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Short Communication

Effect of different natural products and neonicotinoids on the foraging activity of bees on mustard

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Abstract

Different natural products, azadirachtin, and neonicotinoids were evaluated for their effect on the foraging activity of *Apis mellifera* on mustard (*Brassica juncea*). The first spray was given at 50 % flowering of the crop. The findings suggested that thiamethoxam 25 WG and imidacloprid 17.8 SL treatments experienced less bee visits after 1 day of spray. After 2nd and 3rd day of spray, minimum number of bees was recorded in thiamethoxam as compared to other treatments. After 3 days of spray, there was 58.8 per cent reduction in the number of bees per 5 flowers per 5 minutes in thiamethoxam treatment. On fourth day, normal bee activity was resumed in all the treatments except thiamethoxam treated plots. In imidacloprid seed treatment, there was minimum reduction in the number of bees over untreated check.

Key words: *Apis mellifera,* neonicotinoids, natural products, mustard

The family Brassicaceae includes about 3,500 species in around 350 genera and is one of the most economical plant families (Shahzadi *et al.* 2015). The species of the genus *Brassica* belonging to this family comprise diverse type of plants, grown as vegetables, fodder or source of oils and condiments. Oilseed Brassicas also known as rapeseed-mustard forms the major group of oilseed crops broadly including, Indian mustard (*Brassica juncea* L. Crenj.), toria (*B. rapa* var. *toria*), yellow sarson (*B. rapa* var. *yellow sarson*), brown sarson (*B. rapa* var. *brown sarson*) and gobhi sarson (*B. napus*), which are widely grown in the states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Gujarat, West Bengal, Bihar, Jharkhand, Punjab, Himachal Pradesh and Jammu and Kashmir. *B. juncea* is widely cultivated for both the seeds that produce a basic oil and condiment. It is a self-incompatible crop i.e., flowers cannot use their own pollen, demanding the use of biological agents such as various insect groups to transport pollen from male to female flowers (Roy and Mitra 2014). Honey bees have been regarded as the primary pollinators of Brassica crops; nevertheless, during the flowering time, a variety of other insects also visit this crop. The farmers use agrochemicals with a purpose to manage the pests; instead, they end up with killing the beneficial insects especially the pollinators. Honey bees and other pollinators get exposed to different toxic agrochemicals in nature and causing effects such as behavioral disturbances, orientation difficulties and impairment of social activities (El Hassani *et al*. 2008; Maini *et al.* 2010). Thus, minimizing the adverse effect of pesticide poisoning to pollinators is a burning topic of interest. Imidacloprid and thiamethoxam are approved for their use on mustard and are classified as highly toxic to honey bees. The hazards of insecticide application on blooming crops include direct mortality, sublethal and repellent effects and toxicity of the residues present in floral parts and nectar, which may deprive the flowers of pollination benefits (Desneux *et al*. 2007; Abrol and Kumar 2009). To reduce the use of harmful chemicals, natural products namely *Jeevamrit*, *Agniastra*, *Brahmastra* and *Tamar lassi* are being used to prevent insect pests in mustard. Since the honey bees regularly visit the blooming mustard crop, the impact of such natural products and

neonictonoids on foraging workers of honey bees is required to be evaluated.

An experiment was carried out during *rabi* 2020-21 to evaluate the effect of natural products, azadirachtin and neonicotinoids on *A. mellifera,* at the Research Farm of Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The mustard crop (Brown sarson var. KBS-3) was grown at a spacing of 30 x 15 cm in the plots (4x3 m) by following recommended agronomic practices. The experiment was laid out in randomized block design with 3 replications. For the studies, the blooming (50 %) mustard crop was sprayed with recommended dose of insecticides, biopesticides and natural products. In one of the treatments, imidacloprid 70WS @7 g/kg seed was used as seed treatment before sowing. Azadirachtin (@0.003%), *Agniastra* (@10%), *Brahmastra* (@10%), *Tamar lassi* (@10%), imidacloprid 17.8 SL (@0.0089%), thiamethoxam 25 WG (@0.0025%) were the other treatments. Foraging activity of bees was observed on mustard during peak activity period (10 AM to 1 PM) and expressed as mean number of bees visited per five flowers per five minutes. The observations were recorded a day before spray, day of spray and 1, 2, 3, 4, 5, 6, 7, 8 and 9 days after spray of insecticides. The values, after square root transformation were subjected to ANOVA (Analysis of variance) by using statistical analysis software programme. The results obtained are presented and discussed hereunder:

The data recorded on effect of insecticides and neonicotinoids on the foraging activity of honey bees visiting mustard flower are presented in Table 1. The majority of the honey bees visiting mustard constituted the population of *Apis cerana*. The data revealed that 1 day after spray there was marked reduction in the foraging activity among all the treatments except in untreated check and azadirachtin. On 2nd and 3rd day of spray the number of bees / 5 flowers / 5 minutes were minimum in thiamethoxam as compared to other treatments. The number of bees visiting mustard flowers increased in all the treatments

Table 1. Effect of different treatments on the activity of bees in mustard (Pooled data of 3 sprays)

	No. of bees / 5 flowers / 5 minutes										
Treatment	**DBS**	**1 DAS**	**2 DAS**	**3 DAS**	**4 DAS**	**5 DAS**	**6 DAS**	**7 DAS**	**8 DAS**	**9 DAS**	**Mean B**
Imidacloprid 70WS	6.17	5.50	5.67	5.67	6.00	5.67	6.17	6.17	6.83	7.00	6.08
(Seed treatment)	(2.68)	(2.55)	(2.58)	(2.58)	(2.65)	(2.58)	(2.68)	(2.68)	(2.80)	(2.83)	(2.66)
Imidacloprid 17.8	5.50	1.67	2.67	4.00	3.83	4.17	4.50	5.00	5.17	5.17	4.17
SL	(2.55)	(1.63)	(1.91)	(2.44)	(2.20)	(2.27)	(2.34)	(2.45)	(2.48)	(2.48)	(2.26)
Thiamethoxam 25	5.00	1.33	2.17	2.00	2.67	2.67	3.17	3.50	4.00	5.17	3.17
WG	(2.45)	(1.52)	(1.78)	(1.73)	(1.91)	(1.91)	(2.04)	(2.12)	(2.24)	(2.48)	(2.02)
Agniastra	5.00	2.50	3.33	3.00	3.33	3.67	4.00	4.17	4.50	4.67	3.82
	(2.45)	(1.87)	(2.08)	(2.00)	(2.08)	(2.16)	(2.24)	(2.27)	(2.34)	(2.38)	(2.19)
Brahmastra	5.33	2.50	3.00	3.00	3.50	4.17	5.00	4.67	5.17	5.17	4.15
	(2.51)	(1.87)	(2.00)	(2.00)	(2.12)	(2.27)	(2.45)	(2.38)	(2.48)	(2.48)	(2.26)
Tamar lassi	5.33	3.17	3.00	4.50	4.67	5.17	5.17	5.67	5.83	6.17	4.87
	(2.52)	(2.03)	(2.00)	(2.33)	(2.38)	(2.48)	(2.48)	(2.58)	(2.61)	(2.68)	(2.41)
Azadirachtin	4.83	3.67	3.83	4.17	4.17	4.50	5.17	5.17	5.00	5.00	4.55
	(2.41)	(2.16)	(2.20)	(2.27)	(2.27)	(2.34)	(2.48)	(2.48)	(2.45)	(2.45)	(2.35)
Untreated check	6.00	5.50	5.50	5.83	6.17	6.00	6.00	6.50	6.83	7.00	6.13
	(2.65)	(2.55)	(2.55)	(2.61)	(2.68)	(2.65)	(2.65)	(2.74)	(2.80)	(2.83)	(2.67)
Mean A	5.40	3.23	3.65	4.02	4.29	4.50	4.90	5.10	5.42	5.67	
	(2.53)	(2.02)	(2.14)	(2.22)	(2.29)	(2.33)	(2.42)	(2.46)	(2.53)	(2.58)	

Figures in parentheses are square root transformed values, DBS= Day before spray, DAS= Day after spray

Factors	**C.D. (P=0.05)**
Days (A)	0.21
Treatments (B)	0.18
Factor(A X B)	0.58

4 days onwards though the population remained minimum in thiamethoxam treatment. The average of 9 days observations revealed that there were minimum number of bees in thiamethoxam (3.17), *Agniastra* (3.82), both statistically at par followed by *Brahmastra* (4.15), imidacloprid spray (4.17), azadirachtin (4.55) and *Tamar lassi* (4.87) all being at par with each other. Thiamethoxam 25 WG and imidacloprid 17.8 SL both sustained minimum number of foraging bees upto three days. On fourth day, normal bee activity was resumed in case of all the treatments except thiamethoxam treated plots. The number of bees in imidacloprid seed treatment and untreated check remained statistically at par.

There was 70.9 % reduction in number of bees / 5 flowers/5 minutes over untreated check in thiamethoxam after 1 day of spray followed by imidacloprid (66.9 %), *Brahmastra* (48.8 %), *Agniastra* (45.5 %), *Tamar lassi* (35.1 %) and azadirachtin (17.4 %). In imidacloprid seed treatment there was minimum reduction (2.7%) in the number of bees over untreated check. There was 58.8 % reduction in the number of bees / 5 flowers / 5 minutes in thiamethoxam after 3 days of spray followed by 38.3 % each in *Agniastra* and *Brahmastra*. The per cent reduction in the number of bees over untreated check was 25.1, 11.1, 7.4 and 5.4% in imidacloprid spray, azadirachtin, *Tamar lassi* and imidacloprid seed treatment, respectively. Similar trend in the reduction of bees was observed on 5th day of spray, the maximum being in thiamethoxam (46.6 %) followed by *Agniastra* (26.6 %), imidacloprid (24.2 %) and *Brahmastra* (21.8 %). After 7 days of spray the per cent reduction in the number of bees was 35.4 % in thiamethoxam followed by *Agniastra* (23.0 %), *Brahmastra* (19.1 %), imidacloprid (16.1 %). In imidacloprid seed treatment the per cent reduction in number of bees was 7.7 % as compared to 1.8 and 1.2 % in *Tamar lassi* and azadirachtin, respectively.

The present findings are in conformity with the results of earlier workers (Nauman *et al. 1*994; Sonatakke and Dash 1996; Elzen *et al.* 2004; Kumar *et al.* 2010) who observed that azadirachtin did not deter the honey bees in the field. Shneider *et al.* (2012) also reported significant reduction in foraging activity of *A. mellifera* during the first three hours when treated with imidacloprid and clothianidin.

The results of low risk to honey bees to systemic residues in nectar and pollen following the use of thiamethoxam as a seed treatment on oilseed rape and maize have been reported by Pilling *et al*. (2013). The present results of imidacloprid are corroborated with Sharma and Abrol (2014), who also observed reduction in number of honey bee visits in toria upto 3rd day of spray with imidacloprid.

Bajiya and Abrol (2017) investigated the impact of direct insecticide spraying on *A. mellifera* in mustard crop and observed that all the insecticides including imidacloprid and thaimethoxam resulted in 100% mortality within 1 hour of spraying. The present findings indicated that the number of bees visiting mustard flowers reduced upto 4 days of spray in all the treatments except imidacloprid seed treatment. The present findings are in agreement to those of Sharma *et al.* (2018) who reported maximum mortality upto 2 days of application of thiamethoxam and imidacloprid on mustard.

Conclusion

Imidacloprid when used as seed treatment did not influence the bee foraging activity. The minimum reduction in number of bees after 3 sprays of azadirachtin also indicated its safety towards honey bees visiting mustard flowers. Hence, imidacloprid as seed treatment and azadirachtin as spray can be used for management of sucking pests in mustard without affecting the foraging activity of honey bees.

Conflict of interest: The authors declare that there is no conflict of interest in this research paper.

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