Research Article

Effect of Bee Pollination on Seed Yield and Yield Contributing Characters of Bitter Gourd *Momordica Charantia* L.

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Abstract

Studies on role of honey bees as pollinators in seed production of bitter gourd (*Momordica charantia* L.)" were conducted Mahatma Phule Krishi Vidyapeeth, Rahuri, during *Rabi* 2016. The results revealed that the highest number of fruits / plant (35.88) and the highest number of seeds / fruit (41.4) was recorded in the treatment of honey solution 10 per cent. Further, the lowest per cent wrinkled seeds/fruit (1.20 %) was also found in treatment with honey solution 10 per cent. Significantly higher test weight (29.57 g) was recorded in honey solution 10 per. The crop sprayed with honey solution 10 per cent recorded highest seed yield of 2.19 kg/5 plants and the highest seed yield per hectare (4.81 q/ha). Subsequently, open pollination without spray (2.72 q/ha) and pollination without insects (1.14 q/ha) recorded least yield. Next in the order of effectiveness were jaggery solution 10 per cent (3.82 q/ha), molasses 10 per cent (3.56 q/ha) and sugarcane juice 10 per cent (3.34 q/ha).

Keywords: Honey bees, bitter gourd, bee attractants, *A. mellifera, A. cerena, A. dorsata.*

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Introduction

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

Bitter gourd seed yield is heavily depends on pollinators especially bees. Plots caged with bees yielded more fruits per m^2 and heavier and higher quality fruits than other plots i.e. open pollination and crop caged without bees [2]. For efficient pollination in highly cross pollinated crop honey bees are most important. Adequate pollination is vital for any significant increase in production, about 90 per cent cross pollination is carried out by the insects, 85 per cent of which comprises of bees. Maximum fruit set in open pollinated plots (81%) in chow-chow and lowest in control plot (10.5%). Among the honey bee species, maximum fruit set was found in *A. florea* caged plots i.e. 78% and the lowest was found in *T. iridipennis* caged plot (61%). Also, maximum fruit weight and fruit volume was found in open pollinated plots and minimum in control plots. Among the honey bee species, maximum fruit weight and fruit size was found in *A. cerana* caged plots and the lowest was found in *T. iridipennis* caged plots [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 yield of 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 productivity of 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 yield, was studied in the present investigation.

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 per cent flowering and second at 50 per cent 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 honey bees and effect of honey bee visits on seed yield and yield contributing characters of bitter gourd. The following yield contributing parameters were recorded to know the role of bee pollination in enhancing the productivity of bitter gourd.

Number of fruits per plant

In each plot ten plants were selected randomly and number of fruits in these plants was counted. Average number of fruits per plant was worked out from it.

Number of seeds per fruit

This observation was made by selecting fifteen fruits at random, from each replication of treatment during harvesting. The seeds in each fruit were counted and mean seeds per fruit were calculated.

Per cent undeveloped seeds or wrinkled seeds

Similarly from selected fifteen fruits, number of healthy seeds and undeveloped seeds were separated.

Test weight (weight of 100 seeds)

Weighing 100 dried seeds randomly from each sample by using electronic weighing balance and determined in grams.

Yield of five plant in kg

Harvesting of randomly selected five plants from each plot and the yield (Kgs) was recorded.

Seed yield in Q/ha

Each plot was harvested, weighted separately and the yield per plot was recorded and converted into yield per hectare.

Results and Discussion

The results of the present investigation revealed that, all the bee attractants sprayed were significantly effect on seed yield and yield attributing characters. They proved superior in recorded parameters over control i.e., unsprayed and without pollinators.

Number of fruits per plant

As per shown in **Table 1** Honey solution 10 per cent sprayed plots recorded significantly higher number of fruits per plant (35.88 fruits per plant) and found superior. It was followed by jaggery solution 10 per cent, molasses 10 per cent, sugar solution 10 per cent and sugarcane juice 10 per cent which recorded 34.21, 33.42, 32.51 and 32.47 fruits per plant, respectively. Pollination without insect recorded lowest number of fruits (0.16 fruits / plant).

Number of seeds per fruit

The plot sprayed with honey solution 10 per cent was found significantly superior over all the treatments by recording highest number of seeds/fruit (41.40 seeds/fruit). However, it was at par with next best treatment jaggery solution 10 per cent (37.50 seeds/fruit).

The treatments *viz*., molasses 10 per cent, sugarcane juice 10 per cent and sugar solution 10 per cent were found superior over open pollination without spray and pollination without insects (PWI) by recording 36.20, and 34.80 and 34.40 seeds/fruit, respectively. The results are inprignated in Table 1.

Per cent wrinkled seeds/fruit

Treatment with honey solution 10 per cent noticed least number of 1.20 wrinkled seed/fruit and found superior over rest of treatments which was followed by jaggery solution 10 per cent (1.86 wrinkled seeds/fruit).

Table 1 Effect of bee pollination on seed yield and yield contributing characters of bitter gourd

Sr. No.	Treatment	No. of fruits per plant	No. of seeds/ fruit	Per cent wrinkled seeds	Weight of 100 seeds (gm)	Yield of 5 plants (kg)	Yield (Q/ha)
1.	Open Pollination	30.20	31.70	2.83	25.96	1.24	2.72
2.	Pollination Without Insects	0.16	27.00	3.05	24.50	0.52	1.14
3.	Coconut Water 10%	31.34	32.70	2.14	26.59	1.36	2.99
4.	Sugar Solution 10%	32.51	34.40	2.32	26.98	1.50	3.30
5.	Sugarcane Juice 10%	32.47	34.80	2.29	27.03	1.52	3.34
6.	Jaggery solution10%	34.21	37.50	1.86	27.20	1.74	3.82
7.	Molasses Solution 10%	33.42	36.20	1.93	26.91	1.62	3.56
8.	Honey Solution 10%	35.88	41.40	1.20	29.57	2.19	4.81
9.	Pomegranate Juice 5%	31.78	32.90	2.15	26.92	1.40	3.08
10.	SE +	0.30	0.86	0.19	0.44	0.03	0.04
11.	CD 5%	0.92	2.60	0.59	1.32	0.09	0.12

Pomegranate juice 5 per (2.15 wrinkled seeds/fruit), sugarcane juice 10 per cent (2.29 wrinkled seeds/fruit) and sugar solution 10 per cent (2.32) and were at par with each other and significantly superior over the treatments viz. PWI and open pollination without spay.

On the contrary, PWI recorded maximum number of wrinkled seeds/fruit (3.05) and proved least effective. Open pollinated plot without any spray recorded 2.83 wrinkled seeds/fruit. These results are shown in Table 1.

Test weight (weight of 100 seeds)

The open pollinated crop which received honey solution 10 per cent recorded higher test weight (29.57 gm/100 seeds). Jaggery solution 10 per cent (27.20 gm/100 seeds) and sugarcane juice 10 per cent (27.03 gm/100 seeds) were the next better treatments.

Subsequently, the plots sprayed with sugar solution 10 per cent recorded 26.98 gm per 100 seed which was followed by molasses 10 per cent (26.91gm/100 seeds) were significantly superior over open pollination without spray and PWI.

Yield of five plant in kg

The highest seed yield per 5 plants was recorded in treatment with honey solution 10 per cent (2.19 kg) followed by jaggery solution 10 per cent (1.74 kg). Molasses 10 per cent (1.62 kg) was next best treatment. Sugarcane juice 10 per cent (1.52 kg) and sugar solution 10 per cent (1.50 kg) respectively which were independently superior over remaining treatments.

The least seed yield of 5 plants 1.24 kg and 0.52 kg were recorded in treatment open pollination without spray and PWI, respectively which proved significantly inferior to all other treatments.

Seed Yield/ha

Significantly highest yield was recorded in plots sprayed with honey solution 10 per cent (4.818 q/ha). Next better treatment was jaggery solution 10 per cent (3.828 q/ha). It was however at par with molasses 10 per cent (3.564 q/ha).

Discussion

Among the different modes of pollination tried and obtained 326 watermelon fruits in bee pollination which was at par to natural (272 fruits) or hand pollination (247 fruits). In case of bee pollination, about 28.00 per cent of fruits were carried to maturity as against 25.00 per cent in natural pollination and 23.00 per cent in hand pollination. Total fruit weight was maximum in bee-pollinated plants with 738 kg as against 671 kg in natural and 456 kg in hand pollinated flowers. Bold viable seeds were also more in bee pollination (66427) as compared to natural and hand pollinated flowers. In case of bee pollinated flowers, the per cent of bold viable seeds shows 46% which was more compared to the other two modes of pollination (about 27%). The dry weight of bold viable seeds was found around 4 kg in natural and hand pollinated flowers compared to bee-pollinated flowers (7 kg) which was shown by Sunder [4].

The fruit set of cucumber in bee and open pollinated plants were 75 and 58 per cent, respectively and these were significantly higher than the non-pollinated plants which show 33 %. Bee and open pollination also yielded with high weight and uniform fruits as per recorded by Cervancia and Bergonia [5].

The effect of the bee pollination on water melon significantly higher fruits per 30 m^2 were found in two colonies per plot (22.37), followed by one colony per plot (20.75) and lowest was recorded with no colony (18.37). Similar results were obtained with respect to mean fruit weight, fruit diameter, TSS per cent and yield recorded by William Rajasekhar [6].

Significantly highest length of fruits in bitter gourd 26.10 cm as against 13.93 and 13.60 cm fruit length in open pollinated and caged plot without bees, respectively, led to pulp ratio of 0.132 as against 0.09 and 0.07 in open pollinated and caged plot without bees, respectively, highest fruit weight 129.20 as against 72.09 and 62.44 in open pollinated and caged plot without bees, respectively as well as yield of 118.87 quintal as against 68.63 and 45.23 quintal in open pollinated and caged plots without bees, respectively found by Nidagundi [7].

14 insect species including 6 hymenopterans, 5 lepidopterans and 3 dipterans were visiting the bitter gourd flowers. Among them, *T. iridipennis, Halictus gutturosus* and *A. florea* were the most frequent and abundant visitors. Foraging activity of *T. iridipennis, A. florea* and *H. gutturosus* commenced at 06:00, 06:30 and 07:30 h, respectively with peak at 09:00-10:00 h and ceased by 14:00, 12:30 and 13:00 h, respectively as per recorded by G. Subhakar *et al.* [8].

Pollinator species in *M. charantia* included honey bees (*Apis mellifera), Plebeina hildebrandti, Lasioglossum sp.* and carpenter bees (*Xylocopa spp*). Fruit set under natural pollination was very low and this revealed the degree of pollen limitation in *M. charantia*. Low fruit set was consistent with high discrimination against pistillate flowers amongst potential pollinators. Smaller bees belonging to families Apidae (*Plebeina hildebrandti*) and Halictidae (*Lasioglossum sp*.) were the important pollinators which were reported by Mary Lucy Oronje *et al.* [9].

Nine bee species of three families (Apidae, Halictidae and Megachilidae) as visitors to bitter gourd flowers. Amongst these, *Halictus sp., Megachile sp*. and *Apis dorsata* Fabricius were found to be the most frequent visitors. The abundance of *Halictus sp*. was highest, followed by *Megachile sp*. and *A. dorsata*. *A. dorsata* was the most efficient pollinator of bitter gourd, followed by *Halictus sp.* and *Megachile sp.* as per observed Pavana Kumar Balina *et al.* [10].

The pollinator community was composed of 15 insect species in 3 orders and 10 families. Bees were the most dominant (435 individuals) floral visitors. *A. florea, Parnara guttata* and *A. dorsata* were the most abundant pollinators. *A. florea* and *A. dorsata* also exhibited the highest visitation rates and frequencies. 5 major pollinators were tested for their single-visit efficacy, showing that *A. dorsata* was the most effective pollinator, along with *A. florea* and *Eristalinus laetus*. Conserving and enhancing these pollinators may enhance *M. charantia* production in Pakistan which was found by Shafqat Saeed *al.* [11].

Conclusion

On the basis of results obtained during the course of present investigation, it could be concluded that:

- Among the bee attractants honey solution 10 per cent 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 per cent jaggery solution.
- The higher yield contributing characters like number of fruits (35.88 fruit/plant), number of seeds (41.4 seeds/fruit), test weight (29.57 g/100 seeds) and total yield (4.818 q/ha) were recorded in 10 per cent honey solution and found to be the best attractant followed by 10 per cent jaggary solution and 10 per cent molasses solution.
- In contrary lowest yield and yield related attributes recorded in pollination without insects and open pollination.

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