Research Article

Effect of Bee Attractants on Foraging Activities of Rock Bees *Apis dorsata* In Bitter Gourd (*Momordica charantia* L.)

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Abstract

An experiment entitled "Studies on role of rock bees as a pollinator in seed production of bitter gourd (*Momordica charantia* L.)" was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri, during Rabi 2016. The experiment was laid out in randomized block design with nine treatments and three replications with view to find out the effect of bee attractants on foraging activities of rock bees in bitter gourd. The bee attractants were sprayed two times, first at 10 percent flowering and second at 50 percent flowering. The results from the foraging activity of bees noted that the intensity of *Apis dorsata* was increased on 1 day after spraying and it reduced as gone towards 7 days after spray. Spraying of bee attractants i.e. honey solution 10 percent, jaggery solution 10 percent and molasses 10 percent attracted the maximum number of *Apis dorsata* up to 5th day after first spray and 7th day after second spray.

Keywords: Bitter gourd, bee attractants, honey solution 10 %, jaggary solution 10 %, molasses solution 10 %, *A. dorsata*

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Introduction

The insects from Apidae family are the most reliable agents for pollination. Among members of Apidae family, rock bees are particularly important pollinators as they can carry pollen and in the process of collecting of pollens the plants visited by them are benefited [1].

The open position of the flowers in bitter gourd makes them easy for the pollinators to access and exploit floral rewards. The high male to female ratio achieves the production of enough pollen deposits, thus results in effective pollination. A successfully pollinated flower starts to develop fruit on the second to fifth day after it had opened with petals detached, un-pollinated flowers dry up and the ovary become yellow on fifth day [2]. Hence, pollination is largely dependent on various pollinating agents, Insect pollinators play a crucial role in effecting optimum pollination including especially by honey bees. Insects are required for pollen transfer because of the large sized pollen grains, their stickiness, the way they are released from the anthers and thus contributing to both increased production in quantity and quality [3].

The material to increase the honey bee visit to specific crops would be of great practical value to harvest the benefits of cross pollination. Commercial and local bee attractants viz., Bee line, Bee here, Bee scent, Bee scent plus, Fruit boost, Bee-Q, Sugar solution, Sugarcane juice, Jaggery solution, Molasses, etc. are being used to boost the foraging activities in pea, peach, blue berries, watermelon and apple in the United States, Spain and Canada. Though some studies have been made on pollination of bitter gourd, but no attempts have been made for exploring the possible use of bee attractants to boost foraging activities of rock bees in bitter gourd in India. However, the related studies on use of bee attractants in India are scanty. The conservation and management of insect pollinators is gaining importance day by day. In this regard, studies on effect of different bee attractants were studied with effect on foraging activities of rock bees in bitter gourd.

Material and Methods

Investigations were conducted at the seed production plot of All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, during *Rabi* 2016. The bee attractants *viz.*, Coconut water 10%, Sugar solution 10%, Sugarcane juice 10%, Jaggery solution 10%, Molasses 10%, Honey solution 10% and Pomegranate juice 5% were sprayed two times, first at 10 percent flowering and second at 50

percent flowering. The experiment was laid out in randomized block design with nine treatments and three replications with view to find out the effect of bee attractants on activities of rock bees in bitter gourd. The following methodologies were adopted to know the role of bee attractants in foraging activities in bitter gourd.

To study the effect of bee attractants on activities of rock bees in bitter gourd

The attractants were sprayed two times, first at 10 percent and second at 50 percent flowering stages. The crop was protected from various pests and diseases, but no insecticides were used during the flowering period. Recommended agronomical package of practices were followed for raising good seed production plot.

Number of bees visiting per one-meter square area

In each plot one-meter square area was randomly selected and number of rock bees visited the flowers per minute was recorded during its peak period. Such observations were recorded a day before the first and second spray and later 1st, 3rd, 5th and 7th days after first and second spray. Means of all observations were pooled for *A. dorsata*. The data from individual observation were subjected to statistical analysis.

Results and Discussion

The results of the present investigation revealed that, all the bee attractants sprayed were significantly effect on foraging activities of rock bees in bitter gourd. They proved superior in recorded parameters over control i.e., unsprayed and without pollinators.

Influence of bee attractant on activity of rock bee Apis dorsata on bitter gourd

Data pertaining to the effect of bee attractants to attracting *A. dorsata* on Bitter gourd after 10 percent and 50 percent flowering are presented in **Table 1**.

Table 1 Influence of bee attractants on activities of *Apis dorsata* on bitter gourd

Sr. No.	Treatment	Number of bees per square meter per minute													
		1st spray at 10 percent flowering							2nd spray at 50 percent flowering						
		1 DBS	1 DAS	3 DAS	5 DAS	7 DAS	Total	Average	1 DBS	1 DAS	3 DAS	5 DAS	7 DAS	Total	Average
1.	Open Pollination	1.33 (1.35)	1.66 (1.46)	0.77 (1.12)	0.77 (1.12)	0.44 (0.96)	3.64	0.91	0.44 (0.96)	0.99 (1.22)	0.99 (1.22)	0.66 (1.07)	0.66 (1.07)	3.30	0.82
2.	Coconut Water 10%	1.44 (1.39)	2.77 (1.80)	0.88 (1.17)	0.99 (1.22)	0.55 (1.02)	5.19	1.29	0.55 (1.02)	1.21 (1.30)	1.1 (1.26)	0.66 (1.07)	0.66 (1.07)	3.63	0.90
3.	Sugar Solution 10%	1.44 (1.39)	2.99 (1.86)	1.22 (1.30)	0.88 (1.17)	0.88 (1.17)	5.97	1.49	0.88 (1.17)	1.55 (1.43)	1.33 (1.35)	0.88 (1.17)	0.77 (1.12)	4.53	1.13
4.	Sugarcane Juice 10%	1.55 (1.43)	3.21 (1.92)	1.11 (1.26)	1.1 (1.26)	0.55 (1.02)	5.97	1.49	0.55 (1.02)	1.66 (1.46)	1.44 (1.39)	0.88 (117)	0.66 (1.07)	4.64	1.16
5.	Jaggery Solution 10%	1.32 (1.34)	3.77 (2.06)	1.21 (1.30)	0.99 (1.22)	0.66 (1.07)	6.63	1.65	0.66 (1.07)	1.55 (1.43)	1.66 (1.46)	0.99 (1.22)	0.77 (1.12)	4.97	1.24
6.	Molasses 10%	1.66 (1.46)	3.77 (2.06)	1.66 (1.46)	1.33 (1.35)	0.77 (1.12)	7.53	1.88	0.77 (1.12)	2.22 (1.64)	1.77 (1.50)	1.21 (1.30)	0.77 (1.12)	5.97	1.49
7.	Honey Solutions 10%	1.22 (1.30)	3.66 (2.03)	2.1 (1.61)	1.55 (1.43)	0.44 (0.96)	7.75	1.93	0.44 (0.96)	2.21 (1.64)	2.1 (1.61)	1.33 (1.35)	0.99 (1.22)	6.30	1.57
8.	Pome granate Juice 5%	1.21 (1.30)	2.88 (1.83)	1.1 (1.26)	0.77 (1.12)	0.55 (1.02)	5.30	1.32	0.55 (1.02)	1.21 (1.30)	1.22 (1.30)	0.77 (1.12)	0.66 (1.07)	3.86	0.96
9.	SE+	0.0294	0.0275	0.0342	0.016	0.0145			0.0153	0.0288	0.028	0.0271	0.0114		
10.	CD 5%	0.0891	0.0836	0.1037	0.0486	0.0441			0.0464	0.0873	0.0849	0.0821	0.0347		

*= Figures in the parentheses are transformed $\sqrt{x + 0.5}$ values, DBS = Days before spraying, DAS= Days after spraying

First spray

A day before spraying of attractants, the bee activity was ranged from 1.21 to 1.66 bees/m²/min.

The effectiveness of the treatment on 1 day after spraying with 10 percent molasses, 10 percent jaggary solution and 10 percent honey solution were found to be the best treatment in attracting higher number of bees (3.77, 3.77 and 3.66 bees/m²/min respectively). The next best treatment was crop sprayed with sugarcane juice 10 percent (3.21 bees/m²/ min) followed by sugar solution 10 percent (2.99 bees/m²/min) were found at par.

On 3rd day after the first spray, honey solution 10 percent (2.10 bees/m²/ min) was significantly superior in attracting a greater number of bees over the rest of the treatments. Next bee activity was recorded in the plot sprayed with molasses 10 percent, sugar solution 10 percent and jaggary solution 10 percent bees with 1.66, 1.22 and 1.21 bees/m²/min respectively. The lowest bees were observed in treatments with open pollination (0.77 bees/m²/min).

On 5th day after first spray, the same trend was observed. The treatment honey solution 10 percent recoded significantly higher number of bees (1.55 bees/m²/min) was significantly superior over all treatments followed by molasses 10 percent with 1.33 bees/m²/min. The next better treatments were sugarcane juice 10 percent (1.10 bees/m²/ min), coconut water 10 percent (0.99 bees/m²/ min) and sugar solution 10 percent (0.88 bees/m²/ min). However, the least number of bees were observed in crop with open pollination (0.77 bees/m²/ min).

On 7th day after spray no specific results of bee attractants were observed and was showed the result relatively like observations of one day before spraying of bee attractants.

On an average honey solution 10 percent showed relatively highest bee activities with 1.93 bees/minute/m^2 followed by molasses 10 percent with 1.88 bees/minute/m^2 and jaggary solution 10 percent with 1.65 bees/minute/m^2. Open pollination had showed least bee activities.

Second spray

Before second spray, the visitation of *Apis dorsata* was recorded on one day before spray was in the range of 0.44 to 0.88 bees/m^2/min.

One day after second spraying, the treatment with molasses 10 percent and honey solution 10 percent were found significantly superior in attracting a greater number of bees (2.22 and 2.21 bees/m^2/min) and was at par with sugarcane juice 10 percent (1.66 bees/m^2/min). Jaggery solution 10 percent and sugar solution 10 percent (1.55 bees/m^2/min) were next better treatments. Open pollination (without spray) recorded the lowest number of bees (0.99 bees/m^2/min).

Among different treatments, spraying of honey solution 10 percent was found to be superior compared to other treatments (2.10 bees/m²/ min) on the 3rd day after spray and was at par with molasses 10 percent (1.77 bees/m²/min) followed by jaggery solution 10 percent (1.66 bees/m²/min) and sugarcane juice 10 percent (1.44 bees/m²/ min). However, the treatment with open pollination, which recorded as 0.99 bees/m²/min found to be lowest bee attracting treatment.

On 5th day after second spray, honey solution 10 percent attracted maximum number of bees (1.33 bees/m²/min) and found at par with molasses 10 percent (1.21 bees/m²/min). Further, crop sprayed with jaggery solution 10 percent (0.99 bees/m²/min) also next best treatment but the open pollination plot was ineffective in attracting more bees (0.66 bees/m²/min).

Similarly, on 7th day after second spray treatment honey solution 10 percent (0.99 bees/m^2/min) found significantly superior compared to other treatments. The next better treatments were molasses 10 percent, jaggary solution 10 percent, sugar solution (0.77 bees/m^2/min) and sugarcane juice 10 percent, pomegranate juice 10 percent and coconut water 10 percent (0.66 bees/m^2/min). Open pollination without spray recorded lowest number of bees (0.66 bees/m^2/min)

Discussion

The study of spraying of Bee-Q and Bee here on sesamum shows that increase in bee visitation and yield parameters significantly on sprayed crop up to 5th day in Dharwad [4].

Study on attraction of *A. mellifera* to volatile compounds reported that they concluded that anetholes and commercial trace Japanese beetle lure (10:22:11, 2-phenyl ethyl propionate : eugenol : geraniol) exposed in trace in Japanese beetle traps attracted *A. mellifera,* but other floral lures and fatty acids did not attract the bees [5].

The studies on Bee-Q @ 10, 12,5 and 15 gm/lit, Fruit boost @ 0.50, 0.75 and 1 ml/lit, Cinnamon leaf extract @ 5%, Tuberose floral scented water, 10% sugar solution on ridge gourd and crop deprived is control, which is open pollinated observed that spraying of Fruit boost @ 0.5 ml/lit and Bee-Q @ 12.5 gm/lit enhanced foraging activities of rock bees and yield parameters like number of fruits per plant to 19.00 and 17.00 fruits, when compared to 10.66

fruits per plant in open pollinated plot. Number of fruits was 21.83 and 20.83 fruits per plot, when compared to15.68 fruits per plot in open pollinated plots [6].

The research on bee attractants on *Cucumis sativa* proved that 2 applications of Bee-Q (12.5 gm/lit), Bee-here (4 ml/lit) and sugar solution (10 %) on staminate flowers of *Cucumis sativa* enticed a greater number of bees (4.01 to 4.97 bees/flower in 5 min.) up to 5 days after first and second sprays compared to unsprayed crop (3.25 to 3.59 bees). Similarly, higher visitations were recorded on pistillate flowers on the sprayed crop [7].

Comparison between different bee attractants and open pollination observed that spraying of cacambe 10 percent, Bee-Q 1.25 percent and jaggery solution 10 percent have significant influence in attracting a greater number of pollinators over open pollination [8].

Studies on use of bee attractants, Bee-Q and Fruit Boost in the pollination of Niger. Bee visitations to Niger flowers were observed for two weeks and an estimation of seed yield was determined. Results indicate that applications of Bee-Q at 12.5 gm/lit and Fruit boost at 0.75 ml/lit on Niger plots significantly increased the number of bee foragers over control plots. In addition, plots sprayed with these bee attractants significantly enhanced the seed set, seed weight, and germination of Niger [9].

Bee attractants play a beneficial role in enhancing pollination and yield of crops especially when target crop is not so attractive to the bees naturally or when the weather conditions are not conducive for foraging by the bees on target crop and evaluated that Citral E, Citral Z, *F. budrunga, S. densifolia* attracted significantly a greater number of bees with 2.13 to 2.96 bees /10m^2/5 min. Which were on par with each other and were as good as Fruit boost showed 2.00 to 2.17 bees /10m^2/5 min [10].

The usage of bee attractants, Bee-Q and Fruit Boost in the pollination of watermelon at different concentrations and indicated showed that, Bee-Q at 12.5 gm/lit and Fruit boost at 0.5 ml/lit of watermelon plots meagerly attracted several bee foragers than the control plots [11].

The abundance and foraging activity of different bee visitors to pigeon pea (*Cajanus cajan* L.) Millsp) cultivar ICPL–151 and Bahar. The four species of bees were recorded visiting the flowes viz. *Megachile sp., Apis florae, A. cerana indica* and *A. mellifera* and five species of bees namely *A. mellifera, A. dorsata, A. florae, A. cerena indica* and *Megachile spp*. of both cultivars respectively [12].

The mean number of *Apis mellifera* collecting pollen and both nectar and pollen was found to be 14.71 + 2.47 and 3.71 + 0.65 per hour, respectively. The pollen collecting activity reached its peak at 13:00 hrs. after that it began to declined [13].

Apis dorsata, A. cerana indica, A. florae, Xylocopa fenestrata, Andrena sp., Nomia sp., Eristalinus arvorum, E. taeniops, E. punctulatus, Erisyrphus balteatus and Pieris napi as pollinators in rapeseed. Out of these, 6 species of pollinators viz., X. fenestrata, Andrena sp., Nomia sp., E. taeniops, E. punctulatus, and P. napi were abundant [14].

Conclusion

Based on results obtained during present investigation, it could be concluded that:

- Among the bee attractants honey solution 10 percent found to be the superior treatment in attracting higher number of *A. dorsata, A. cerana indica, A. mellifera* and other pollinators followed by 10% molasses solution and 10 percent jaggery solution.
- Irrespective of treatments, the peak pollinator activity was found on 1st day after spraying of bee attractants and reduces towards 7th day after spraying.
- In contrary lowest yield and yield related attributes recorded in pollination without insects and open pollination.
- In commercial seed production plot molasses 10 % and Jaggary solution 10 % has higher importance as they demand less cost for applying and it returned more yield as compared with non-sprayed plots.

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