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Effect of bee attractants on foraging activities of European bees Apismellifera in Bitter gourd (Momordica charantiaL.)

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----------ABSTRACT----------
An experiment entitled "Studies on role of honey 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 European 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 Apismelliferawas 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 ofApismellifera up to 5thday after first spray and 7thday after second spray.
KEYWORDS: *Bitter gourd, bee attractants, honey solution 10 %, jaggary solution 10%, molasses solution 10 %,Apismellifera.*

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I. INTRODUCTION

The insects from Apidae family are the most reliable agents for pollination. Among members of Apidae family, European bees are particularly important pollinators as they can carrypollen 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 European 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 European bees in bitter gourd.

II. 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 European beesin 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 European 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 ofEuropean 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 7thdays after first and second spray. Means of all observations were pooled for Apismellifera. The data from individual observation were subjected to statistical analysis.

III. RESULTS

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

Influence of bee attractant on foraging activities of Apis mellifera on bitter gourd

Data pertaining to the effect of attractant on activity of A. mellifera on Bitter gourd is presented in Table 1.

First spray

There was no significant difference in the bee visitation among the various treatments, a day before first spray and it was ranged from 0.88 to 1.10 bees/m^2/min.

One day after first spray, a greater number of bees (2.22 bees/m^2/min) was attracted in the treatment sugar solution 10 percent and found to be significantly superior over all the treatments over honey solution 10 percent, jaggery solution 10 percent and sugarcane juice 10 percent (1.88 bees/m^2/min each). Molasses 10 percent and pomegranate juice 5 percent were also which recorded 1.66 bees/m^2/min each better treatments over Open pollination without spray recorded the lowest number of bees (0.99 bees/m^2/min).

Similarly, on 3rd day after first spray, plot treated with honey solution 10 percent attracted maximum number of bees (2.10 bees/m^2/min). The next better treatment was molasses 10 percent (1.66 bees/m^2/min) followed by jaggery solution 10 percent and sugarcane juice 10 percent with 1.55 bees/m^2/min each. Rest of the treatment also found superior over open pollination without spray which recorded the least number of bees (0.77 bees/m^2/min).

On 5th day after second spray, the treatment honey solution 10 percent (1.77 bees/m^2/min) proved to be superior among treatments of bee attractants. Jaggery solution 10 percent was another better treatment followed by sugar solution 10 percent, molasses 10 percent and sugarcane juice 10 percent which attracts 1.44, 1.10, 1.10 and 1.10 bees/m^2/min, respectively. Molasses 10 percent was the next best treatment which recorded 3.95 bees/m^2/min and found at par with sugarcane juice 10 percent (3.91 bees/m^2/min).

On 7th day after second spray, the treatment honey solution 10 percent was successful in attracting highest number of bees (0.66 bees/m^2/min) and it was at par with sugar solution 10 percent, sugarcane juice 10 percent, jaggery solution 10 percent and molasses 10 percent having 0.55 bees/m^2/min each which were superior over open pollination without spray which attracted minimum number of bees (0.44 bees/m^2/min).

Second spray

The visitation of A. mellifera on one day before second spray was in the range of 0.44 to 0.66 bees/m^2/min.

A day after the second spray, molasses 10 percent attracted higher number of bees (3.21 bees/m^2/min). Honey solution 10 percent, jaggery solution 10 percent (2.33 bees/m^2/min) and sugarcane juice 10 percent were next better treatments attracted 2.33, 2.33 and 2.22 bees/m^2/min respectively. The least number of bees was recorded in open pollination without spray (1.66 bees/m^2/min).

Similarly, on 3rd day after second spray, honey solution 10 percent recorded maximum number of bees (2.32 bees/m^2/min) and found superior over all the treatment. The next best treatments were molasses 10 percent and jaggerry solution 10 percent which was recorded 2.21 bees/m^2/min each. Sugarcane juice 10 percent, and sugar solution 10 percent which recorded 2.10 bees/m^2/min each. Open pollination without spray was inferior over all the treatments as it recorded a smaller number of bees (1.55 bees/m^2/min).

Table 1. Influence of bee attractants on foraging activities of Apis mellifera 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	0.99 (1.22)	0.99 (1.22)	0.77 (1.12)	0.77 (1.12)	0.44 (0.96)	2.97	0.74	0.44 (0.96)	1.66 (1.46)	1.55 (1.43)	0.77 (1.12)	0.77 (1.12)	4.75	1.18
2.	Coconut Water 10%	1 (1.22)	1.44 (1.39)	1.1 (1.26)	0.88 (1.17)	0.44 (0.96)	3.86	0.96	0.44 (0.96)	1.99 (1.57)	1.77 (1.50)	0.77 (1.12)	0.88 (1.17)	5.41	1.35
3.	Sugar Solution 10%	1.1 (1.26)	2.22 (1.64)	1.44 (1.39)	1.1 (1.26)	0.55 (1.02)	5.31	1.32	0.55 (1.02)	2.11 (1.61)	2.1 (1.61)	0.99 (1.22)	0.88 (1.17)	6.08	1.52
4.	Sugarcane Juice 10%	0.88 (1.17)	1.88 (1.54)	1.55 (1.43)	1.1 (1.26)	0.55 (1.02)	5.08	1.27	0.55 (1.02)	2.22 (1.64)	2.1 (1.61)	1.21 (1.30)	0.88 (1.17)	6.41	1.60
5.	Jaggery Solution 10%	1.11 (1.26)	1.88 (1.54)	1.55 (1.43)	1.44 (1.39)	0.55 (1.02)	5.42	1.32	0.55 (1.02)	2.33 (1.68)	2.21 (1.64)	1.11 (1.26)	0.88 (1.17)	6.53	1.63
6.	Molasses 10%	0.88 (1.17)	1.66 (1.46)	1.66 (1.46)	1.1 (1.26)	0.55 (1.02	4.97	1.24	0.55 (1.02)	3.21 (1.92)	2.21 (1.64)	1.33 (1.35)	0.88 (1.17)	7.63	1.90
7.	Honey Solutions 10%	0.88 (1.17)	1.88 (1.54)	2.1 (1.61)	1.77 (1.50)	0.66 (1.07)	6.41	1.60	0.66 (1.07)	2.33 (1.68)	2.32 (1.68)	1.32 (1.35)	1.1 (1.26)	7.09	1.76
8.	Pomegranate Juice 5%	0.88 (1.17)	1.66 (1.46)	1 (1.22)	0.77 (1.12)	0.66 (1.07)	4.09	1.02	0.66 (1.07)	1.99 (1.57)	1.77 (1.50)	0.77 (1.12)	0.77 (1.12)	5.30	1.32
9.	SE +	0.0218	0.0188	0.0207	0.0153	0.0143			0.0157	0.0135	0.0245	0.0275	0.0204		
10.	CD 5%	0.066	0.057	0.0627	0.0463	0.0432			0.0477	0.0409	0.0744	0.0835	0.062		

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

DAS = Days after spraying

On 5th day after second spray, treatment molasses 10 percent and honey solution 10 percentwere significantly superior to attract the maximum number of bees (1.33 and 1.32 bees/m^2/min respectively) followed by sugarcane juice 10 percent and sugar solution 10 percent with 1.21 and 0.99 bees/m^2/min respectively. The treatment open pollination without spray recorded lowest number of bees (0.77 bees/m^2/min).

On 7th day after second spray, the plots sprayed with honey solution 10 percent attract the maximum number of bees (1.10 bees/m^2/min) and found at par with sugar solution 10 percent jaggery solution 10 percent, molasses 10 percent and sugarcane juice 10 percent (0.88 bees/m^2/min) and found significantly superior over open pollination without spray which recorded least number of bees(0.77 bees/m^2/min).

Overall observations showed that molasses 10 percent was having highest bee attractant ability over other bee attractants with average of 1.90 bees/m^2/min. Thereafter honey solution 10 percent, jaggery solution and sugarcane juice having average ability of 1.76, 1.63 and 1.60 bees / m^2 / min. respectively.

IV. 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 gms/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 European 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 (Cajanuscajan L.) Millsp) cultivar ICPL–151 and Bahar. The four species of bees were recorded visiting the flowes viz. Megachile sp., Apis florae, A. ceranaindica and A. mellifera and five species of bees namely A. mellifera, A. dorsata, A. florae, A. cerenaindicaandMegachile 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].

Apisdorsata, A. ceranaindica, A. florae, Xylocopafenestrata, Andrena sp., Nomia sp., Eristalinusarvorum, E. taeniops, E. punctulatus, Erisyrphusbalteatusand 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].

V. CONCLUSION:

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

- ✓ Among the bee attractants honey solution 10 percentfound to be the superior treatment in attracting higher number ofApismelliferafollowed by 10% molasses solution and 10 percent jaggery solution.
- ✓ Irrespective of treatments, the peak pollinator activity was found on 1st dayafter spraying of bee attractants and reduces towards 7th day after sparying.
- ✓ In contrary lowest yieldand yield related attributes recorded in pollination without insects and open pollination.

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