Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [2] 2017: 133-136

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Effect of Newer Neonicotinoides On Honey Bee Visits In Brinjal Ecosystem

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ABSTRACT
The honey bee visits in all insecticidal treatments were significantly low indicating that all the insecticides were significantly harmful to honey bees. Pooled data on 1 DAS showed that the lowest honey bee visits count was observed in plots treated with imidacloprid 17.8 SL (0.76 bees/plant/min) and clothianidin 50 WDG (0.89 bees/plant/min) followed by dinotefuran 20 SG (1.10 bees/plant/min) and diamethoate 30 EC (1.20 bees/plant/min). The maximum honey bee visits were recorded from the plots the plots treated with flonicamid 50 WG (2.12 bees/plant/min) followed by acetamiprid 20 SP (2.11 bees/plant/min) and thiamethoxam 25 WG (2.03 bees/plant/min). There was no statistical difference in order of their safety to bees. The order of toxicity of neonicotinoids to honey bee visits at 3 and 7 DAS was imidacloprid > clothianidin > dimethoate > dinotefuran > thiamethoxam > flonicamid > acetamiprid. At 14 DAS, the untreated plots (3.29 bees/plant/min) received maximum honey bee visits as compared to treated plots. Amongst treatments clothianidin 50 WDG (1.84 bees/plant/min), imidacloprid 17.8 SL (2.03 bees/plant/min), dinotefuran 20 SG (2.27 bees/plant/min) and diamethoate 30 EC (2.41 bees/plant/min) were highly toxic and showed no statistical differences in their toxicity to bees. Whereas, maximum honey bee visits recorded in plot treated with flonicamid 50 WG (2.63 bees/plant/min) and acetamiprid 20 SP (2.63 bees/plant/min) and thiamethoxam 25 WG (2.41 bees/plant/min). These treatments were observed to be comparatively less harmful to bees in this investigation.
***Key words**: Rice blue beetle, biology, Leptispa pygmaea, development.*

Received 11.07.2017 Revised 02.08.2017 Accepted 21.08.2017

INTRODUCTON

Brinjal or eggplant (*Solanum melongena* L.) is an important Solanaceous crop of subtropics and tropics. Brinjal has been cultivated in India for the last 4,000 years and is often thought of as a Mediterranean or Mid-Eastern vegetable. The brinjal is of much importance in the warm areas of Far East, being grown extensively in India, Bangladesh, Pakistan, China and the Philippines. It is also popular in Egypt, France, Italy and United States. It is known as a "King of vegetables" originated from India where a wide range of wild types and land races occurs (Thompson and Kelly, 1957).

It is the third most important vegetable crop grown throughout the year in all parts of India and contributes 17.8 per cent of the total production of vegetables in the country. Further, it is a popular vegetable in China, Turkey, Syria, Egypt, Indonesia, Philippines, Thailand, France, Taiwan, Italy and USA.

In India, brinjal is cultivated on an area of 664 thousand ha with an annual production of 12552 thousand million tonnes with productivity of 18.9 tonnes ha^{-1} during 2015-16. The total area under brinjal cultivation is 26.7 thousand ha in Maharashtra producing 543.9 thousand million tonnes annually with productivity of 20.4 tonnes fruits ha^{-1}. The west Bengal is a leading state in brinjal production (2,985.4 thousand MT) and area (161.9 thousand ha) in India. The major brinjal producing states are Orissa, Bihar, Karnataka, West Bengal, Andhra Pradesh, Karnataka and Uttar Pradesh (Anon., 2017).

In India, brinjal is widely cultivated in 8 states, practically on all soils from light sand to heavy clay and in almost all eight vegetable growing zones including Maharashtra- Madhya Pradesh. Although several varieties of brinjal are cultivated, the expected yield of the crop is not achieved so far because of the crop damage caused by the insect pests. Insect pests are most limiting factor for accelaring crop yield. Brinjal is attacked by more than 70 insect pests (Subbaratnam and Butani, 1982), of which the major important ones are the shoot and fruit borer (*Leucinodes orbonalis* Guen :pyralidae), stem borer (*Euzophera* *perticella* Ragonot : Phycitidae), leaf hopper (*Amrasca biguttula biguttula* Ishida: Cicadellidae), aphid (*Aphis gossypii* Glover : Aphididae), Leaf roller (*Antoba olivacea* Walker :Noctuidae), leaf beetle (*Henosepilachna vigintiopunctata* Fab: Coccinellidae), whitefly (*Bemisia tabaci* Gennadius: Aleyrodidae), lace wing bugs (*Urentius echinus* Distant and *U. sentis* Distant: Tingidae), mealy bug (*Coccidohystrix insolitus* Green: Pseudococcidae) and non insect pest, red spider mite (*Tetranychus macfurlanei* Baker and Pritchard) which cause about 70-92 per cent loss in the fruit yields (Vevai, 1970).

Both nymphs and adults of sucking pests *viz., A. biguttula biguttula*, *B. tabaci* and *A. gossypii* occur regularly on the crop from the early stage and remain till harvest of the crop causing enormous damage by sucking cell sap from the leaves and tender plant parts. Due to aphid infestation under surface of the leaves get crinkled and slightly curled backwards. The vitality of the plant is diminished and the plants turn yellow, get deformed and dry away. The nymphs and adults of jassid inject their toxic saliva while feeding. As a result the plant become stunted, the leaves crinkle, turn yellowish and become cup shaped. Brownish or reddish colour may develop along the edges of the leaves. Sarkar and Kulshreshtha (1978) reported that leaf hopper acts as a vector for transmission of little leaf disease in brinjal. Due to whitefly infestation leaves wrinkled, curled downwards and ultimately shed. Besides the feeding damage, aphids and whitefly also exude honeydew which favours the development of sooty mould. In case of severe infestation, this black coating is so heavy that it interferes with the photosynthetic activity of the plant resulting in stunted growth. Mites produce injury primarily by removing cell contents by penetrating stylet into leaf tissues resulting into appearance of yellowish spots. The dense web produced by spider mite often covers the plants where dust particles adhere which in turn affect the physiological activity of the plants, making it stunted. The entire plant becomes yellowish giving poor unhealthy look. Infested leaves wither and eventually fall off (Gupta, 1985; Channabasavanna, 1985). The yield losses due to mite infestation were 13.64 to 31.09 per cent at Bangalore and Varanasi (Anon., 1996). For controlling these pests more neonicotinoids are used in brinjal ecosystem.

Recently, there has been a lot of press related to pollinator health and some troubling information indicates that certain neonicotinoids, when used during bloom, can negatively affect the health of honey bees. This is a complicated problem with the solutions relying on understanding the detailed relationships among chemicals, pollinators and pest management needs. It is not prudent to treat this topic with a broad brush with statements such as "All neonicotinoid insecticides are bad for all pollinator species," or "No insecticides should be sprayed during bloom." Therefore, the studies were further extended to find out the effect of neonicotinoids on honey bees in brinjal ecosystem

MATERIALS AND METHOD

In the same plot which was grown for studying the efficacy of neonicotinoids against sucking pests was also observed to study the effect of neonicotinoids on the honey bee visits in brinjal ecosystem. The observations on honey bee visits to each experimental plot were taken at 11-13 hrs at 1, 3, 7, and 14 days after insecticidal spray.

From each treatment plot, 5 plants were randomly selected and were separately labeled with identifying tags. The number of honey bees visiting to brinjal flowers sprayed with insecticide was counted through visual observation. A bee landing on an open flower for 5-10 seconds was considered to be a 'visit'.

RESULTS AND DISCUSSION

Pooled data on honey bee visits (average number/plant/min) of two seasons *viz., Kharif* 2015-16 and *Kharif* 2016-17 were presented in Table 1 and Fig.1 The pre-treatment count of honey bee visits before initiation of the spray treatments was in the range of 2.27 to 3.27 bees/plant/min. Based on the mean of two sprays of both the years, the post-treatment counts of honey bee visits on untreated control plots were 2.83, 3.13, 3.27 and 3.29 bees/plant/min on 1, 3, 7, and 14 days after spray (DAS), respectively. The honey bee visits in all insecticidal treatments was significantly low indicating that all the insecticides were significantly harmful to honey bees.

Pooled data on 1 DAS showed that the lowest honey bee visit count was observed in plots treated with imidacloprid 17.8 SL (0.76 bees/plant/min) and clothianidin 50 WDG (0.89 bees/plant/min) followed by dinotefuran 20 SG (1.10 bees/plant/min) and diamethoate 30 EC (1.20 bees/plant/min). All these treatments were statistically at par with each other. The maximum honey bee visits were recorded from the plots treated with flonicamid 50 WG (2.12 bees/plant/min) followed by acetamiprid 20 SP (2.11 bees/plant/min) and thiamethoxam 25 WG (2.03 bees/plant/min). There was no statistical difference in order of their safety to bees.

The order of toxicity of neonicotinoids to honey bee visits at 3 and 7 DAS was imidacloprid > clothianidin > dimethoate > dinotefuran > thiamethoxam > flonicamid > acetamiprid.

At 14 DAS, the untreated plots (3.29 bees/plant/min) received maximum honey bee visits as compared to treated plots. Amongst treatments clothianidin 50 WDG (1.84 bees/plant/min), imidacloprid 17.8 SL (2.03 bees/plant/min), dinotefuran 20 SG (2.27 bees/plant/min) and diamethoate 30 EC (2.41 bees/plant/min) were highly toxic and showed no statistical differences in their toxicity to bees. Whereas, maximum honey bee visits were recorded in plots treated with flonicamid 50 WG (2.63 bees/plant/min) and acetamiprid 20 SP (2.63 bees/plant/min) and thiamethoxam 25 WG (2.41 bees/plant/min). These treatments were observed to be comparatively less harmful to bees in this investigation.

The reports of earlier researchers on effect of newer neonicotinoids on honey bee activity are discussed here. Takahashi *et al.*, (1992) found that acetamiprid appeared to be safe to honey bees. Andrew Porterfield (2017) found that 26 pesticides, including many (but not all) neonicotinoids, organophosphates, and pyrethroids killed nearly all of the bees that came into contact with the test pesticide sprays.

However, seven pesticides, including glyphosate and one neonicotinoid (acetamiprid) killed practically no bees in the tests. Takao Iwasa *et al*., (2003) suggested that P 450s is an important mechanism for acetamiprid and thiacloprid detoxification and their low toxicity to honey bees. Decourtye and Devillers, (2010) reported that nitro-substituted compounds (clothianidin, dinotefuran, imidacloprid and its metabolites, thiamethoxam and nitenpyram) appeared to be most toxic to bees, whereas the cyano-substituted neonicotinoids seem to exhibit a much lower toxicity (acetamiprid and thiacloprid).

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Table 1. Overall effect of newer neonicotinoids on honey bee visits to brinjal flowers based on pooled data (*Kharif* 2015-16 and 2016-17)

Sr. No	Treatments	Dose g.a.i/ha	Average number of honey bee visit / plant				
			1DBS	1DAS	3DAS	7DAS	14DAS
1	Imidacloprid 17.8 SL	20	2.97 (1.86)	0.76 (1.12)	1.18 (1.30)	1.27 (1.33)	2.03 (1.59)
2	Acetamiprid 20 SP	10	3.27 (1.94)	2.11 (1.61)	2.53 (1.74)	2.41 (1.71)	2.63 (1.77)
3	Clothianidin 50 WDG	20	2.30 (1.67)	0.89 (1.18)	1.08 (1.25)	1.35 (1.36)	1.84 (1.53)
4	Flonicamide 50 WG	75	2.50 (1.73)	2.12 (1.62)	2.13 (1.62)	2.07 (1.60)	2.63 (1.77)
5	Thiamethoxam 25 WG	50	2.64 (1.77)	2.03 (1.59)	1.36 (1.36)	1.52 (1.42)	2.41 (1.70)
6	Dinotefuran 20 SG	30	2.27 (1.66)	1.10 (1.26)	1.38 (1.37)	1.55 (1.43)	2.27 (1.66)
7	Diamethoate 30 EC	200	2.30 (1.67)	1.20 (1.30)	1.42 (1.38)	1.58 (1.44)	2.41 (1.70)

8	Control (Water spray)	-	2.70 (1.78)	2.83 (1.81)	3.13 (1.90)	3.27 (1.94)	3.29 (1.94)
	S.E ±		**0.07**	**0.06**	**0.05**	**0.04**	**0.06**
	CD at 5 %		**NS**	**0.19**	**0.15**	**0.12**	**0.17**

DAS-Days after spray DBS- Day before spray Figures in parenthesis are $\sqrt{x+0.5}$) transformed values

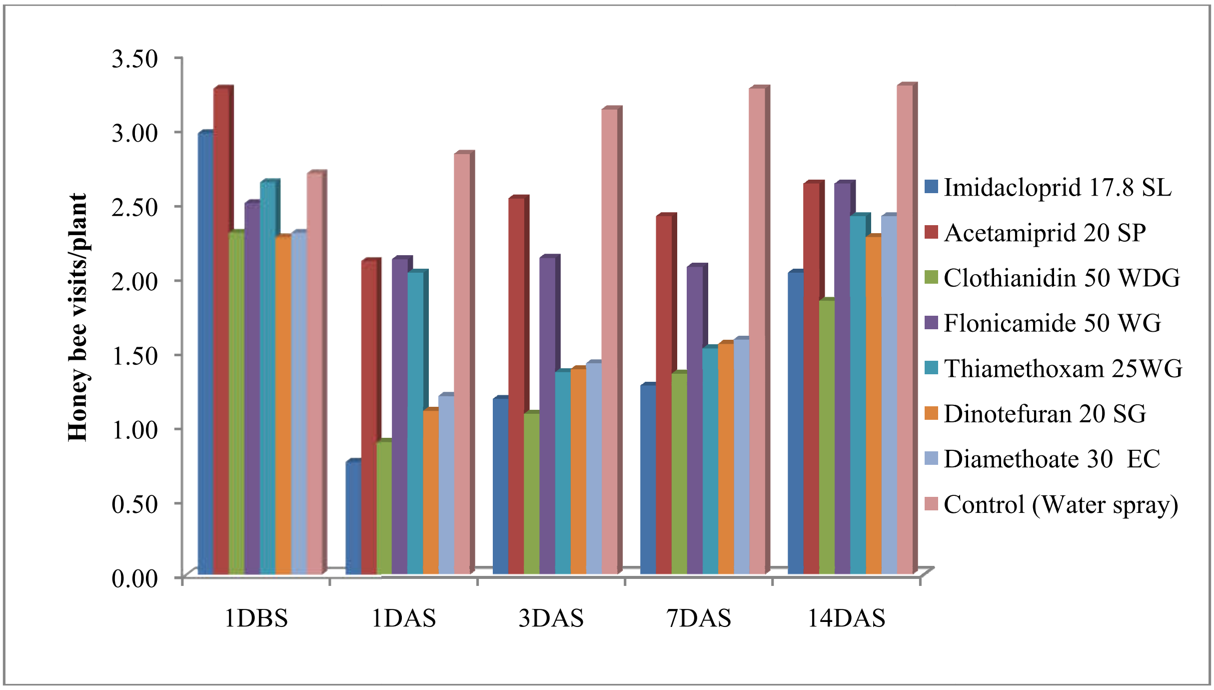

Fig. 1: Overall effect of newer neonicotinoids on honey bee visits in brinjal ecosystem (*Kharif* 2015-16 and 2016-17)

CITATION OF THIS ARTICLE

M.S. Masal, D.R. Kadam And S. R. Surwase. Effect of Newer Neonicotinoides On Honey Bee Visits In Brinjal Ecosystem .Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 2, 2017: 133-136