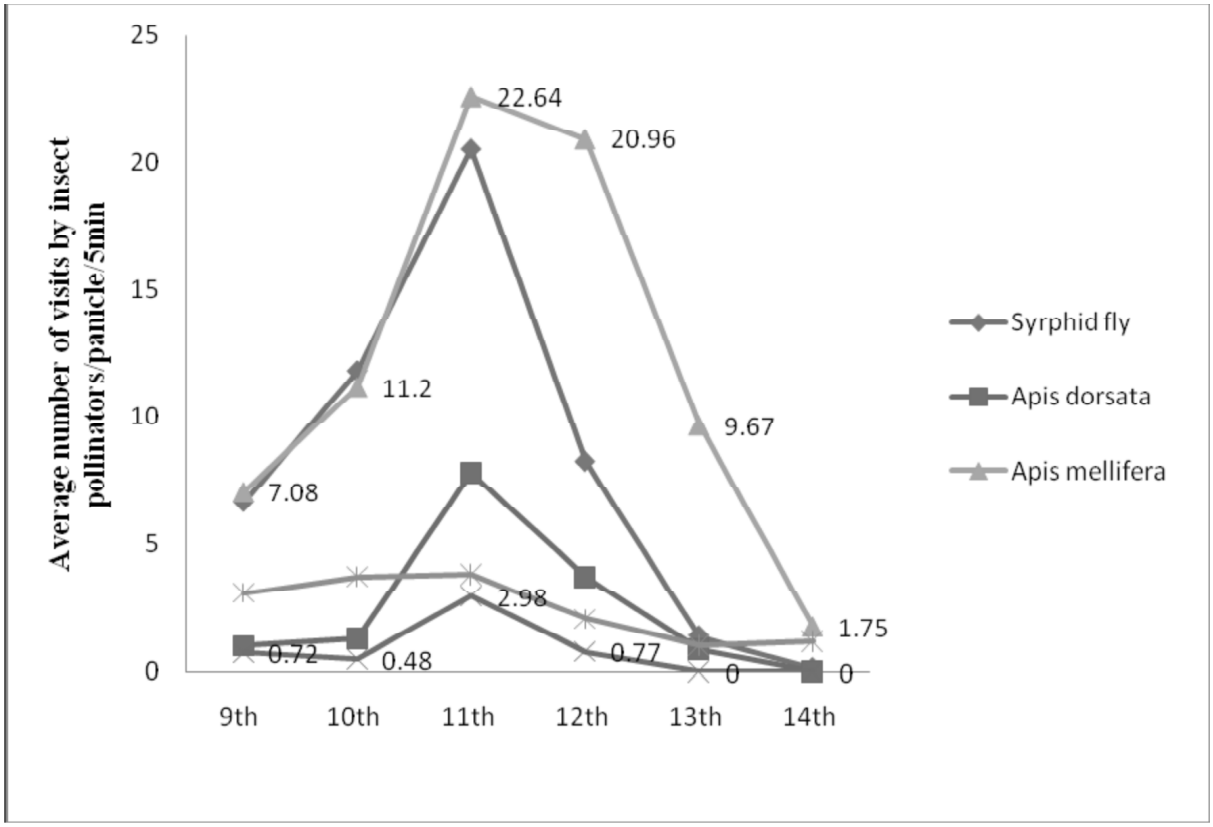

Figure 2: Influence of weather parameters on foraging behaviour of insect pollinators during the year 2011

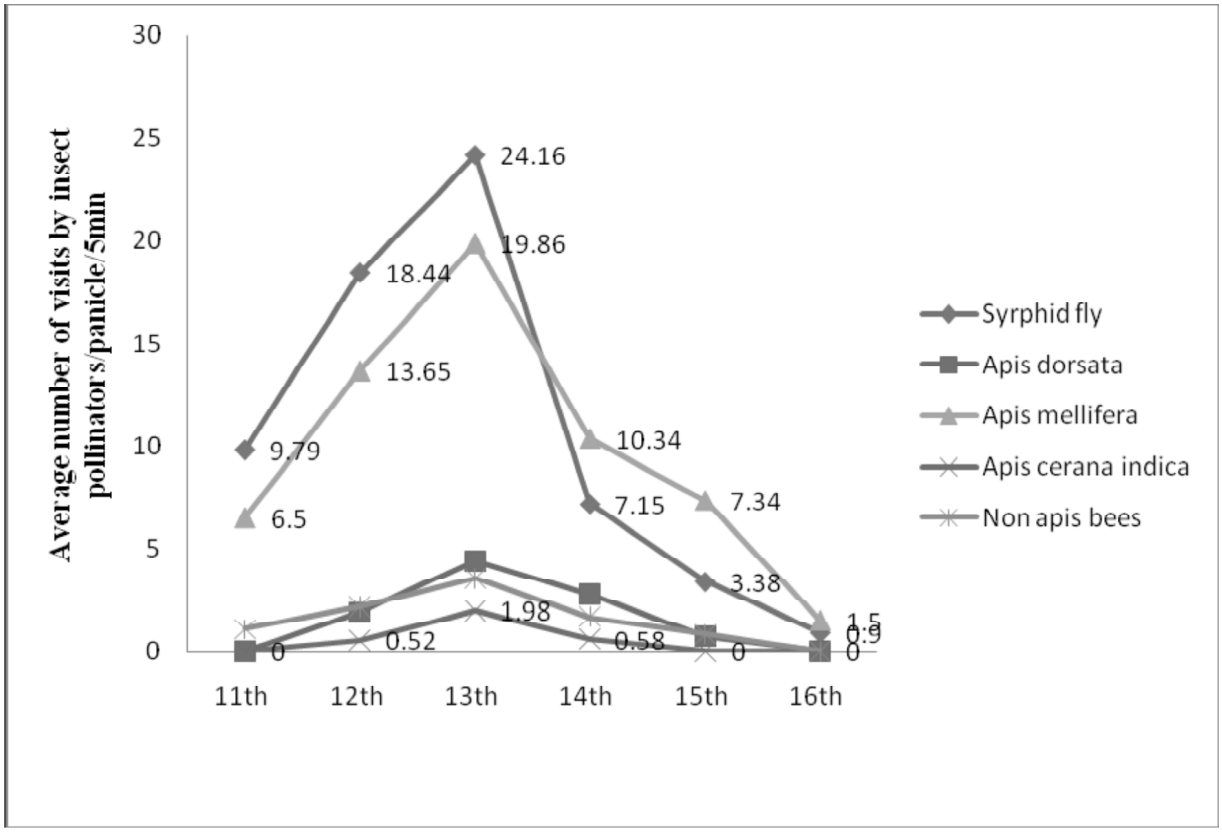

Figure 3: Influence of weather parameters on foraging behaviour of insect pollinators during the year 2012

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