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Floral Biology and Impact of Bee Pollination in Mango

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ABSTRACT: Mango is very important fruit crop in Nagaland and is visited by large number of insect visitors. The faunal diversity and the true pollinators of mango in this region is not recorded scientifically with a very less data is available on this aspect of mango cultivation. Keeping in view the importance of insect fauna and to know the role of specific pollination in mango, an experiment was laid out with 4 different pollination treatments i.e. stingless bee (*Tetragonula iridipennis*) pollination, *Apis cerana* pollination, open pollination and pollinator exclusion (Control). Floral biology and pollinator's diversity of mango was studied using standard methods. Trees were caged with insect proof nylon nets for pollination treatments in 3 replications. A total of 27 major insect visitors/ pollinators' fauna species were recorded foraging on mango. The Shannon-Wiener diversity Index revealed higher pollinator diversity. Pollination Efficiency Index (PEI) for pollinators was also calculated. The maximum diurnal abundance of pollinators recorded between 0800-1200 h and the maximum foraging rate was found with syrphid flies and stingless bees. Floral biology showed that stigma remained receptive for more than 72 hours after anthesis. Yield and quality parameters under different modes of pollination revealed bee pollination was significantly superior over crop without pollination. Without pollination the yields and quality were too less in mango. The flies of Syrphidae and bees of genus Apidae were found as major pollinators of mango in this region. With these studies, the phenology of mango and its association with the nectarophiles is established. The impact of these pollinators on mango also worked out to ascertain the specific role of pollination in mango which will help the mango growers in increasing fruit production and conservation of pollinators.

Keywords: Mango, Floral biology, Diversity index, Pollination Efficiency Index, Pollination, Stingless bees, *Apis cerana*, Open pollination, Impact, Production, Quality.

INTRODUCTION

Honey bees have been conserved and utilized for their pollination services in various crops around the globe. *Apis mellifera*, *A. cerana*, *A. dorsata* and *A. florea* are the main pollinators abundantly found in different parts of the country. Among these species of honey bees, only two domesticated ones (*A. mellifera* and *A. cerana*) were recorded special value while other bee species were not studied widely (Meena, 2016). Honey bees are the primary and only dependable pollinators of many crops (Free, 1993). Stingless bees, Xylocopa bees, bumble bees, syrphid flies etc., are now emerging as pollinators for pollination of crops grown under open field and protected conditions (Chauhan *et al.*, 2019; Chauhan and Singh 2022). Different studies suggest horticultural crops such as mango, pomegranate, ber, aonla, phalsa, citrus, brinjal, tomato, bale, field beans, cucurbits, jamun and fig etc. need insect pollinators for effective pollination to acquisition the maximum yield (Haldhar, 2018; Heard, 1999).

Mango (*Mangifera indica* L.) is one of the important tropical fruit in the world belongs to family Anacardiaceae. In mango, both perfect and hermaphrodite flowers occur on the same panicle (Fraser, 1927). Anthesis starts early in the morning and completes at noon. Stigma receptivity remains for 72 hours but most receptive period is for the first 6 hours. Minimum pollen germination time is 1.5 hours (Spencer and Kennard, 1955). Initial fruit set depends upon the ratio of the number of hermaphrodite flowers to male flowers. The style of the hermaphrodite flower has a small stigmatic surface grooved as a receptive surface for pollen grains (Ding and Darduri 2013). The point at which flower buds fully open and become functional is called anthesis, which used to happen during the morning hours. Active pollination plays a crucial role in transfer of pollen grains from stamens to stigma. The flowers in return provide pollen and nectar for this service extended. Visits by insects increase yields of mango (Free and Williams 1976). In mango, the flowers are unspecialized, allowing pollination by most of the visiting insects. Pollination in mangoes is mainly due to insect pollinators from the orders Diptera, Hymenoptera, Coleoptera, and Lepidoptera (Ramirez and Davenport 2016). However, Kumar *et al.* (2016) found that Hymenopteran and Dipteran insects are major pollinators of mango orchards. Other insect orders such as Lepidoptera and Coleoptera are also recognized as pollinators but these insects are comparatively less important ones. Stingless bees are the most common insects visiting mango blooms (Singh, 1988). Different researchers reported honeybees, stingless bees, flies, megachilids etc. as important visitors of mango blooms (Singh, 1997; Sung *et al.*, 2006; Sharma *et al.*, 1998). Keeping in view the importance of different insects in pollination of mango, effectiveness of different modes of pollination on mango production and productivity was evaluated in this study.

MATERIAL AND METHODS

The experiment was carried out at the Experimental farm, Central Institute of Horticulture, Medziphema and Honeybee farm, School of Agricultural sciences and Rural Development, Medziphema (23°45′43″N and 93°52′04″ E) for two years. Floral biology of mango flowers was studied pertaining to characters like time of anthesis, type of flowers, panicle length, stigma receptivity, pollen size etc. After flowering, colonies of *T. iridipennis*, *A. cerana* were introduced at 10% blooming stage in separate cages and control (no pollinator was introduced). Similarly, mango trees were kept without net open condition for treatment. All agronomical practices were done as per good agricultural practices. The observations started in February and went up to July each year. The trees came to bloom in the third week of February. After that the bee colonies were shifted in the experimental farm as per treatment and data were recorded. Foraging activity of bees and other pollinators was recorded as per the method adopted by Chauhan (2015) under open field conditions from early morning (0600 h) till late evening (1800 h) at two hours interval for seven days continuously. Pollination efficiency was derived for each species as suggested by Bohart and Nye (1960). Impact of different pollination modes on mango was evaluated with per cent fruit set in tagged panicles round the tree. Ten panicles from each treatment were selected and tagged randomly. The fruit set on these panicles were then recorded and total yield was calculated on fruit set basis. Healthy fruits (%) and deformed fruits (%) were also calculated. Similarly, fruit length (cm), fruit width (cm), TSS (%), dry matter (%), ash content (%) and moisture (%) seed weight and seed number were calculated to know the impact of pollination. Analysis of data was done as per statistical methods.

RESULTS AND DISCUSSION

The diversity of different pollinators visiting mango blooms was observed and recorded. A total of 27 major insect visitor species were recorded to visit the flowers of mango. Out of these, 20 fauna were identified at species level and 7 were identified at genus level and three more dipteran species were visiting the flowers and could not be identified, although 16 pollinator species were Hymenopterans, seven were Dipterans, two Lepidopterans and one Hemiptera and Coleoptera each. Out of Hymenoptera, 11 species belong to family Apidae, 5 Syrphidae, 2 Megachilidae, 2 Muscidae and one each of Halictidae, Formicidae, Vespidae, Biblionidae, Papilionidae, Nymphalidae and Coccinellidae family. Out of insect visitors, those 13 species which collected both nectar and pollen were *Apis cerana*, *A. dorsata*, *A. florea*, *A. mellifera, Tetragonula iridipennis*, *T. gressitti*, *Lophotrigona canifrons*, *Lepidotrigona ventralis*, *Xylocopa tenuiscopa*, *X. fenestrata*, *Amegilla zonata, Megachile monticola* and *Megachile umbripennis*. However, *Episyrphus balteatus, Eristaltis* sp., *Eupeodus* sp., *Syrphus corollae*, *Melanostoma* sp., *Musca* sp., *Calliphora* sp.*, Halictus semiaerinus*, *Vespa* sp., *Monomorium indicum*, *Plecia nearctica*, *Papilio demoleus* and *Danaus* sp.were collecting nectar while *Coccinella septumpunctata* was collecting pollen and nectar from mango flowers. The most frequent visitors on mango inflorescence were recorded as *Apis cerana*, *A. dorsata*, *A. florea*, *A. mellifera, T. iridipennis*, *T. gressitti*, *L. canifrons*, *L. ventralis*, *A. zonata, M. monticola, Episyrphusbalteatus, Eristaltis* sp., *Eupeodus* sp., *Syrphus corollae*and *Megachile monticola* while *X. tenuiscopa*, *X. fenestrata*, *Melanostoma* sp., *Megachile umbripennis, Musca* sp., *Calliphora* sp.*, Halictus semiaerinus*, *Monomorium indicum* and *Plecia nearctica* were noted as frequent visitors. However, *Papilio demoleus*, *Danaus* sp. and *Coccinella septumpunctata* were least frequent visitors. Similar observations were made by different researchers where the insects of order Hymenoptera and Diptera were the most important visitors on mango blooms (Hawkeswood, 1983; Tangmitcharoen and Owens 1997). Among different insect visitors on mango flowers, 14 insect visitor's gestures were observed as true insect pollinators throughout the blooming period of mango. All these 14 true pollinators belong to order Hymenoptera and Diptera. The Shannon-Wiener Diversity Index and Evenness Index of mango insect pollinator in Medziphema were H'= 2.73 and E= 0.96. The data reflects the rich insect pollinator's diversity of mango prevailing in Medziphema.

The diurnal abundance of pollinators varied significantly from each other. The activity of all the pollinators was high during late morning 0800-1000 h and the activity started declining afterwards and ceased at 1725 h. *Apis cerana*, *A. dorsata*, *A. florea*, *A. mellifera, T. iridipennis*, *T. gressitti*, *L. canifrons*, *L. ventralis*, *A. zonata, M. monticola, Episyrphus balteatus, Eristaltis* sp., *Eupeodus* sp., *Syrphus corollae, Megachile monticola, X. tenuiscopa*, *X. fenestrata*, *Melanostoma* sp., *Megachile umbripennis, Musca* sp., *Calliphora* sp.*, Halictus semiaerinus*, *Monomorium indicum* and *Plecia nearctica* were the important pollinators that visited the crop throughout the flowering time. Similarly, the foraging period of insect pollinators on mango flowers was recorded at blooming period of mango crop, among them, the earliest foraging initiation was observed with *Apis dorsata* (0548 h) followed by *Apis cerana* (0621 h), *Apis mellifera* (0635 h), *Lepidotrigona ventralis* (0714 h), *Apis florea* (0715 h), *Tetragonula iridipennis* (0719 h), *Tetragonula gressitti* (0726 h), *Syrphus corollae* (0741 h), *Lophotrigona canifrons* (0751 h), *Eristaltis* sp. (0754 h), *Eupeodus* sp. (0821h), *Episyrphus balteatus* (0832 h), *Megachile monticola* (0854 h), *Amegilla zonata* (0919 h), *Xylocopa fenestrate* (0954 h) and *Xylocopa tenuiscapa* (1028 h), The earliest cessation of activity was observed from *Eristaltis* sp.

(1421 h) while the activity was ceased late in *Apis dorsata* (1735 h) and *Xylocopa tenuiscapa* (1826 h). However, the peak activity of all pollinators ranged with in time frame of 0900-1230 h.

Floral biology of mango. The floral biology of mango is presented in Table 1. The panicles emerged in the third week of February. The panicles were of two types and mainly borne on the terminal shoots with two types of flowers i.e. male and hermaphrodite in mango. The length and breadth of the panicles were 25.67 cm ± 0.84 and 17.54 cm ± 0.31. The mango flowers were small but in huge numbers (800-2600/ panicle), yellowish or reddish, shiny, erect and pyramidal. The flower spread ranged between 6.12-6.54 mm in diameter and the length of the stamen and pistil ranged between 1.28-1.46 mm and 1.0-1.1 mm. The anthesis was higher during early and late morning hours (47.67 %) and stigma remains receptive for 3 days ± 0.94 after opening of flowers. The pollen grains are sticky, spheroidal/round in shape and having diameter of about 22.26 µm. The pollen viability was found as 89.40 per cent. Similar observations were recorded by Mandal *et al*. (2020) where they found the receptivity of stigma for 72 hours in certain cultivars of mango.

The different pollinators recorded active on the mango flowers are categorized into four groups *viz*., honey bees, stingless bees, syrphids and megachilids and other pollinators (Table 2). The relative abundance, foraging rate, foraging speed and loose pollen grains were recorded for these pollinators and pollination efficiency was worked out as per Bohart and Nye (1960).

Foraging activity of different pollinators on mango. Mean relative abundance of different pollinators on mango flowers revealed the mean activity of pollinators started at 0600h (6.17 pollinators/5 min/m^2) which then increased significantly to 7.27 pollinators/5 min/m^2 at 0800 h with peak activity at 1000 h (8.74 pollinators/ 5 min). The mean activity of syrphids and megachilids (8.68) was higher as compared to honey bees (5.43), stingless bees (5.68) and other pollinators (3.79) irrespective of time (Table 3). Thus, signifies the importance of dipterans in mango. The stingless bee activity (5.68) was at par with the activity of honey bees (5.43 bees). According to different researchers, insect pollinators have different foraging behavior that may influence their pollination efficiency (Neeman *et al*., 2010; Singh, 1988). Similarly, Singh and Chauhan (2020) observed stingless bees (*T. iridipennis, L. canifrons, L. ventralis*) as important visitors of several vegetable, fruits and medicinal crops in Nagaland and Heard (1999) in Australia.

Average foraging rate of different pollinators visiting the mango flowers revealed that the pollinators visited 6.98 flowers/5 minutes and significantly higher numbers of mango flowers were visited in late morning time 6.02 at 1000 h and 1200 h. Stingless bees visited a greater number of flowers (4.86 flowers/ 5 min) followed by syrphids (4.68 flowers/ 5 min), honey bees (3.81 flowers/5min) and other pollinators (3.02 flowers/5 minutes).

Foraging speed of different pollinators visiting the mango blooms revealed significantly more time per flower was spent in the early morning time 10.61 sec/flower at 0600 h irrespective of pollinator group. Honey bees and stingless bees spent approximately equal time on mango flowers during collection of pollen and nectar (7.18 and 7.16 sec/flower) followed by syrphid and megachilids (5.05 sec/flower) and other pollinators (3.42 sec/flower).

Numbers of Loose Pollen Grain (LPG) attached to pollinator's body were recorded. Honey bees (1307.33) outnumbered the stingless bees (1061.33), syrphids (571) and other pollinators (425.67 pollen grains). Similar results were found in ash gourd and watermelon while studying the foraging efficiency of pollinators (Chauhan *et al*., 2019, Jamir *et al.,* 2022). On comparison with Dipteran pollinators, bees and many other Hymenopterans carried a significantly higher proportion of pollen on their bodies (Howlett *et al*., 2011; Rader *et al*., 2011; Abrol, 2012).

Pollination Efficiency Index. Pollination efficiency data on mango revealed that Syrphid flies and Megachilid group have more pollination index value (32) as compared to stingless bees (27), honey bees (14) and other pollinators (6). Thus, based on the ranks assigned for different pollinators to different pollination attributes *viz*., relative abundance, foraging rate, foraging speed and loose pollen grains, Syrphid flies and megachilids (*Episyrphus balteatus, Eristaltis* sp., *Eupeodus* sp., *Syrphus corollae, Megachile monticola* and *Megachile umbripennis*) were found to be the best pollinators followed by stingless bees (*Tetragonula iridipennis*, *T. gressitti*, *L. canifrons* and *L. ventralis*) and honey bees (*Apis cerana*, *A. dorsata*, *A. florea* and *A. mellifera*) under low hill conditions in Nagaland. Bomfim *et al*. (2014) reported that the stingless bees primarily seek nectar in both pistillate and staminate flowers, although during their visits to staminate flowers, they got their bodies dusted with a great amount of pollen grains. Pollen of mango was found in pollen stores of hives of *Trigona angustula* in Chiapas (Sosa-Najera *et al.*, 1994). Similarly, in Australia, *Trigona* bees were the most efficient pollinators on the basis of the proportions of flowers pollinated after a visit. This efficiency is due to the large amount of pollen carried on their bodies and the close contact they made with the stigma. Furthermore, *Trigona* bees moved more frequently from tree to tree and thus were probably the most effective cross pollinators (Anderson *et al*., 1982).

Effect of different pollination modes on different parameters in mango. The role of pollinators in mango was determined by comparison of per cent fruit set, deformed fruits, fruit weight and fruit yield. The results revealed highest per cent fruit set (2.01 %) was recorded in open pollination followed by *Tetragonula iridipennis* pollination (1.33 %) and honey bee pollination (1.17%) while in control experimental conditions (without insect pollination), the fruit set was very low (0.02 %). Rajan and Reddy (2019) also found 41.93% less fruit set in bee pollinators excluded mango. The highest per cent deformed fruits were recorded from open pollinated trees (9.16 %) followed by stingless bees (7.00 %) and honey bees (7.63 %) which were at par to each other. However, without pollination the deformed fruit percentage was significantly less

(4.68 %). The highest fruit yield (21.34 kg/ tree) was recorded from open pollinated trees as compared to *Tetragonula iridipennis* (18.50 kg/ tree) and *Apis cerana* (18.44 kg/tree) which was significantly at par to each other. Under control conditions, the fruit yield was 1.44 kg/tree. The fruit weight was comparably at par in all pollinator treatments (192.54, 191.66 and 192.14 g) and higher in trees pollinated by pollinators over non pollinated trees (84.50 g). Several researchers observed that honey bees are not strongly attracted to mango flowers and are only occasionally observed (McGregor, 1976; Free, 1993). Flies are the most common visitors to mango flowers in many parts of the tropics (McGregor, 1976) and are probably also efficient pollinators. Thus, stingless bees and flies are the most important pollinators of this crop. Roselino *et al*. (2009) when compared two stingless bee species, *Nannotrigona testaceicornis* and *Scaptotrigona depillis*, as strawberry pollinators, reported that that *N. testaceicornis* was a superior pollinator to *S. depillis*. This might be due to the foraging habit of the bees for pollen and nectar in which *N. testaceicornis* take longer to forage than the *S. depilli*. Namwong (2003) found that high fruit yield of dragon fruit was obtained with stingless bees than open and hand pollination. Additionally, Kakutani *et al*. (1993) compared the performance of stingless bee *Trigona minangkabae* with *Apis mellifera* to pollinate strawberries in greenhouse and the results showed that both the bees have similar efficiency in pollinating the strawberries.

Effect of different modes of pollination on different quality parameters *viz*., fruit length (cm), fruit width (cm), TSS (%), dry matter (%), ash content (%) and moisture (%) was observed and data were recorded which revealed that longest fruits were observed in both *Apis cerana* (10.33 cm) and *T. iridipennis* (10.31 cm) treatments followed by open pollination (9.02 cm) and control (5.67 cm). However, the fruits from all treatments were having at par effect of pollination. TSS was higher (26.20 %) in mangoes pollinated by stingless bees and honey bees (26.14), but on the contrary, under open pollination and pollinator exclusion, TSS was at par to each other. The dry matter percentage was at par in all pollination treatments but higher than control. Similarly, ash content and moisture showed the similar trend (Table 4). In water melon, higher per cent fruit set and fruit quality reported by Chauhan and Singh (2020) by using stingless bees as pollinators against open pollination and pollinator exclusion. Slaa *et al.* (2006) reported that some stingless bee's species in the genera *Trigona* and *Plebeia* are efficient pollinators of avocado crop. Ish-Am and Eisikowitch (1998) also reported that eight to ten species of stingless bees were effective pollinators of avocado, together with the Mexican honey wasp. Can-Alonso *et al*. (2005) found that *A. mellifera* and *Trigona nigra* carried comparable amounts of avocado pollen grains on their bodies. Similarly, Viana *et al.* (2014) found that stingless bee (*M. quadrifasciata*) plays an important role as pollinator of apple flowers.

Table 1: Floral biology of mango.

Flower type	Time (h)	Anthesis (%)	Stigma receptivity	Anther dehiscence (10 panicles tagged)	Pollen viability (%)	Pollen shape and size (μ) (L × D)
1. Male and hermaphrodite 2. yellowish or reddish, shiny, erect and pyramidal	0500-0900	47.67	0-72 h (erect, shiny and translucent) Stigma remains receptive up to 3 days (non-receptive stigmas are dry and brownish in colour	7	89.40	Spheroidal Round 22.26± 0.49
	0900-1300	43.73		3		
	1300-1700	5.34		0		
	1700-1900	3.26		0		

Table 2: Pooling of different pollinators visiting blooms of mango.

Sr. No.	Pollinator	Categorization
1.	*Apis cerana*	Honey bees
2.	*Apis dorsata*	
3.	*Apis florea*	
4.	*Apis mellifera*	
5.	*Tetragonula iridipennis*	Stingless bees
6.	*Lophotrigona canifrons*	
7.	*Lepidotrigona ventralis*	
8..	*Tetragonula gressitti*	
8.	*Episyrphusbalteatus*	Syrphids and Megachilids
9.	*Eristaltis* sp.	
10.	*Eupeodus* sp.	
11.	*Syrphus corollae*	
12.	*Megachile umbripennis*	
13.	*Megachile monticola*	
14.	*Xylocopa tenuiscapa*	Other pollinators
15.	*Episyrphus*sp.	
16.	*Amegilla zonata*	
17.	*Halictus semiaerinus*	
18.	*Musca* spp.	
19.	*Monomorium indicum*	

Table 3: Foraging activity and Pollination Efficiency Index of pollinators on mango.

Time (h)	Stingless bees				Honey Bees				Syrphids and megachilids				Other pollinators			
	*RA	FR**	#FS	LPG***	RA	FR	FS	LPG	RA	FR	FS	LPG	RA	FR	FS	LPG
0600	6.16	5.77	14.55		6.52	3.44	13.67		8.33	4.33	8.54		3.67	1.67	5.67	
0800	6.66	5.84	11.67		6.23	4.33	10.12		11.54	5.55	8.12		4.66	3.12	4.14	
1000	8.33	6.52	7.12		7.64	4.46	8.33		13.67	7.64	7.65		5.33	5.47	4.67	
1200	7.64	6.66	7.66	1061.33 ± 27	6.59	6.11	7.67	1307.33 ± 38	12.54	6.65	5.48	571± 16	5.67	4.67	4.84	425.67± 31
1400	4.33	4.22	6.11		4.82	4.56	5.44		7.67	4.67	3.22		3.33	3.11	1.67	
1600	5.99	3.67	2.33		5.86	2.11	3.67		5.67	3.22	1.33		2.67	2.11	2.33	
1800	0.67	1.33	0.67		0.33	1.66	1.33		1.36	0.67	1.00		1.22	1.00	0.67	
Mean	5.68	4.86	7.16		5.43	3.81	7.18		8.68	4.68	5.05		3.79	3.02	3.42	
$CD_{0.05}$	0.73	0.62	0.71		0.73	0.62	0.71		0.73	0.62	0.71		0.73	0.62	0.71	
Pollination Efficiency Index (PEI)			27		14				32				6			

*Relative abundance= number of foragers/ 5 min/ m^2; **Foraging rate= Number of flowers visited / 5 min;#Foraging speed= time spent / flower (in seconds); Loose pollen grains***

Table 4: Effect of pollination treatments on different parameters in mango.

Parameters	**Pollination treatments**				
	Apis cerana	***Tetragonula iridipennis***	**Open pollination**	**Pollinator exclusion**	**cd (*p*= 0.05)**
Fruit set (%)	1.17	1.33	2.01	0.02	0.71
Deformed fruits (%)	7.63	7.00	9.16	4.68	1.68
Fruit yield (kg/ tree)	18.44	18.50	21.34	1.44	2.41
Fruit weight (g)	192.54	191.66	192.14	84.50	2.56
Length(cm)	10.33	10.31	9.02	5.67	1.67
Width (cm)	4.71	4.65	4.72	4.16	1.69
TSS (%)	26.14	26.20	25.33	25.16	2.94
Dry matter (%)	1.42	1.41	1.42	1.23	0.04
Ash content (%)	0.44	0.44	0.45	0.43	0.04
Moisture (%)	86.91	86.74	85.45	81.66	1.37

CONCLUSIONS

In mango, 27 major insect visitor fauna species were recorded collecting nectar and pollen. Among these insect visitors, 14 major true insect pollinators' species were observed foraging throughout the blooming period of mango. The Shannon-Wiener diversity Index of mango's insect pollinator revealed higher diversity in this region. The syrphid flies, megachilid bees, honey bees, stingless bees and flies populations were abundant on mango flowers along with major portions of *Apis* and non-*Apis* bees and dipterans. The maximum diurnal abundance of pollinators recorded between 0800-1200 h and the maximum foraging rate was found with syrphid flies and stingless bees. In open pollination of crop, Syrphids and Megachilids are important pollinators. Floral biology of mango disclosed two different types of flowers with complex structure in panicles with stigma receptivity of 72 hours. Yield and quality parameters under different modes of pollination revealed bee pollination was superior over open pollination and without pollination. In open pollination of mango, for adequate pollination Diptera fauna should be conserved along with non *Apis* bees. Without pollination the yields and quality are too less in mango. The flies of Syrphidae and bees belong to genus Apidae were major true pollinators of mango. Thus, there is significant increase in yield obtained in open and bee pollinated treatments as compared to pollinator excluded treatments which infers that for increasing the yield pollination is highly required in mango. Stingless bees are alternative pollinators for managed pollination in mango.

FUTURE SCOPE

The pollination studies revealed the importance of bees and other insects in the production of mango. The diversity studies could be extended to conserve the insect's fauna of this region. The role of flies and bees which was not quantified can be quantified for further pollination studies on requirement of pollinators in mango orchards. The quality production and productivity could be enhanced by placing the pollinators in mango orchards which lead to increase the financial gains of the farmers with conservation of fauna.

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Conflict of Interest. None.

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