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Effect of neonicotinoids *i.e.* imidacloprid 17.8% SL on foraging behaviour of honey bee on safflower (*Carthamus tinctorius* L.)

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Abstract
The Effect of Neonicotinoids on foraging behaviour of honey bees on safflower (*Carthamus tinctorius* L.) at Department of Agriculture Entomology, College of Agriculture, Parbhani during *Rabi* 2016-17. The Effect of imidacloprid 17.8% SL insecticides spraying at full dose and visit of honey bees initially low on 1st day after spraying (was in the range of 1.66 to 1.00 bees/m^2) followed by 5th day after spraying (was in the range of 1.66 to 2.00 bees/m^2). The visit of honey was initially high on 14th day after spraying and found at par (in the range of 3.33 to 4.00 bees/m^2) with honey bees observed before spraying of imidacloprid 17.8 SL followed by 10th day after spraying (in the range of 2.00 to 3.00 bees/m^2). The Effect of imidacloprid 17.8% SL spraying insecticides at half dose and visit of honey bees was initially high in before spraying of insecticides (5.66 to 7.33 bees/m^2) and initially low on 1st day after spraying (was in the range of 2.00 to 3.33 bees/m^2) followed by 5th day after spraying (was in the range of 2.33 to 3.00 bees/m^2). The visit of honey was initially high on 14th day after spraying and found at par (in the range of 5.00 to 5.33 bees/m^2) with honey bees observed before spraying of imidacloprid 17.8 SL followed by 10th day after spraying (in the range of 2.33 to 4.00 bees/m^2). However results revealed that the comparison of full dose and half dose of imidacloprid among which at half dose of imidacloprid has found to more visits of honey bees than the full dose of imidacloprid spraying on safflower.

Keywords: imidacloprid, honey bees, safflower, PBNS-12, nylon mosquito nets

Introduction
Safflower (*Carthamus tinctorius* L.) an oilseed crop is being a member of the family Compositae or Asteraceae. Carthamus is the latinized synonym of the Arabic word coartem, or gurtam, which refers to the color of the dye extracted from safflower flowers. Several Neonicotinoids, i.e. Imidacloprid, acetamiprid, thiomethoxide, however they show very strong toxicity to pollinating insects and in particular to the honey bee (*Apis mellifera* L.), causing also other effects which are seldom easily identifiable, such as behavioral disturbances, orientation difficulties and impairment of social activities (e.g. Guez *et al.* 2001; Bortolotti *et al.* 2003; Decourtye *et al.* 2004a; 2004b; Desneux *et al.* 2007; Hassani El *et al.* 2008; Maini *et al.* 2010) [5, 11, 12]. Several neonicotinoids i.e. Imidacloprid Assessment of chronic Sublethal effect of Imidacloprid on honey bee colonies supplemental pollen diet containing multiple brood cycle. (e.g. Galen P. Dively *et al*. 2015) [13].
The Neonicotinoids, a class of neurotoxic insecticides designed in the ’80s, are highly systemic with long-term persistence. They permanently bind to nicotinic receptors of acetylcholine, blocking them and consequently the passage of nerve impulses. Neonicotinoids are implicated in the decline of bee population. As agonists of nicotinic acetylcholine receptors, they disturb acetylcholine receptors signaling leading to neurotoxicity. Here we elucidated molecular effect at environmental realistic levels of three neonicotinoids and nicotine, and compared laboratory studies to field exposure with acetamiprid (e.g. Christen. V, Mittner. F, Fent. K 2016). In 2013-2014, India ranks second position in harvested area of safflower seed among the Asian Countries after Kazakhstan of 1,50,000 ha. Production of Safflower (Rabi) in India during 2014-2015 was 0.90 Lakh Tonns. (Anonymous, 2015-2016). In India, Productivity levels of Maharashtra and Karnataka states (2014-2015) accounts for 55 and 37% of total safflower area and production, respectively. The other safflower producing states are Andhra Pradesh, Orissa, Madhya Pradesh, Chhattisgarh and Bihar. Safflower production in India was mostly confined to rain-fed conditions during winter.

Materials and Methods

The present experiment was carried out in Rabi season of the year 2016-2017 at Department of Agricultural Entomology, College of Agriculture, VNMKV, Parbhani. The soil was uniform with heavy black cotton having good fertility and drainage. The safflower variety PBNS-12 was sown with spacing 45 x 10 cm dated on 25/10/2016. The study was made on the crop raised in 3.0 × 3.0 m plot in Rabi season of 2016-17. Insects other than honeybees that were visiting safflower were collected from 0600 hrs to 1800 hrs at one hour interval by using a standard insect collecting hand net. The role of honeybee species on yield parameters had ten treatments with three replications laid out in randomized complete block design with following treatments: T1: Spray with Imidacloprid 17.8 SL @ 2.24ml/10lit, T 2: Spray with Imidacloprid 17.8 SL @1.12ml/10lit, T 3: Spray with Acetamiprid 20 SP @2gm/10lit, T4: Spray with Acetamiprid 20 SP @1.2 gm/10lit, T5: Open pollination (OP), T6: Pollination without insects (PWI), T7: One A. florea Fab. Colony (1 AF), T8: Six framed A. mellifera Linn. Colony (6 FAM), T9: Sugar syrup spray 5% (SSS) and T10: Cinnamon sprays 10% (CS). Nylon mosquito nets having 6 X 6 m3 size (mesh 20 micron) was erected over the plots by using the bamboo sticks for treatment no. T6, T7 and T8. One colony of A. florea and six framed colony of A. mellifera were kept in T7 and T8 respectively. When 10 per cent of flowering was observed, the bee colonies was kept in the cages supplemented with water and 50 per cent sugar solution, which was replaced as and when required. The colonies were retained in the cages till the cessation of flowering and all the cages were also removed at the same time. The 10 per cent cinnamon spray solution was prepared by using 100 g of cinnamon in 1 lit of water and sugar syrup was sprayed at 5% concentration was sprayed at 10 per cent flowering. In the plots under pollination without insect treatments, no pollinating insects were allowed to enter inside the net. Insecticides were not applied during flowering period of the crop. Observations on bee activity were recorded from 10 per cent flowering to cessation of flowering of the crop. For recording observations, 1x1m-2 area randomly was demarcated by bamboo sticks in each plot and numbers of different species of honeybees visiting safflower per minutes were recorded from 06.00hrs to 18.00hrs at two hourly intervals. Such observations were recorded at every week at 1st, 7th, 14th and 21st days after 10 per cent flowering.

Results and Discussion

1. Effect of neonicotinoids *i.e.* Imidacloprid 17.8% SL spraying on honey bees: full dose on safflower

The data on the effect of Imidacloprid 17.8% S Lon honey bees population @ 5 ml/10 lit of water are presented in Table-1 and graphically depicted in Fig. 1

Table 1: Effect of Imidacloprid 17.8% SL Spraying on honey bees population at Full dose on safflower

S. No	Particulars	Honey bees species	Observation recorded in hours (mean)			SE(m)±	CD at 5 %
			8.00 hrs	10.00 hrs	16.00 hrs		
1	Before spraying	*A. Melifera*	4.66 (2.27)	6.66 (2.67)	5.00 (2.34)	0.91	2.33
		A. florea	4.00 (2.12)	6.00 (2.55)	4.66 (2.27)	0.45	1.76
		A. indica	4.66 (2.27)	6.33 (2.61)	4.66 (2.27)	0.19	0.75
2	1st Day After Spraying	*A. Melifera*	1.66 (1.47)	1.33 (1.35)	1.00 (1.22)	0.23	0.92
		A. florea	1.66 (1.47)	1.66 (1.47)	1.33 (1.35)	0.38	1.50
		A. indica	0.66 (1.02)	1.66 (1.47)	1.66 (1.47)	0.33	1.00
3	5th Day After Spraying	*A. Melifera*	1.66 (1.47)	2.00 (1.58)	1.33 (1.35)	0.33	1.30
		A. florea	1.33 (1.35)	2.33 (1.68)	1.66 (1.47)	0.38	1.50
		A. indica	1.33 (1.35)	2.00 (1.58)	2.00 (1.58)	0.50	1.99
4	10th Day After Spraying	*A. Melifera*	2.00 (1.58)	2.33 (1.68)	1.66 (1.47)	0.33	1.30
		A. florea	1.66 (1.47)	3.00 (1.87)	2.33 (1.68)	0.47	1.87
		A. indica	2.00 (1.58)	3.00 (1.87)	2.00 (1.58)	0.57	2.26
5	14th Day After Spraying	*A. Melifera*	3.33 (1.95)	3.33 (1.95)	4.33 (2.20)	0.38	1.50
		A. florea	3.00 (1.87)	4.00 (2.12)	3.66 (2.04)	0.50	1.52
		A. indica	1.33 (1.35)	2.33 (2.68)	3.33 (1.96)	0.42	1.46

*Figures in parentheses are $\sqrt{X + 0.5}$ transformed values

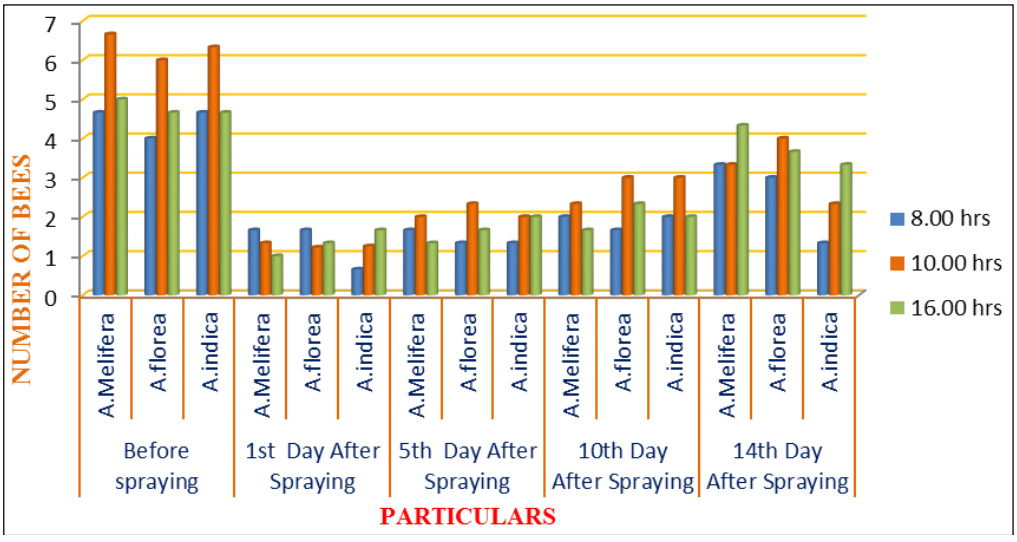

Fig 1: Effect of Neonicotinoids *i.e.* Imidacloprid 17.8% SL Spraying on honey bees at full dose

Effect of Imidacloprid on honey bees observed at 08, 10 and 16 hours at 1st, 5th, 10th and 14th day after spraying after treatment was presented in Table-1. The data revealed that visit of honey bees was initially high on experimental plot before spraying of insecticides and initially effect was low on 1st day after spraying (was in the range of 1.66 to 1.00 bees/m^2) followed by 5th day after spraying (was in the range of 1.66 to 2.00 bees/m^2). The visit of honey was initially high in 14th day after spraying and found (in the range of 3.33 to 4.00 bees/m^2) with honey bees observed before spraying of imidacloprid 17.8% SL followed by 10th day after spraying (in the range of 2.00 to 3.00 bees/m^2) bees population.

2. Effect of Neonicotinoids i.e. Imidacloprid 17.8% SL on honey bees population: Half dose on safflower

The data on the effect of Imidacloprid 17.8% SL spraying on honey bees population @ 2.25 ml/10 lit of water are presented in Table-2 and graphically depicted in Fig. 2.

Table 2: Effect of Imidacloprid 17.8% SL Spraying on honey bees at: half dose on safflower

S. No	Particulars	Honey bees species	Observation recorded in hours (mean)			SE (m) ±	CD at 5%
			8.00 hrs	10.00 hrs	16.00 hrs		
1	Before spraying	*A. Melifera*	5.66 (2.48)	7.33 (2.79)	5.66 (2.48)	0.76	2.42
		A. florea	4.33 (2.19)	6.33 (2.61)	6.00 (2.54)	0.60	1.92
		A. indica	5.66 (2.48)	6.66 (2.67)	5.33 (2.41)	0.19	0.75
2	1st Day After Spraying	*A. Melifera*	2.66 (1.77)	3.00 (1.87)	2.00 (1.58)	0.38	1.50
		A. florea	2.33 (1.68)	3.00 (1.87)	3.33 (1.95)	0.38	1.50
		A. indica	2.00 (1.58)	2.33 (1.68)	2.66 (1.77)	0.56	1.65
3	5th Day After Spraying	*A. Melifera*	2.00 (1.58)	1.33 (1.35)	2.33 (1.68)	0.50	1.52
		A. florea	2.33 (1.68)	3.33 (1.95)	2.66 (1.77)	0.50	1.99
		A. indica	2.33 (1.68)	3.66 (1.92)	3.00 (1.87)	0.47	1.84
4	10th Day After Spraying	*A. Melifera*	3.00 (1.87)	3.66 (2.03)	2.66 (1.77)	0.50	1.99
		A. florea	2.33 (1.68)	3.00 (1.87)	4.00 (2.12)	0.51	1.68
		A. indica	3.33 (1.95)	4.33 (2.19)	3.00 (1.87)	0.30	0.96
5	14th Day After Spraying	*A. Melifera*	3.00 (1.87)	2.66 (1.77)	3.66 (1.92)	0.45	1.28
		A. florea	4.00 (2.12)	4.33 (2.19)	4.66 (2.27)	0.33	1.30
		A. indica	5.00 (2.34)	5.33 (2.41)	5.00 (2.34)	0.38	1.50

*Figures in parentheses are $\sqrt{X+0.5}$ transformed values

Effect of Imidacloprid on honey bees observed at 08, 10 and 16 hours at 1st, 5th,10th and 14th day after spraying after treatment was presented in Table-2. The data revealed that visit of honey bees was initially high on before spraying of insecticides (5.66 to 7.33 bees/m^2) and initially low in 1st day after spraying (was in the range of 2.00 to 3.33 bees/m^2) followed by 5th day after spraying (was in the range of 2.33to 3.00 bees/m^2). The visit of honey was initially high on 14th day after spraying and found (in the range of 5.00 to 5.33 bees/m^2) with honey bees observed before spraying of imidacloprid 17.8% SL followed by 10th day after spraying (in the range of 2.33 to 4.00bees/m^2) honey bees population. However the comparison of full dose and half dose application of imidacloprid were presented and result revealed that at half dose application of imidacloprid shows more visits of honey bees population than the full dose of imidacloprid spraying on safflower crop.

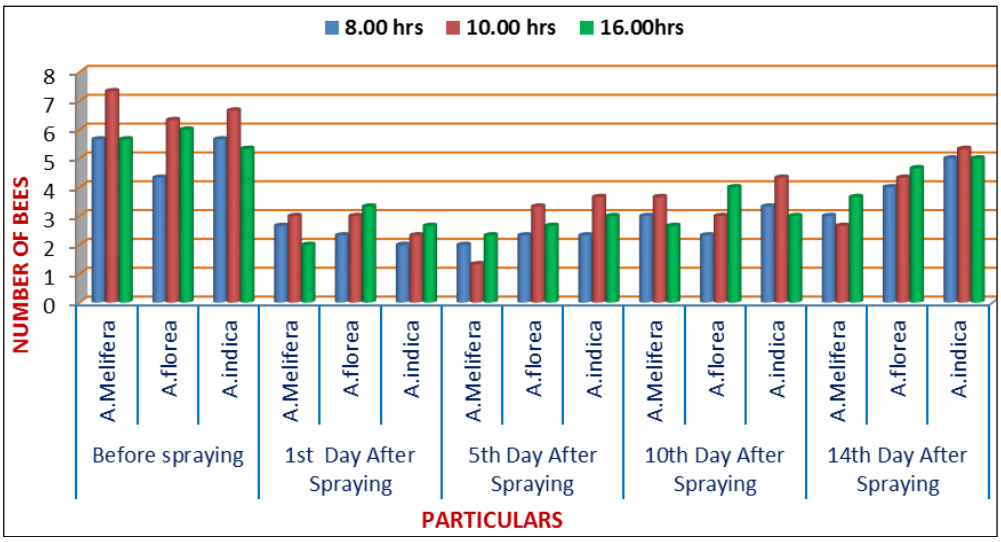

Fig 2: Effect of Neonicotinoids *i.e.* Imidacloprid 17.8% SL Spraying on honey bees at half dose

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