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Influence of Bee-attractants on Yield Parameters of Ridge Gourd (*Luffa acutangula* L.) (Cucurbitaceae)

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Abstract: Ridge gourd (*Luffa acutangula* L.) is an important green vegetable among cucurbitaceous crops. It is highly cross-pollinated and depends on various pollinating agents. Studies were made on foraging time and frequency of honeybee visitation on Ridge gourd, influence of bee-attractants in increasing bee visitation, effectiveness of bee-attractants in yield parameters on Ridge gourd at Kuntanahalli, Bangalore district, India. The crop was raised with recommended package of practices in RBD (Randomized Block Design) having 5x5m plot size with a spacing of 5 m in the farmers field during Kharif season of 2007. Treatments involved were, spraying of Bee-Q @ 10, 12,5 and 15 gms/l, Fruit boost @ 0.50, 0.75 and 1 ml/l, Cinnamon leaf extract @ 5%, Tuberose floral scented water, 10% sugar solution and crop deprived is control, which is open pollinated. Spraying of Fruit boost @ 0.5 ml/l and Bee-Q @ 12.5 gms/l enhanced yield parameters like number of fruits / plant to 19.00 and 17.00 fruits, when compared to 10.66 fruits / plant in open pollinated plot. Number of fruits was 21.83 and 20.83 fruits / plot, when compared to15.68 fruits / plot in open pollinated plots. Fruit length was 42.41 and 41.21cm, when compared to 32.95 cm in open pollinated plots. Fruit weight was 285.00 and 246.33 gms, when compared to 229.67 gms in open pollinated plots and yield was 154.00 and 152.00 q/ha, when compared to 130.67 q/ha in open pollinated plots were studied.

Key words: Honeybees · Ridge gourd · Pollination · Bee-attractants

INTRODUCTION

Honeybees are considered as one of the efficient and eco-friendly approach in maximizing the yield of cross-pollinated crops [1]. Ridge gourd constitutes an important green vegetable among cucurbitaceous crops. It is mainly grown for edible tender fruits used in soups and curries and it is highly cross pollinated and depends on various pollinating agents including insects for its pollination as the reproductive organs of male and female flowers occur separately on same plant but in different internodes. The flowering ratio of male to female is 25 to 30:1, i.e., for every 25-30 male flowers one female flower is produced [2]. Male flowers are borne in raceme and female flowers are borne solitary, normally in same axis as male flowers. Ovary is inferior with a short style. Flowers open normally in late afternoon between 1500 hrs to 1600 hrs of the day [3]. Pollen grains being sticky and large in size need to be transferred to the pistillate flowers for fruit set. Hence, insects are required for pollen transfer.

Any material to increase honeybee visit to specific crop could be of great practical significance to harness benefits of cross-pollination. Commercial bee attractants viz; Bee-Q, Fruit boost, Bee scent, etc., are used to boost the yield of peas, peach, blue berries, watermelon and apple in United States, Spain and Canada. However, in India, studies on the use of different bee attractants for fruit production have not been well understood. To fulfill these lacunae, the present investigation on impact of bee pollination on yield of Ridge gourd was undertaken by achieving the following objective.

- Relative effectiveness of bee-attractants and yield parameters

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MATERIALS AND METHODS

The experiment was conducted at Kuntanahalli village located three kilometers from Doddaballapur and 36km from North of Bangalore on Doddaballapur-Tumkur road at 13° 17[1] North latitude. 77° 29[1] East longitude and at an altitude of 890 meters above mean sea level. Material and methods adopted to study the various objectives were as follows:

Relative Effectiveness of Bee Attractants and Yield Parameters of Ridge Gourd: The samples of commercial bee-attractants namely Bee-Q (Synthetic bee-attractant composed of protein and carbohydrates) and fruit boost (Queen mandibular pheromone) were obtained from M/s Excel industries Ltd, Hubli and Pherotech, INC Canada respectively. Other materials tested for the efficacy, as attractants were Cinnamon leaf extract, 10% sugar solution and Tuberose floral scented water, which were obtained locally.

Tuberose floral scented water was prepared by soaking 100 g of flowers in one litre of water for 24 hours and filtering it, the next day to remove flowers and other debris. For preparation of Cinnamon leaf extract, matured leaves were collected and dried under shade for 2 to 3 days, the leaves were powdered by using a grinder. 50 gms of powder is dissolved in one litre of water separately to obtain 5% of the extract. The experiment is laid in a Randomized block design with three replications and the treatments involved were as follows:

- T1-Crop treated with Bee-Q @ 10 g/l
- T2-Crop treated with Bee-Q @ 12.5 g/l
- T3-Crop treated with Bee-Q @ 15 g/l
- T4-Crop treated with Fruit boost @ 0.5 ml/l
- T5-Crop treated with Fruit boost @ 0.75 ml/l
- T6-Crop treated with Fruit boost @ 1.00 ml/l
- T7-Crop treated with Cinnamon leaf Extract @ 5 %
- T8-Crop treated with Tuberose floral scented water
- T9-Crop treated with 10% sugar solution
- T10-Open pollination (control)

The crop which did not receive any spray of attractant serves as a control (OP). During flowering season by following recommended package of practices in the plots of 5x5m with buffer zone of 5 m between the 2 plots were followed. No insecticide is sprayed from flowering to seed set stages on the crop. Two colonies of *A. cerana* were kept near the experimental plot during flowering.

In order to study the role of bee attractants in enhancing the productivity the following yield parameters were recorded from the plots sprayed with different bee attractants.

Number of Fruits / Plant: This observation was made on the selected five plants in each treatment in all replications during harvesting. The number of fruits in these plants was counted and mean number of fruits/plot was recorded.

Number of Fruits/ Plot: This observation was made on the selected five plants in each treatment in all replications during harvesting. The number of fruits in these plants was counted and mean number of fruits/plot was recorded.

Fruit Weight (gms): This observation was made by selecting 5 plants at random, each treatment of all replications during harvest. The average fruit weight was computed by taking total weight of fruits and per fruit weight from the total number of fruits.

Fruit Length (cms): The length of 5 randomly selected fruits from each treatment was selected and measured using measuring tape. The mean fruit length was calculated and statistically analyzed.

Yield (q/ha): Fruits of selected crops are removed after maturity from each plot and are weighed by using weighing scale. This yield is later converted to one hectare of area.

RESULTS

Relative Effectiveness of Bee-Attractants and Yield Parameters of Ridge Gourd: Data on the effectiveness of attractants and yield parameters viz., number of fruits / plant, number of fruits / plot, Fruit length (cm), Fruit weight (gm) and yield (q/ha) are presented in table 1.

Number of Fruits / Plant: The number of fruits / plant were recorded from the treatment that received fruit boost @ 0.5 ml/l (19.00 fruits / plant) and next best treatment was

Table 1: Relative effectiveness of bee-attractants and yield parameters of Ridge gourd

Treatments	No. of fruits/ plant	% Increase Decrease/Over OP	No. Of Fruits /plot	% Increase/ decrease/over OP	Fruit length (cm)	% Increase/ Decrease/over OP	Fruit weight (gms)	% Increase/ Decrease/over OP	Yield (q/ha)	% Increase/ Decrease/overOP
T1-Bee-Q @ 10 gms/ltr	15.33c	43.80	18.13d	15.62	38.75c	17.60	240.33b	4.64	147.33b	12.74
T2-Bee-Q @ 12.5 gms/ ltr	17.00b	59.47	20.83b	32.84	41.21b	25.06	246.33b	7.25	152.00a	16.32
T3-Bee-Q @ 15 gms/ ltr	14.66d	37.52	18.12d	15.56	38.16c	15.81	238.33c	3.77	147.00b	12.49
T4-Fruit boost @ 0.5ml/ltr	19.00a	78.23	21.83a	39.22	42.41a	28.71	285.00a	24.09	154.00a	17.85
T5-Fruit boost @ 0.75ml/ltr	16.00c	50.09	19.13c	22.00	38.41c	16.57	239.67b	4.35	149.33b	14.28
T6-Fruit boost @ 1ml/ltr	15.00d	40.71	19.08c	21.68	38.83c	17.84	239.00c	4.06	147.67b	13.00
T7-Cinnamon leaf extracts (5%)	13.00e	21.95	17.96d	14.54	37.55d	13.96	238.00c	3.62	143.33c	9.68
T8-Tuberose floral scented water	12.66e	18.76	17.51e	11.67	36.83d	11.77	233.33c	1.59	137.67d	5.35
T9-Sugar solution (10%)	12.00f	12.57	17.05f	8.73	35.80e	8.64	232.00d	1.01	134.33e	2.80
T10-Open pollination (control)	10.66g	-	15.68g	-	32.95f	-	229.67d	-	130.67f	-
F-value	17.07		41.10		15.30		14.40		25.80	
SEm±	0.327		0.152		0.371		2.278		0.832	
CD at 5%	0.964		0.448		1.094		6.720		2.454	

Sem±-Standard error CD-Critical difference.

Means followed by the same letter in a column do not differ significantly by DMRT.

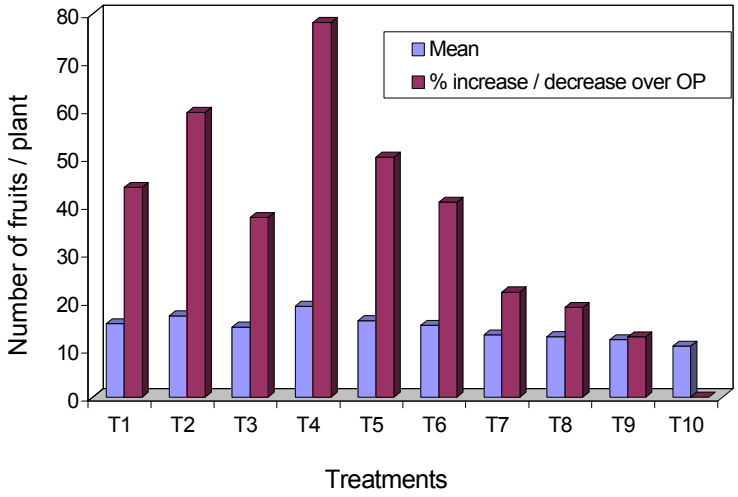

Fig-1a: Effect of bee attractants on the number of fruits per plant on Ridge gourd

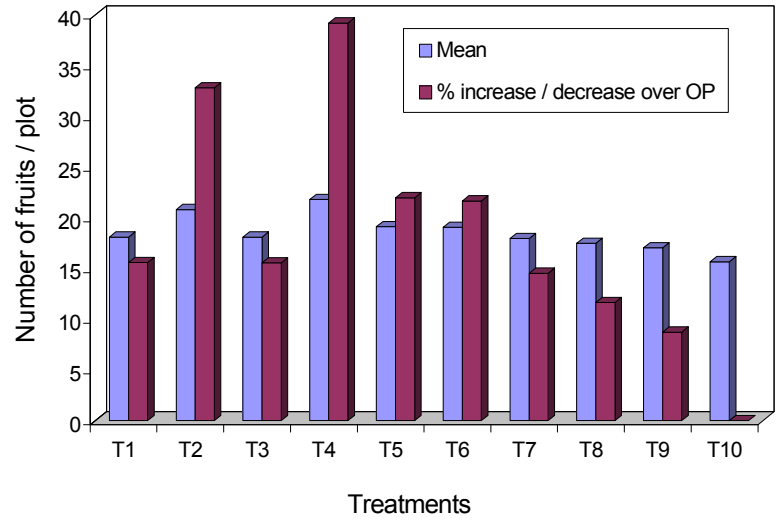

Fig-1b: Effect of bee attractants on the number of fruits per plot on Ridge gourd

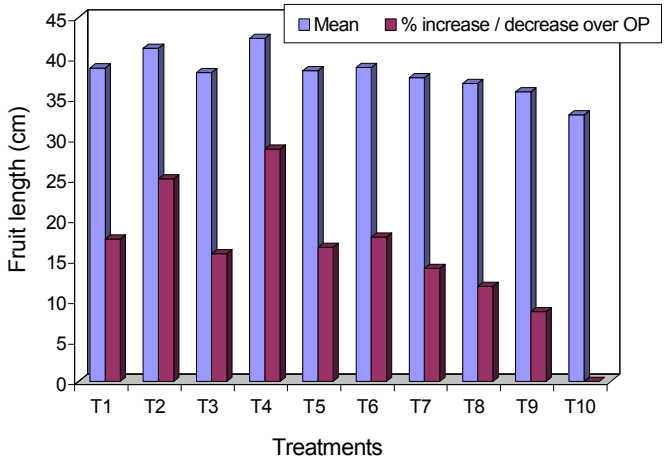

Fig-1c: Effect of bee attractants on fruit length (cm) of Ridge gourd

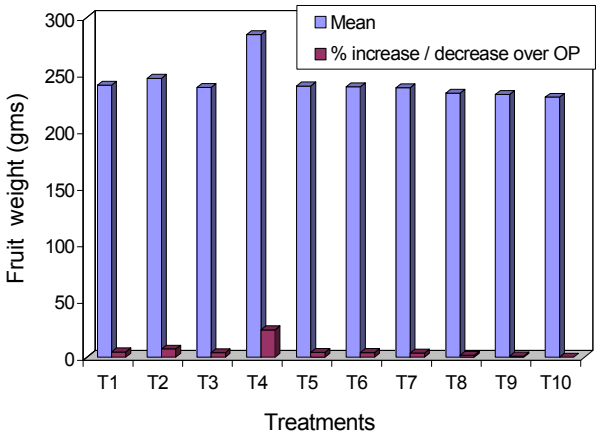

Fig-1d: Effect of bee attractants on fruit weight (gms) of Ridge gourd

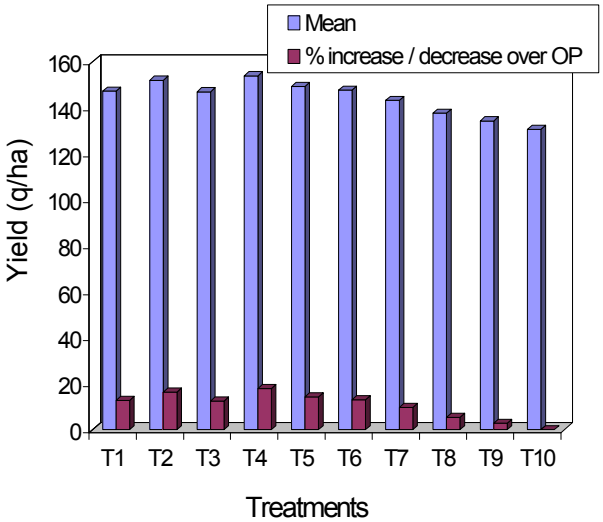

Fig-1e: Effect of bee attractants on yield (q/ha) in Ridge gourd

T1-Bee-Q @ 10 gms/l T2-Bee-Q @ 12.5 gms/l T3-Bee-Q @ 15 gms/l T4-Fruit boost @ 0.5ml/l
T5-Fruit boost @ 0.75ml/l T6-Fruit boost @ 1.0ml/l T7-Cinnamon leaf extract (5%) T8-Tuberose floral scented water
T9-Sugar solution T10-Open pollination (control)

Bee-Q @ 12.5 g/l (17.00 fruits / plant) these were on par with fruit boost @ 0.75 ml/l and Bee-Q @ 10 g/l when compared to the open pollinated plots (Fig. 1a).

Number of Fruits / Plot: Crop sprayed with Fruit boost @ 0.5 ml/l produced significantly highest number of fruits / plot (21.83 fruits / plot), which accounted for 39.22 % increase over open pollinated crop. However, next highest fruits / plot were recorded from Bee-Q @ 12.5 g/l (20.83 fruits / plot), which resulted in 32.84% increase over open pollinated plot which were on par with Fruit boost @ 0.75, 1 ml/l (19.13 and 19.08 fruits / plot). Whereas the remaining treatments were also effective in producing more number of fruits when compared to open pollinated crop (15.68 fruits / plot) (Fig. 1b).

Fruit Length (cm): Spraying of Fruit boost @ 0.5 ml/l produced the higher fruit length of 28.7% over open pollinated plot. The next best bee attractant to increase the length of the fruit was Bee-Q @ 12.5 g/l (41.21 cm) over open pollinated plot (32.95 cm). Where as the treatment that received Fruit boost @ 0.75 ml/l (38.83 cm) and Bee-Q @ 10 g/l (38.75 cm) were on par with the above said treatments. The remaining treatments recorded less length when compared to open pollinated crop (Fig. 1c).

Fruit Weight (gms): Significantly higher fruit weight was recorded in the treatment that received Fruit boost @ 0.5 ml/l (285.00 gms), which accounted for 24.09% increase over the open pollinated crop. The next best treatment was Bee-Q @ 12.5 g/l (243.33 gms), which resulted in 25.06 % increase over the open pollinated plot. Treatment with Bee-Q @ 10 g/l (240.33 gms) and Fruit boost @ 0.75, 1ml/l (239.67 gms and 239.00 gms) were the next superior treatments as against the open pollinated plot (229.67 gms). The remaining treatment was not effective to yield more weight of fruits than open pollinated crop (Fig. 1d).

Fruit Yield (q/ha): Crop sprayed with fruit boost @ 0.l produced significantly highest fruit yield of 154.00 q/ha, which accounted for 17.85 % increase over open pollinated plot. However, the next best treatment was Bee-Q @ 12.5 g/l (246.33 q/ha), which accounted for 16.32 % increase over open pollinated crop. This treatment was on par with fruit boost @ 0.75 ml/l (149.33 q/ha) which resulted in 14.28 % increase over open pollinated crop. The remaining treatments were also effective than that of open pollinated crop (Fig. 1e).

DISCUSSION

Role of Bee-attractants on the Yield Parameters Are Discussed

Relative Effectiveness of Bee-attractants and Yield Parameters of Ridge Gourd

Number of Fruits / Plant: The crop sprayed with fruit boost @ 0.5 ml/l produced significantly higher number of fruits (19.00 fruits / plant) and the next best attractant was Bee-Q @ 12.5 gms/l (17.00 fruits / plant) followed by fruit boost @ 0.75 ml/l and Bee-Q @ 10 gms/l.

These findings corroborate the results of McGregor and Todd(1952) [4] who also reported that no melon flowers set fruit until the bees were introduced into caged melon plot, but when bees were introduced, there was a rapid fruit set resulting in the production of 184 marketable melons.

Number of Fruits / Plot: Crops sprayed with Fruit boost @ 0.5 ml/l produced significantly highest number of fruits/plot (21.83 fruits / plot) which accounted for 39.22 % increase over open pollinated crop. Whereas the remaining treatments were also effective in producing more number of fruits when compared to open pollinated crop (15.68 fruits / plot). These findings corroborate the results of Kalmath [5] on onion, Guruprasad [6] on Niger.

Fruit Length (cm): Spraying of Fruit boost @ 0.5 ml/l produced higher fruit length of 28.7% over controlled plot. The next best bee attractant to increase the length of the fruit was Bee-Q @ 12.5 g/l (41.21 cm) over open pollinated plot (32.95 cm). The remaining treatments recorded less length when compared to open pollinated crop.

These findings corroborate the results of Mohan Rao and Suryanarayana [7] and Sattigi *et al.* [8] on Watermelon, Kauffels *et al*. [9].

Fruit Weight (gms): Significantly higher fruit weight was recorded in the treatment that received Fruit boost @ 0.5 ml/l (285.00 gms) which accounted for 24.09% increase over the open pollinated crop. The remaining treatment was not effective to yield more weight of fruits than open pollinated crop. The present results are in close agreement with the reports of Sunder [10] and Rafiq Ahmed [11] on Cucumber.

Fruit Yield (q/ha): Crop sprayed with fruit boost @ 0.l produced significantly higher fruit yield of 154.00 q/ha, which accounted for 17.85 % increase over open

pollinated plot. However, the next best treatment was Bee-Q @ 12.5 g/l (246.33 q/ha), which accounted for 16.32 % increase over open pollinated crop. The remaining treatments were ineffective than that of open pollinated crop. The present results are in close agreement with the reports like Schultheis *et al*., [12] and Prakash [13].

Increase of yield parameters like Number of fruits / plant, Number of fruits / plot, Fruit length (cm), Fruit weight (gms) and Fruit yield (q/ha) was due to spraying of Fruit boost and Bee-Q. Fruit boost with its Pheromonal effect attracted more pollinators, i.e., honey bees transferring pollen grains from one flower to another and providing the most favorable conditions for better selectivity and higher stigmatic receptivity. Bee-Q is rich in carbohydrate content and has a phagostimulatory effect, which attracted more pollinators to the flowers. Bee-Q increased bee-visits on both staminate and pistillate flowers, which resulted in adequate pollination.

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