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Natural attractants enhance pollinator visitation frequency in mango

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ABSTRACT: An experiment was carried out to evaluate the attractiveness of different natural compounds to major mango pollinators *viz., Chrysomya megacephala* and *Apis florea*. Sugar solution, jaggery solution, cane juice, mango pulp, fish wash and water were evaluated for their efficiency in attracting mango pollinators. All the attractants were tested at 10% concentration and a control spray was given with water. The attractants were tested in mango cultivar Alphonso. For *Apis florea*, cane juice recorded the highest attraction on 3rd day after spray followed by Jaggery solution with 1.20 and 0.96 bees/minute /panicle respectively. Fish wash spray reported highest attraction to *Chrysomya megacephala* with 2.06 fly/minute/panicle followed by Jaggery solution with 1.53 fly/minute/panicle.

Keywords: *Apis florea, Chrysomya megacephala*, attractants, fish wash

INTRODUCTION

Mango (*Mangifera indica* L) belong to the family Anacardaceae and it is grown under tropical and subtropical climates. Owning to its delicacy and aroma mango is often referred as the king of fruits. (Indu Metha, 2017). India is the largest producer of mango with 19687 Metric tonnes during the year 2016 – 2017 and the area under mango cultivation is increasing. The major mango growing states in India includes Tamil Nadu, Andhra, Telangana and Karnataka (Mamata Saxena, 2017). In mango, flowers are born as terminal inflorescence with sticky pollen which is a characteristic feature of entomophily (Fernando, 2016). Across the mango growing regions insects belonging to Orders Hymenoptera, diptera, lepidoptera and coleopteran were documented to forage on mango inflorescence. The mango pollinator guild is often dominated by dipterans irrespective of geographic variations. Calliphorids often referred as carrion flies, forage in large numbers on mango flowers during the flowering period (Dag, 2009; Reddy *et al.,* 2010; Huda *et al.,* 2015). Little bee, *Apis florea* forage on mango flowers in large numbers when compared to other *Apis* species. (Vasanthakumar *et al.,* 2018). Pollination efficiency is directly correlated to the pollinator visitation rate. Increased pollinator visitation has resulted in enhanced fruit and seed set in different crops (Benoît Geslina *et al.,* 2017; Marabi and Bhowmick, 2014). However, Pollinator decline and corresponding deficit in crop pollination is of much concern globally. Decline in managed pollinator like Honey bees due to various factor like habitat loss (Dhruda Naud, 2009), pesticides (Tomasz Kiljanek *et al.,* 2016), diseases Dennis vanEngelsdorp, 2017), climate change (Le Conte, 2008) to name a few is evident. Recruiting large number of pollinators to the flowering plants in orchards will help in enhancing crop pollination. In nature flowers produce a boquet of odour to attract pollinators. Artificial attractants which contain specific chemical has increased pollinator visitation. For instance, commercial products like Fruit boost and BeeQ are effective in recruiting more bees to the crops in which they are sprayed (Viraktamath and Patil, 2002). Although much work is done on the lines of attractants for honey bees, research on attractant studies of other order of insect pollinators like diptera and coleoptera are very scarce. Crop loss due to pollinator deficit in mango orchards is already reported (Muhammad Khalid Rafique, 2016). Hence, considering the above literature, experiment was designed to find the efficiency of naturally available compounds to attract the major pollinators of mango viz., *Chrysomya megacephala* and *Apis florea*

MATERIALS AND METHODS

Field studies were was carried out in the six years old mango cultivar 'Alphonso' at Indian Institute of Horticultural Research fruit orchard, Bengaluru. Ready availability and cost effectiveness are the major factors which govern the protocol adaptability by the farmers. Hence, the following six attractants, *viz.*, Sugar solution (10%), Cane Juice (10%), Jaggery (10%), Mango juice (10%), Fish wash (filtrate of 100gm minced fish in 20 litres water) and water were chosen for the study with three replications for each treatment. Spray volume of ten litres was prepared in the required concentration for each treatment and sprayed during the evening hours covering the entire tree canopy with a knapsack sprayer. Trees which were in 50% flowering were selected for the experiment. In each treatment pollinator activity was recording during 0900 hrs to 1200 hrs on ten randomly selected panicles for one minute. Data were recorded one day prior to spray, one day after spray and then after every alternate day till seventh day. The data were subjected to

statistical analysis using SPSS 2.0 software.

RESULTS AND DISCUSSION

Apis florea was observed at densities 0.56 to 0.80 bees/panicle/min before spray. There is no statistically significant difference among samples. The observation on the visitation rate following spray is tabulated in Table 1. Cane juice (10%), sugar solution (10%) and water spray showed highest attraction (1.10, 0.90 and 0.90 bees/panicle/min) one day after spray followed by Jaggery solution (10%) and mango juice (10%) with 1.06 and 0.60 bees/panicle/min respectively. Fish wash spray showed least attraction with 0.26 bees/panicle/min ($F= 18.82$, $df = 5$, $p < 0.0005$). On third day after spray cane juice (10%) was the most effective followed by Jaggery (10%) and mango juice (10%) with 1.20, 0.96 and 0.76 bees/min/panicle respectively. Sugar solution (10%) and water attracted 0.60 and 0.56 bees/panicle/min respectively and fish wash spray remained least attractive with 0.33 bees/panicle/min. On fifth day after spray still cane juice (10%) and Jaggery solution (10%) remains superior over other treatments with 0.83 and 0.63 bees/panicle/min. attractiveness by sugar solution (10%) and fish wash was on par with each other ($F=13.40$, $df =5$, $p< 0.0005$). On seventh day after spray except for fish wash treatment all other treatments were on par with each other. In summery among the treatments cane juice 10% was more effective in recruiting *Apis florea* followed by Jaggery solution (10%). Fish wash was least effective. The results were in corroboration with the findings of Jogindar and Painkra 2018, where cane juice spray was superior to Jaggery solution in attracting more number of bees. In an similar studies on the attraction of bees to cucumber flower with different spray modules, Patel and Sattagi 2017 found no significant difference among cane juice spray, jaggery spray and sugar spray in attracting *Apis florea* but jaggery spray recruited more *Apis cerana* and *Apis dorsata* to the flowers significantly deciphering the difference in preferences towards natural compounds among the honey bees.

Fly, *Chrysomya megacephala* on the other hand responded differently to the spray modules. Like *Apis florea*, the population density on the flowers one day before spray did not show any difference statistically.

Table 1. Effect of different attractants on visitation frequency of *Apis florea* in mango cv Alphonso

Treatment	No. of bees/minute/panicle (mean ± SD)				
	Pre count	1 DAS	3 DAS	5 DAS	7 DAS
Sugar (10%)	0.66± 0.11^{a}	0.90 ± 0.10^{a}	0.60 ± 0.10^{c}	0.47 ± 0.05^{cd}	0.63±0.05^{a}
Jaggery (10%)	0.70± 0.10^{a}	1.06 ± 0.05^{b}	0.96 ± .05^{b}	0.63 ± 0.11^{b}	0.70±0.10^{a}
Cane juice (10%)	0.73± 0.11^{a}	1.10 ± 0.20^{a}	1.20 ± .17^{a}	0.83 ± 0.05^{a}	0.76±0.05^{a}
Mango juice (10%)	0.63± 0.15^{a}	0.60 ± 0.10^{b}	0.76 ± 0.05^{bc}	0.60 ± 0.10^{bc}	0.63±0.11^{a}
Fish wash	0.56 ± 0.05^{a}	0.26 ± 0.15^{c}	0.33 ± 0.11^{d}	0.46 ± 0.05^{cd}	0.43±0.15^{b}
Water	0.80 ± 0.20^{a}	0.90 ± 0.10^{a}	0.56 ± 0.08^{c}	0.36 ± 0.05^{d}	0.66±0.13^{a}
S.E	0.03	0.07	0.07	0.04	0.03
C.D (P=0.05)	0.09	0.23	0.22	0.12	0.09

DAS – Days after spray; means in column followed by common letter are not significantly different at 5% (DMRT)

Counts were between 0.80 to 1.26 flies/panicle/min. One day after spray fish wash, Jaggery solution (10%), Mango Juice (10%) attracted more flies and were on par with each other recruiting 1.96, 1.6, 1.63 flies/panicle/min respectively. Likewise, cane juice (10%), sugar solution (10%) and water were on par with each other with 0.96, 1.03, 0.96 flies/panicle/min respectively. On the third day after spray fish wash spray was superior over all other spray modules with 2.06 flies/min/panicle ($F=13.28$, $df = 5$, $p < 0.0005$), next to fish wash spray the order of attractiveness was Jaggery solution (10%), cane juice (10%), sugar solution (10%), mango juice (10%) and water with 1.53, 1.16, 0.90, 0.93 and 1.03 flies/panicle/min respectively. Fish wash remained superior even at fifth day after spray over the other spray modules. Jaggery (10%), cane juice (10%), Mango juice (10%) and water spray attracted 1.20, 0.96, 0.93, 0.95 flies/panicle/min respectively and were on par with each other. Seventh day after spray except for fish wash all other treatments were on par with each other with Sugar solution (10%), Jaggery (10%), cane juice (10%), Mango juice (10%) and water spray attracting 0.93, 0.96,

Table 2. Effect of different attractants on visitation frequency of *Chrysomya megacephala* in mango cv Alphonso

Treatment	No. of flies/minute/panicle (mean ± SD)				
	Pre count	1 DAS	3 DAS	5 DAS	7 DAS
Sugar (10%)	0.93± 0.15^{a}	1.03±0.11^{b}	0.90±0.10^{c}	0.73±0.25^{b}	0.93±0.05^{b}
Jaggery (10%)	0.80±0.36^{a}	1.6±.35^{a}	1.53±0.45^{b}	1.20±0.30^{ab}	0.96±0.20^{b}
Cane juice (10%)	0.83±0.05^{a}	0.96±0.11^{b}	1.16±0.06^{bc}	0.96±0.20^{ab}	0.93±0.15^{b}
Mango juice (10%)	1.13±0.30^{a}	1.63±0.40^{a}	0.93±0.15^{c}	0.93±0.20^{ab}	0.90±0.20^{b}
Fish wash	1.26±0.64^{a}	1.96±0.30^{a}	2.06±0.15^{a}	1.40±0.43^{a}	1.63±0.37^{a}
Water	0.93±0.05^{a}	0.96±0.20^{b}	1.03±0.11^{c}	0.95±0.20^{ab}	0.86±0.34^{b}
S.E	0.07	0.10	0.10	0.07	0.08
C.D (P=0.05)	0.23	0.33	0.32	0.24	0.25

DAS – Days after spray; means in column followed by common letter are not significantly different at 5% (DMRT).

0.93, 0.90 and 0.86 flies/panicle/min respectively. Fish wash outstood other treatments with 1.63 flies/panicle/min in the seventh day after spray. In summery fish wash was most effective in recruiting more number of flies followed by jaggery solution (10%).

Calliphorids are attracted towards flowers emanating pleasant smell and foul smell in nature. *Aristolochia cymbifera* flowers emits foul smell which attract members of the family Calliphoridae, sarcophagidae and musidae. The pleasant smell of *Antidesma montanum* flowers were reported to attract *Chrysomya* sp. (Johnson and Jurgens 2010, Li and Zhang 2007). Woodcock *et al* 2014 review lists few dominant chemical volatile compounds found in the flowers which are frequented by flies, this includes amine derivatives, alchohols, aliphatics, benzenoids, monoterpenoids, Phenylpropanoids and sulphur compounds. Eighty five percentage of *Chrysomya megacephala* flies were attraction to catfish when provided as food source within 5 minutes of introduction in the study conducted by Nophawan Bunchu *et al* 2008. Similarly in our findings fish wash was more attractive to *Chrysomya megacephala.* In Ghana farmers hang pieces of meat in trees during mango flowering season to attract more number of calliphorids to their orchards. (FAO, 2008)

Cane juice is chemically diverse, it contains carbohydrates, sugars, inorganic ions, organic acid and vitamins. (Walford S.N 1996). Cane juice is the raw material for jaggery and sugar production. Jaggery contains essential vitamins like thiamine, riboflavin and niacin which insects cannot synthesise, in addition other vitamins are also present in jaggery. Jaggery also contains key minerals like copper, manganese, copper which play important role as cofactors in enzymatic reactions and amino acid phenylalanine. In a study conducted by Hendriksma *et al*., (2014) about behavioural response of bees to amino acids in floral nectars, honey bees prefer foraging in nectar with phenylalanine than sucrose even when the concentration of sucrose is 84 times higher than the amino acid. Various phenolics, glycosides and antioxidants are also found in jaggery (Walter R. Jaffe 2015). This could be the reason for jaggery spray and cane juice spray to recruit both *Apis florea* and *Chrysomya megacephala* to mango flowers. Refined Sugar contains only carbohydrate lacking most of the nutrients during the refining process rendering it nutritionally poor. This could be the reason for less attractiveness of pollinators to sugar solution spray.

Flies and bees are good pollinators of mango. Further combination of the spray modules could help in understanding more about the attractants and deciphering combinations modules for attracting both group of pollinators.

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