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Influence of Bee Attractants on Watermelon (*Citrullus lanatus* L.) For the Improvement of the Crop

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Abstract: The usage of bee attractants, Bee-Q and Fruit Boost™ in the pollination of watermelonwas evaluated. The bee visitations on target crop flowers were made for two weeks followed by estimation of yield parameters. The different concentrations of Bee-Q and Fruit boost™ was evaluated to understand the honeybee visitation pattern of the target crop for improving pollination efficacy. The observations indicate that, Bee-Q at 12.5 g/l and Fruit boost at 0.5 ml/l of watermelon plots meagerly attracted a number of bee foragers than the control plots. In addition, the plots sprayed with bee attractants marginally enhanced of the fruits/plant, weight of fruits. The present investigation suggests that the bee attractants increases certain amount of bee visitation, in turn, leads to increase in fruits/plant, weight of fruits on watermelon.

Key words: Bee visitation · Bee-attractants · *Citrullus lanatus* L. *Apis florea* · *Apis dorsata*

INTRODUCTION

Watermelon (*Citrullus lanatus*) belongs to the family Cucurbitaceae, it also contains a bottle gourd, ridge gourd and snake gourd. The fruit is generally eaten raw. Watermelon has very high water content (93 ml/ 100g edible portion). It contains carbohydrates (5mg), calcium (8mg), phosphorous (9 mg), ascorbic acid (8 mg) and vitamins (0.64 g) per 100 g of edible portion. Among insect pollinator agents, honeybees are known to be the most efficient pollinating agents of cucumber for many years [1, 2, 3]. Honeybees are known to increase the yield of Cucurbitaceous crops by 100 to 150% [4]. According to [5] a cucumber flower should be visited 8 to 10 times for satisfactory fruit set, but the number of seeds and weight of fruit increases by 40-50 honeybee visits. The cucumber plants were caged before bloom to illustrate that female blossoms need to be pollinated by insect to set fruit and placed a strong colony of *Apis mellifera*to supplement a limited supply of wild pollinators [6]. A number of workers claim that to ensure cucumber pollination and fruit set, the bee must visit 8 to 10 times per flower [7 and 8].A study was carried out to show that 15 to 20 bee visits were needed to get uniform cucumbers and multiple bee visits increased the average number of seeds which resulted in better and maximum fruit weight [9].

In the present situation we required more pollinators for better fruit set on target cropand it is too difficult to attract honeybees to the target crop, because of all neighboring crops also compete for limited pollinators [10]. Under conditions of compromised pollinator efficacy, honeybee attractants may help focus limited pollinators onto the crop of interest [11]. Of a handful of tests bee attractants [12, 13, 14, 15, 16 and 17], those based on queen mandibular pheromone (QMP), Fruit boost and Bee-Q based on carbohydrate rich have had the most promising research record [18, 19 and 20]. Impact of bee attractants in increasing marginal pollination and yield on Ridge Gourd has been reported[21], on Guava [22], on Pumpkin [23], on Niger [24], on Pigeon pea [25], on Ridge gourd bee visitation [26] on Mustard [27].The objective of this study was to determine the use of bee attractants to watermelonduring bloom promotes pollination by honey bees under conditions of requirement of more pollinators to the target crop for better fruit set.

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MATERIALS AND METHODS

Experimental Layout: The experiment was conducted in an agricultural farm located 20 km from Bangalore, India during 2010-2012. Watermeloncrop was raised in an area of one hectare by following suitable agricultural practices recommended by the Agriculture Department. Seven experimental plots of 5x5 square meter area with row spacing of 2 meters were set up in the agricultural farm. The number of bee attaractants including Bee-Q was purchased from M.S Excel Industries, Bombay. Fruit boost purchased from Canada. We conducted many experiments to know the efficacy of bee attaractants performed with three concentrations of Bee-Q (10, 12.5 and 15 g/l) and three concentrations of Fruit boost (0.5, 0.75 and 1.00 ml/l) and without any spray as a control.

Treatment Assignments: From each plot we selected 10 branches with flowers randomly (three plots per treatment) and were labeled. The agricultural field was introduced with two heavy colonies of honeybees for pollination. Bee attractants like Bee-Q and Fruit boost were sprayed on the target crop bloom with a sprayer. These attractants were sprayed on flowers of watermelon during different intervals. The number of honeybees visiting the watermelonflowers sprayed with bee attractants was counted through vision. Many bees visited to the crop between 08.00 to 16.00 hrs in a day [28]. Each observer walked down each row for five minutes foe counting of bees visited to the flowers (5min x 3 replicas =15 min per plot, 7 rows x 3 replicas = 21min, 21min x 5min=105 min for all plots within two hours). The bee touches the flowers for about 10 to 15 seconds was considered to be a 'visit'. Observations on bee visitation were recorded on the first day after spray (08 Oct, 2012), followed by the 3rd day (10 Oct) and 5th day (12 Oct) after spraying the bee attractants. The first day after the second spray (50 percent blooming) of attractants were sprayed on watermelon (14 Oct) followed by 2nd day (16 Oct) and 3rd day (18 Oct, 2012) after spray. Each observer recorded by sight the number of honeybee flower visitors in respect of many species.

Harvest Parameters: On 1th Dec 2012, the earlier tagged branches with fruits were harvested from each treatment and the number of fruits per plant was recorded. From these fruit length and diameter were measured from each replication of treatment and data were statistically analyzed.

Climate and Statistical Analysis: The meteorological data were collected from the University of Agricultural Sciences, meteorological center located about two km from the experiment station. All response variables were analyzed statistically by using SPSS version 11.0 with one way ANOVA and DMRT with standard errors.

RESULTS

First Spray (10% Flowering) and Bee Visitation: Observations on honeybee visitation on Cucumber treated with bee-attractants at 10 and 50% flowering of the crop are presented in Table 1. The spray with Fruit boost 0.5 ml/l and Bee-Q 12.5 g/l attracted the maximum number of beeson the 1st, 3rdand the 5th day after 1st spray. A second spray (50% flowering) and bee visitation. First, 3rd and 5th day after the 2nd spray withFruit boost 0.5 ml/l and Bee-Q 12.5 g/l attracted more number of bees.

Table 1: Bee-attractants and honeybee-visitation, showing all 7 treatments with first (10% and second (50%) spray on Watermelon

	Number of honeybees / 10 flowers / 5 min						
	First spray (10% flowering)				Second spray (50% flowering)		
Treatments	1 DBFS	1 DAFS	3 DAFS	5 DAFS	1 DASS	3 DASS	5 DASS
T1–Bee-Q 10 g/l	2.66	4.66	4.33	4.66	4.33	4.00	4.66
T2–Bee-Q 12.5 g/l	2.66	4.33	7.68	5.00	4.33	7.45	4.66
T3–Bee-Q 15 g/l	2.66	4.33	3.00	3.00	4.00	4.66	4.66
T4– Fruit boost 0.5ml/l	2.00	5.00	8.66	7.00	5.66	7.33	5.33
T5–Fruit boost 0.75ml/l	2.33	4.66	4.00	3.66	3.66	4.33	4.00
T6–Fruit boost 1ml/l	2.66	4.66	4.33	4.00	4.66	4.33	4.00
T7– Open pollination (control)	12.66	2.66	2.33	2.33	2.33	2.66	2.66
F-Value	25.45	30.38	60.49	62.78	21.18	57.89	40.97
Sem±	0.048	0.082	0.058	0.063	0.074	0.061	0.071
CD at 5%	0.141	0.242	0.171	0.186	0.218	0.180	0.209

DAFS - Day after first Spray, DASS-Day after second spray, *- Significant at P<0.05, SEm± - Standard error, NS – Non significant, CD- Critical difference,

Table 2: Effect of bee attractants on the yield parameters in Watermelon

Treatments	Total no. of fruits / plant Mean	% Increase / Decrease over OP	Single Fruit Weight (kgs) Mean	% Increase / Decrease over OP
T1–Bee-Q 10 g/l	6.66	57.81	6.5	116.66
T2–Bee-Q 12.5 g/l	9.85	133.41	7.5	150.00
T3–Bee-Q 15 g/l	5.60	32.70	5.5	83.33
T4–Fruitboost 0.5ml/l	10.66	152.60	8.5	183.33
T5–Fruitboost 0.75ml/l	5.57	31.99	6.5	116.66
T6–Fruit boost 1ml/l	5.48	29.85	4.5	50.00
T7– Open pollination (control)	4.22	--	3.0	--
F-value	14.85		74.67	
SEm±	0.161		0.152	
CD at 5%	0.475		0.448	

SEm± - Standard error *- Significant at P<0.05, CD- Critical difference

Table 3: Environmental conditions (average) during seven treatments conducted on Watermelon

Dates	Temperature (°C)	Relative Humidity (%)	Cumulative wind (Km)	Sun light (Hrs)
Oct-08-2012	30.0	49	270	8.6
Oct-10-2012	18.8	58	130	6.8
Oct-12-2012	27.8	98	230	1.8
Oct-14-2012	27.2	88	90	1.9
Oct-16-2012	29.2	95	270	5.5
Oct-18-2012	18.4	91	130	6.8

Harvest Parameters: The data on the yield parameters of Watermelon is given in Table 2. More number of fruits / plant,higher fruit weightwas recorded in the plot treated with Fruit boost 0.5 ml/l and Bee-Q @ 12.5 g/l.The number of fruits per plant was higher in plots treated with Fruit boost at 0.5 ml/l (10.66 fruits/plant representing a 152.60% increase over control). Similar results were observed in plots treated with Bee-Q at 12.5 g/l (9.85 fruits per plant, which represents a 133.41% increase over control. For Single Fruit Weight (kgs) was also higher when treating with Fruit boost at 0.5 ml/l 8.5 kgs per fruit, representing a 183.33% increase over the control. Plots treated with Bee-Q at 12.5 g/l also showed a significant difference in Single Fruit Weight (7.5 kgs /fruit), which equated to a 150.00% increase over control.

Climatic Conditions: The data on the climatic factors of Watermelon is given in Table 3. This data showed there is temperatureco-relation between the bee visitation on 08th and 18 th October is favorable for frequent bee visitation on watermelon.

DISCUSSION

Our work shows a consistent benefit of honeybee attractant in promoting pollination on watermelon. The two bees attract like Fruit boost at 0.5 ml/l and Bee-Q at 12.5 g/l increased honeybee visitation on flowers of watermelon compared to the open pollinated plots. Among the bee attractants Fruit boost 0.5 ml/l and Bee-Q 12.5 g/lwere recorded as the most effective on honeybee visitation on watermelon on the 3rd day after 1st spray and 3rd day after 2nd spray.These results are in close agreement with who reported spraying of bee attractants attracted the maximum number of bees [29]. The data on the climatic factor like temperature is favorable for bee visitation this leads to better fruit set on target crop.Observations made on the watermelon flowers are found that bee visits began when the temperature was about 17°C but flights were not abundant until the temperature reached 21°C [8]. The fruit number and weight were increased for the spraying of two most concentrated attractants namely Fruit boost 0.5 ml/l and Bee-Q 12.5 g/l. These results were in close line with the two commercial bee attractants on cucumber and watermelon [30 and 31]. They found that these attractants increased the yield and also bee visitation.

In conclusion, it appears that Fruit boost at 0.5 ml/l and Bee-Q at 12.5 g/l sufficiently increased honeybee visitation on flowers of watermelon to improve pollination performance over that in control plots. The bee visitation on this plant translated into a greater increase of yield parameters.

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REFERENCES

1. McGregor, S.E., 1976. Insect pollination of cultivated crop plants. USDA Agric. Handbook. U.S. Government printing office, Washington, D.C., pp: 345-351.
2. Grewal, G.S. and A.S. Sidhu, 1979. Note on the role of bees in the pollination of *Cucurbitapepo* L. Ind. Jou. of Agri. Sci., 48: 79-83.
3. Free, J.B., 1970. The conditions under which foraging honeybees expose their Nasonov gland. J. Api. Res., 7: 139-145.
4. Mel'nichenko, A.N., 1977. Pollination of agricultural crops. Amerind Publ. Co. Pvt. Ltd., New Delhi, pp: 406.
5. Shemetkov, M.P., 1957. The use of bees for pollinating cucumber in hot. Hours and forcing bees. Byall. Nacichnolekh Inf. Instpchelovedstro, 2: 21-24.
6. Coleman, V.R., 1979. Demonstrated commercial value of cucumber pollination by honeybees, Apis mellifera. *Proceedings of 4th International Symposium on Pollination*. Maryland Agricultural Experimental Station Special Miscellaneous Publication, 1: 189-190.
7. McGregor, S.E., M.D. Levin and R.E. Foster, 1965. Honeybee visitors and fruit set of cantaloupes. J. Eco. Ent., 58: 968-970.
8. Conner, L.J. and E.C. Martin, 1969. Honeybee activity in hybrid Cucumbers (*Apis mellifera* L.) Brch. Ento. Soci. of Ame., 24: 25-26.
9. Collison, C.H., 1976. The inter-relationship of honeybee activity, foraging behaviour, climatic conditions and flowering in the pollination of pickling Cucumber (Cucumis sativus L.) Ph.D Thesis submitted to Michigan State Univ., U.S.A, pp: 268.
10. Levin, D.A. and W.W. Anderson, 1970. Competition for pollinators between simultaneously flowering species. The Amer. Natu., 104(939): 455-467.
11. Delaplane, K.S. and D.F. Mayer, 2000. Crop pollination by bees. CABI; Wallingford, United Kingdom, pp: 344.
12. Mayer, D.F., R.L. Britt and J.D. Lundon, 1989a. Evaluation of Bee scent as a honeybee attractant. Ame. Bee J., 129: 41-42.
13. Mayer, D.F., R.L. Britt and J.D. Lundon, 1989b. Evaluation of Bee scent as a honeybee attractant. Good-Fruit Grower, pp: 40-40.
14. Elmstrom, G.W. and D.N. Maynard, 1991. Attraction of honeybees to the watermelon with bee attractant. Proceedings of the Florida state Horticultural Society, 103: 130-133.
15. Winston, M.L. and K.N. Slessor, 1993. Application of queen honeybee mandibular pheromone for beekeeping and crop pollination. Bee World, 74: 11-128.
16. Ambrose, J.T., J.R. Schuetheis Jr., S.B. Bambara and W. Mangum, 1995. An evaluation of selected commercial bee attractants in the pollination of Cucumbers and Watermelons. Amer. Bee J., 135: 267-271.
17. Higo, H.A., M.L. Winston and K.N. Slessor, 1995. Mechanism by which honeybee (Hymenoptera:Apidae) queen pheromone sprays enhance pollination. Ann. of Entom. Soci. of Amer., 88: 366-373.
18. Currie, R.W., M.L. Winston and K.N. Slessor, 1992a. Effect of synthetic queen mandibular pheromone sprays on pollination of fruit crop by honeybees (Hymenoptera: Apidae). J. Eco. Ento., 85(4): 1293-1299.
19. Currie, R.W., M.L. Winston and K.N. Slessor, 1992b. Effect of synthetic queen mandibular pheromone sprays on honeybee (Hymenoptera:Apidae) pollination of Berry crops. J. Eco. Ento., 85(4): 1300-1306.
20. Naumann, K., M.L. Winston, K.N. Slessor and M.J. Smirle, 1994. Synthetic honeybee (Hymenoptera: Apidae) queen mandibular gland pheromone applications affect pear and sweet cherry pollination. J. Eco. Ento., 87: 1595-1599.
21. Jayaramappa, K.V., P. Mahesh and H.R. Bhargava, 2011. Influence of Bee-attractants on yield parameters of Ridge Gourd (*Luffa acutangula* L.) Cucurbitaceae. Wor. Appl. Scie. J., 15(4): 457-462.
22. Menon, A., V. Sivaram and K.V. Jayaramappa, 2012. Influence of bee attractants and yield parameters of Guava (*Psidium guajava* L.). The Inter. J. Repro. Bio., 4(1): 37-42.
23. Jayaramappa, K.V. and V. Sivaram, 2013. Some aspects of Bee-attractants on Pumpkin. J. Che. Bio. and Phy. Sci., 3(3): 1801-1807.

24. Sivaram, V., K.V. Jayaramappa, M. Anita and R.M. Ceballos, 2013. Use of Bee-attractants in Increasing Crop Productivity in Niger (*Guizotiaabyssinica.* L). An Inter. J. Brazi. Archi. of Bio. and Tech., 56(3): 365-370.
25. Sivaram, V. and K.V. Jayaramappa, 2013. Influence of bee-attractants on pollination and yield in pigeon pea (*Cajanus cajan* (L.) Mill sp. The Inter. J. Plant Repro. Bio., 5(2): 194-198.
26. Jayaramappa, K.V. and H.R. Bhargava, 2013. Role of bee attractants on honey bee visitation of Ridge guard (*Luffa acutangula* L.) (Cucurbitaceae), J. Apic., 28(2): 131-137.
27. Sivaram, V. and K.V. Jayaramappa, 2013. Can commercial bee attractants influence in increasing bee attractants and productivity of Mustard, *Brassica campestries* L.? J. Api., 28(2): 139-145.
28. Rao, G.M. and M.C. Suryanarayana, 1990. Studies on the foraging behaviour of honeybees and its effect on the seed yield in Niger. Indi. Bee J., 52: 32-33.
29. Pateel, M.C. and H.N. Sattagi, 2007. Effect of different attractants on attracting the bees to Cucumber (*Cucumis sativus* L.) Crop. Kar. J. Agri. Sci., 20(4): 761-763.
30. Schuthesis, J.R., J.T. Ambrose, S.B. Bambara and W.A. Mangum, 1994. Selective bee attractants did not improve Cucumbers and Watermelon yield. Horti. Sci., 29: 155-158.
31. Viraktamath S. Anagoudar, 2002. Influence of bee attractants in enhancing pollination and yield parameters in *Cucumis sativa* L. Ind. Bee Jou. 64(1&2): 23-27.