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Effect of thiamethoxam on brood and capped cell area of *Apis mellifera* L.

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Abstract
The present study was carried out at Govind Ballabh Pant University of Agriculture and Technology Pantnagar. Genus *Apis* is the most studied because of their fascinating and complex lifestyle, communication systems, role as keystone and the valuable hive products that they produce. Recently a sharp decline in population of *Apis mellifera* has been observed throughout the World. Among the various factors, the major one is the use of different classes of pesticides, neonicotinoids in particular. Thiamethoxam, a neonicotinoids, is widely used against sucking pest in various crops inluding mustard to which honey bees are attract largely. The present study try find out the possible effect of thiamethoxam on growth, development of *Apis mellifera* colony. The risk to honey bee colonies in the field was investigated by exposing the colonies to thiamethoxam treated mustard crop at rates recommended for insect control. Throughout the study, brood and capped cell area were found to be lower in colonies exposed to thiamethoxam treated fields as compare to control condition.

Keywords: honey bee, thiamethoxam, brood cell, capped cell

Introduction
Genus *Apis* play a crucial role both ecologically and economically by pollinating wild plants and variety of crops around the world (Gallai *et al*., 2009) [1]. However numerous studies have reported a weakening in honey bee population and numbers of colonies in recent years throughout the world (van Engelsdorp *et al*., 2007; Potts *et al*., 2010) [2, 3]. Bee keepers in many countries have stated a decline in the capability of colonies to effectively survive the winter, while others report the sudden vanishing of all but a few bees, with just the young and the queen remaining (van Engelsdorp *et al*., 2008; Spivak *et al*., 2011) [4, 5]. Many factors may have contributed to this decline in health, for example the spread of parasites and pathogens (Alaux *et al*., 2010) [6], decrease in available forage (Decoutye *et al*., 2010) [8], beekeeping management practices (for example, parasitic mite *Varroa destructor* management and the development of resistance to treatments), migratory bee keeping, weather and climate change (Kluser *et al*., 2011) [9]. Exposure to certain pesticides is also another factor that has been involved in bee health decline (Mullin *et al*., 2010) [10]. In particular, the application of neonicotinoid insecticides in crops where bees forage has been reported as a potentially contributing factor (Greatti *et al*., 2002; Girolami *et al*., 2009) [11, 12]. Among neonicotinoids thiamethoxam is widely used for the management of sucking pest such as aphid in mustard crops, a principal pollen and nectar provide crop for *Apis mellifera*. Being systemic in action these compound exert toxic effect on honeybees for a longer period of time. Uses of these toxic chemicals affect the foraging activity of *Apis mellifera* directly hence brood cell area, brood development, capped cell area and yield of mustard crop both in terms of quality and quantity indirectly.

Materials and Methods
The experiment was conducted at G. B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand). The observations were recorded during the peak flowering period i.e. from last week of February to last week of March, 2017. Semi field test involving cages having area of 40 m^2 were used. Small healthy queen-right colony per cage containing approximately 3000-5000 bees and at least three full frames containing all brood stages was used. The condition of the colonies such as brood cell and capped cell area was assessed on the day before introduction into the cage and on day 7, 14, 21 and 28 after spraying of thiamethoxam.

Results and Discussion

The average brood and capped cell area recorded in colonies placed on treated and control field at seven days interval are embodied in table 1. One observation was recorded before application of thiamethoxam. The bee colonies placed in the field to be treated had the brood and capped cell area of 124.66 cm^2 and 240.33 cm^2 while control colonies had average 122.66 cm^2 and 266.00 cm^2 respectively. Second observation was made seven days after the spraying on 4th march where 61.00 cm^2, 206.66 cm^2 and 230.66 cm^2, 383.33 cm^2 brood and capped cell area were noticed in colonies placed on treated fields and control colonies respectively. Third observation was recorded on 15 days of application on 11th march where brood and capped cell area of 17.33 cm^2 149.33 cm^2 were noticed in colonies placed on treated fields and of 272.00 cm^2 438.00 cm^2 in control colonies. Fourth observation was recorded on 21 day of application and it was noticed that both brood and capped cell area were confused with decline trend in colonies placed on treated field (4.00 cm^2, 56.00 cm^2). In contrary the control colonies was able to maintain increased brood and capped cell area (273.33 cm^2, 448.00 cm^2). Fifth and last observation was made on 25th march and it was noticed that brood cell area was increased slightly (11.33 cm^2) as compared to previous observation (4.00 cm^2) in colonies placed in treated field while capped cell area was again decreased to 31.33 cm^2. In contrary both brood and capped cell area were decreased in control colonies (228.00 cm^2, 388.66 cm^2) as compared to previous observation (273.33 cm^2, 448.00 cm^2). Throughout the study both pollen and nectar cell area were found to be decreased in colonies placed on thiamethoxam treated field whereas brood and capped cell area were found to be increase in case of colonies placed on control field. Similar types of results are observed by Sandrock *et al*. (2014) [14] who found that exposure of honeybee colonies to thiamethoxam and clothianidin resulted in significantly less pollen, nectar, brood and capped cell area and reduced honey production. On the contrary, Pilling *et al.* (2013) [13] reported that there was no effects on brood cell and capped cell area in colonies that are repeatedly exposed to thiamethoxam treated rape seed and mustard crops.

Table 1: Effect of thiamethoxam on brood cell and capped cell area of *Apis mellifera* L.

Date of observation		Mean brood cell area (cm^2)		Mean capped cell area (cm^2)	
		Thiamethoxam	Control	Thiamethoxam	Control
Before exposure	24.02.2017	124.66 (11.14)	122.66 (11.06)	240.33 (15.46)	266.00 (16.22)
During exposure	04.03.2017	61.00 (7.79)	230.66 (15.14)	206.66 (14.32)	383.33 (19.44)
	11.03.2017	17.33 (4.12)	272.00 (16.46)	149.33 (11.89)	438.00 (20.86)
	18.03.2017	4.00 (1.15)	273.33 (16.46)	56.00 (6.92)	448.00 (21.08)
After exposure	25.03.2017	11.33 (2.68)	228.00 (14.96)	31.33 (4.17)	388.66 (19.70)
GM		5.38	14.82	10.55	19.46
SEM		0.78	0.65	0.98	0.53
CD		2.55	2.14	3.22	1.73
CV		25.18[s]	7.70[s]	16.21[s]	4.73[s]

*Data presented in parentheses are square root transformed values √N+0.

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