Effect of thiamethoxam on foraging activity and mortality of *Apis mellifera* (L.)

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**ABSTRACT**

Thiamethoxam, a neonicotinoid commonly used for its high selective toxicity to insects, is one of the most commonly used pesticides. However, its effect on beneficial insects such as the honeybee *Apis mellifera* L is still controversial. As young adult workers perform out-hive duties that are crucial for colony development and survival, the effect of sublethal doses of thiamethoxam on honeybee foraging activity and mortality was assessed. Thiamethoxam had a negative impact on foraging activity and cause mortality of honey bees for a period of three to four days following the spraying in field condition.

**Key words:** Foraging activity, Honey bee, Mortality, Neonicotinoid, Thiamethoxam.

**INTRODUCTION**

Pollinators play a crucial role in environment by providing vital ecosystem services. In particular, the honey bee, *Apis mellifera* L., is a key worldwide pollinator of crops and native plants (Klein et al., 2007). The decline of managed honey bee colonies has therefore outstretched concern about ecological influences, crop production, food security and human welfare (Potts et al., 2010). Multiple factors comprising disease and pesticides are responsible for poor honey bee health (Sanchez-Bayo et al., 2016). Among pesticides, attention has focused on the neonicotinoids (Stokstad, 2012) a group of neurotoxic insecticides that are globally used on multiple crops for the management of sucking pest (Simon-Delso et al., 2014). Neonicotinoids are environmentally persistent and systemic *i.e* they can be translocated throughout the plant and present in all plant parts including nectar, pollen, and guttation droplets that bees collect (Bonmatin et al., 2014; Godfray et al., 2015). Moreover, exposure to even low concentrations of neonicotinoids can harm bee health via synergistic interactions between multiple stressors (Sanchez-Bayo et al., 2016; Godfray et al., 2015; Pisa et al., 2014).

Thiamethoxam, a systemic neonicotinoid has been widely used for the management of sucking pests such as aphids in mustard crop throughout the world. Being systemic in action, it can remain in the plant parts for several days and affects the insect visitors including honey bees and other pollinators. The current investigation was carried out in order to find out whether thiamethoxam had a negative impact on foraging activity and mortality of *Apis mellifera* at field relevant dose or not.

**MATERIALS AND METHODS**

The experiment was conducted at G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). In order to assess the effect of thiamethoxam on foraging activity and mortality of *Apis mellifera* mustard crop was taken. Small healthy queen-right colony containing approximately 3000-5000 bees and at least three full frames containing all brood stages was used. There were about 6 number of plots (size 40 m²), three of which are treated with thiamethoxam and rest three are considered as control for assessing the foraging activity. Similarly there were about 6 number of hives, three of which were kept near (within 100 meter) the treated field and considered as three replications. Rest three colonies were kept two kilometer away from the field and were considered as control colonies for assessing the mortality. Thiamethoxam 25 % WG was applied at the recommended dose *i.e* @ 100 g per hectare with the help of knapsack sprayer at the time of 50 % flowering on 25*th* February 2017. The observations were recorded during the peak flowering period *i.e*. from last week of February to last week of March, 2017. Foraging activity was recorded 3 times each day (at peak foraging times, e.g. morning, early afternoon and late afternoon) for a period of two minutes through visual observations. It was assessed by counting number of bees visited to m² area of treated and untreated crop at least one day prior to application and after application on days 1, 2, 3, 5, 7. Mortality of bees was recorded one day prior to application and after application on days 1, 2, 3, 5, 7 and 7. Mortality was recorded by counting the number of dead bees in front of the hive as well as inside the hive. Dead bee in the field are also counted Simultaneously data was recorded on control colonies. The computation of

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Table 1: Effect of thiamethoxam on foraging activity and mortality of *Apis mellifera* L.

| Date of observation | Mortality (Number of bees dead) | Foraging activity (Number of bees that visited the field) |
|---------------------|---------------------------------|-------------------------------------------------------|
|                     | Thiamethoxam | Control | Thiamethoxam | Control |
| 24.02.2017          | 0.00          | 0.33    | 12.66        | 14.00    |
|                     | (0.00)        | (0.33)  | (3.55)       | (3.73)   |
| 26.02.2017          | 12.33         | 1.33    | 4.66         | 12.00    |
|                     | (3.48)        | (0.91)  | (2.15)       | (3.45)   |
| 27.02.2017          | 7.33          | 1.33    | 6.00         | 14.66    |
|                     | (2.70)        | (1.13)  | (2.42)       | (3.82)   |
| 28.02.2017          | 5.00          | 0.33    | 7.00         | 14.33    |
|                     | (2.22)        | (0.33)  | (2.64)       | (3.77)   |
| 02.03.2017          | 3.66          | 1.00    | 7.33         | 17.00    |
|                     | (1.91)        | (1.00)  | (2.69)       | (4.12)   |
| 04.03.2017          | 2.33          | 0.00    | 8.66         | 15.66    |
|                     | (1.52)        | (0.00)  | (2.93)       | (3.95)   |
| GM                  | 1.97          | 0.61    | 2.73         | 3.81     |
| SEM                 | 0.15          | 0.25    | 0.16         | 0.12     |
| CD                  | 0.47          | 0.81*   | 0.52         | 0.40     |
| CV                  | 13.20*        | 72.00** | 10.63*       | 5.82**   |

*Data presented in parentheses are square root transformed values.*

### RESULTS AND DISCUSSION

#### Effect on foraging activity: The mean number of forager bees and dead bees recorded one day before the application of thiamethoxam and 1, 2, 3, 5, 7 day after the application of thiamethoxam in treated and control fields are embodied in Table 1. One observation was recorded before the application of thiamethoxam where the number of forager bees in field to be treated was found to be 12.66 while in control fields the number was 14.00. Second, third, fourth and fifth observations were made on 1, 2, 3, 5 days after the application of chemical where 4.66, 6.00, 7.00 and 7.33 forager bees were noticed in treated field while 12.00, 14.66, 14.33 and 17.00 numbers of forager bees were noticed in the control fields. Sixth and last observation was recorded after seven day after of application where 8.66 numbers of forager bees were noticed in the treated field while 15.66 forager bees were noticed in the control fields.

#### Effect on mortality: The mean number of dead bees recorded one day before the application of thiamethoxam and 1, 2, 3, 5, 7 days after the application of thiamethoxam where the number of dead bees in colonies exposed to the field to be treated was found to be 0.00 while in control colonies the number was 0.33. 12.33, 7.33, 5.00, 3.66 numbers of dead bees were noticed in the colonies exposed to treated field and 1.33, 1.33, 1.00 numbers of dead bees were noticed in the control colonies at 1, 2, 3 and 5 days after the application of thiamethoxam. Sixth and last observation was recorded after seven day after of application where 2.33 numbers of dead bees was noticed in the colonies exposed to treated field and no dead bees were noticed in the control colonies. It was noticed that the number of dead bees were considered to be high in all hives that were exposed to treated field and low in control hives throughout the period of the experiment. From this experiment it was found that thiamethoxam had a negative impact on foraging activity of *Apis mellifera* for a period of three to four days following the spraying in field condition. Similar type of results were observed by Tremolada et al. (2010) where the number of foraging bees is significantly lower in the neonicotinoid (thiamethoxam in particular) treated field as compared to untreated field. On the contrary, Pilling et al. (2013) reported that on an average, the foraging activity of *Apis mellifera* was similar between thiamethoxam treated and control field. It was also found that mortality of bees in colonies placed on treated mustard field was significantly higher for a period of one to four days after spraying. Similar results are found by Henry et al. (2012) where non-lethal exposure of honeybees to thiamethoxam (neonicotinoid systemic pesticide) caused high mortality due to homing failure behavior that could put a colony at risk of collapse.

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