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Effect of the Blowflies (Diptera: Calliphoridae) on the size and weight of Mango (*Mangifera indica* L.)

Shafqat Saeed, Muhammad Nadir Naqqash, Waqar Jaleel, Qamar Saeed, Fozia Fozia Ghouri

Background: Pollination has a great effect on the yield of fruit trees. Blowflies are considered as an effective pollinator compared to hand pollination in fruit orchards. Therefore, this study was designed to evaluate the effect of different pollination methods in mango orchards. **Methodology:** The impact of pollination on quantity and quality of mango yield by blowflies was estimated by using three treatments, i.e., open pollinated trees, trees were covered by a net in the presence of blowflies for pollination, and trees were covered with a net but without insects. **Results:** The maximum number of flowers was recorded in irregular type of inflorescence, i.e., 434.80flowers/inflorescence. Fruit setting (bud) was higher in open pollinated mango tree (i.e. 37.00/inflorescence) than enclosed pollination by blowflies (i.e. 22.34/inflorescence). The size of the mango fruit was the highest (5.06mm) in open pollinated tree than the pollinated by blowflies (3.93mm) and followed by without any pollinator (3.18mm) at marble stage. We found maximum weight of mango fruit (201.19g) in open pollinated trees. **Discussion**: The results demonstrated that blowflies can be used as effective mango pollinators along with other bees. The blowflies have shown a positive impact on the quality and quantity of mango. This study will be helpful in future and also applicable at farm level to use blow flies as pollinators that are cheap and easy to rear.

Manuscript Title

Effect of the Blowflies (Diptera: Calliphoridae) on the size and weight of Mango (*Mangifera indica* L.)

Running Title: Pollination in Mango by Blowflies

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Abstract

Background: Pollination has a great effect on the yield of fruit trees. Blowflies are considered as an effective pollinator compared to hand pollination in fruit orchards. Therefore, this study was designed to evaluate the effect of different pollination methods in mango orchards.

Methodology: The impact of pollination on quantity and quality of mango yield by blowflies was estimated by using three treatments, i.e., open pollinated trees, trees were covered by a net in the presence of blowflies for pollination, and trees were covered with a net but without insects.

Results: The maximum number of flowers was recorded in irregular type of inflorescence, i.e., 434.80flowers/inflorescence. Fruit setting (bud) was higher in open pollinated mango tree (i.e. 37.00/inflorescence) than enclosed pollination by blowflies (i.e. 22.34/inflorescence). The size of the mango fruit was the highest (5.06mm) in open pollinated tree than the pollinated by blowflies (3.93mm) and followed by without any pollinator (3.18mm) at marble stage. We found maximum weight of mango fruit (201.19g) in open pollinated trees.

Discussion: The results demonstrated that blowflies can be used as effective mango pollinators along with other bees. The blowflies have shown a positive impact on the quality and quantity of mango. This study will be helpful in future and also applicable at farm level to use blow flies as pollinators that are cheap and easy to rear.

Key words: Blowflies, Mango, Pollination

Introduction

Mango, *Mangifera indica* L., is very popular and economically important fruit. It is dicotyledonous plant and widely cultivated in the tropical and subtropical areas of the world (Tjiptono et al., 1984). Although some varieties of mango fruit plant are self-pollinated, adequate pollinators are required to transfer the pollen to female part of the plant (Popenoe, 1917; Singh, 1954; Free & Williams, 1976). Biology of mango pollinators have been studied in India and Israel, and their results demonstrated that insects of the Diptera and Hymenoptera play major roles in the pollination of this important fruit (Singh, 1988; Bhatia et al., 1995; Singh, 1997; Dag & Gazit, 2000). Crop pollination mediated by wild and domesticated animals is a crucial and endangered ecosystem service (Potts et al., 2010; Klein et al., 2007). Recently, the global economic value of pollination from domesticated and wild animals has been estimated at €153 billion, while the consumer surplus loss associated with a total loss of animal pollination service was estimated between €190 and €310 billion (Gallai et al., 2009). About 87 crops, i.e. 70% of the 124 main crops used directly for human consumption in the world, depend on the pollinators (Klein et al., 2007).

The members of the family Calliphoridae (Schizophora, Calyptratae, Oestroidea) are commonly known as blowflies, bluebottles, cluster flies or greenbottles. They are worldwide distributed, with over 1,000 species and about 150 genera described (Shewell, 1987; Vargas & Wood, 2010). Diptera was probably among the first important angiosperm pollinators and may have been instrumental in the early angiosperm radiation (Labandeira, 1998; Endress, 2001; Skevington & Dang, 2002), comprised of over 160,000 species and 150 families (Evenhuis et al., 2008). At least, seventy-one families of Diptera contain flower-visiting flies, and flies are pollinators of almost 555 flowering plant species (Larson et al., 2001) and more than 100

cultivated plants, including important crops such as mango, cashew, tea, cacao, onions, strawberries, canola, and sunflower (Heath, 1982; Hansen, 1983; Mitra & Banerjee, 2007; Clement et al., 2007; Heath, 2015). Blowflies thought to be the most dislike fly among all the flies of Dipteran, and it is a carrier of most of diseases and cause myiasis (Zumpt, 1965; Greenberg, 1973). This character has been recognized nearly 1500 years ago that flies are transmitters of diseases (Greenberg, 1973). Because earlier research was done only on the negative aspects of flies but now most of the studies have shown that blowflies species have many beneficial aspects such as surgeons, pollinators, agents of decay, forensic indicators, and recreational uses (Jarlan et al., 1997; Losey & Vaughan, 2006; Klein et al., 2007; Heath, 2015).

Considering the importance of beneficial aspects of blowflies in Pakistan, role of pollinators especially dipterans (blowflies) were never studied in *Mangifera indica*. Therefore, this research was conducted to evaluate the effects of blowflies on the mango pollination and fruit yield. The blowflies are the cheapest source of pollination as compared to other pollinators, such as honey bees, syrphid flies, *xylocopa spp* that are difficult to rear.

Material and methods

Plant material

The impact of pollination by blow fly on mango yield was studied in the orchard of Faculty of Agricultural Science and Technology (FAS&T), Bahauddin Zakariya University Multan. A total of three trees and 10 branches from each tree were selected for recording the data. Following treatments were used: 1) open pollinated trees; 2) fruit trees were covered by net and blowflies were used for pollination; 3) fruit trees were covered by nets and no insect was kept inside the net for pollination. Three replications were used for each treatment.

96 **Rearing of blow fly for mango pollination**

97 Blowfly's adults were collected from the different poultry farms of Multan, Pakistan. Mass culture
98 of blowflies was reared in Bio-Ecology Lab of FAS&T, BZU Multan. Adults were released into
99 the plastic cage (18 cm in diameter and 24 cm in height) with diet (10 percent honey solution), and
100 chicken livers were also placed in the plastic trays for egg laying. The six plastic cages were used
101 for rearing blowflies. Then hatched larvae were separated into the plastic pots (4cm in diameter
102 and 8cm in height) that were half filled with sterilized sand and 50 g chicken liver. In each plastic
103 pot, 20 larvae were released and maximum adults of blowflies were reared in the laboratory for
104 field application.

105 **Installation of cages**

106 Mango trees with a height of 2.1m and width of 2.4m at the emergence of inflorescence were
107 selected for the installation of cages. The cages, made by muslin cloths, were used for the covering
108 of mango trees (3.35×3.35×3.35 meters). A total of 100 adults of blowflies were released for
109 pollination efficacy in the covered mango trees (Figure 1) and control was kept free of blowflies.

110 **Data recording**

111 Total number of flowers and their types of inflorescences were counted in each treatment (Figure
112 b). Data as number of flowers on each type of inflorescence, size (mm) and weight (g) of fruits at
113 marble stage (30 days after the fruit set and have no stone inside the fruit) of mango was recorded
114 by tagging ten twigs in each repeating unit.

115 **Statistical analysis**

The data were analyzed by using LSD test as Post-ANOVA at 5% levels for estimating the effect of different pollination methods on the number of flowers/inflorescence. Each type of the inflorescence (i.e., conical, pyramid and irregular) was analyzed in treatments. The number of flowers, buds, size and weight of mango fruit were also analyzed by using SAS (SAS, 2011).

Results

The number of flowers/inflorescences was compared among three treatments in each type of inflorescence (conical, pyramid and irregular). We detected highly significant differences in the number of flowers/inflorescence in the open pollinated mango trees on irregular type of inflorescence (434.80) than pyramid (400.90) and conical (327.97) types of inflorescence in open pollinated trees. However, number of flowers/inflorescence was significantly increased than blowfly and closed cage treatments in open pollinated trees (Figure 2).

The number of buds/inflorescence was compared between three different treatments in each type of inflorescence (conical, pyramid and irregular). Maximum number of buds/inflorescences was found in blowfly's cage on irregular inflorescence (4.16) that was significantly higher than pyramid inflorescence (2.96) and conical inflorescence (2.73). However, higher number of buds was found in blowfly's cage for irregular inflorescence than open pollinated and closed cages. After 10 days, the highest number of buds/inflorescence was found in open mango pollinated trees for irregular inflorescence (2.67) compared to pyramid (1.96) and conical inflorescence (1.93). Similar pattern was recorded in blowflies and closed cage. However, the number of buds/inflorescence for each type of inflorescence was significantly higher in blowflies than closed cage treatment (Figure 3b).

Mango fruit formation at marble stage was compared between three different treatments in each type of inflorescence (conical, pyramid and irregular inflorescence). The maximum numbers of fruits/inflorescences were found in open pollinated mango tree at marble stage for irregular inflorescence (1.36), which was significantly higher than pyramid (1.24) and conical (1.20). The trees covered with blowflies produced significantly higher number of fruits for each type of inflorescence than closed cages (Figure 4).

The size and weight of mango fruits at marble stage was statistically higher in open pollinated trees (5.06mm and 210.20g, respectively) than blowflies cages (3.93mm, 180.80g, respectively) and closed cages (2.88mm, 139.51g, respectively). In open pollinated condition, mango size and weight were highly significant because of a variety of pollinators e.g. *Apis dorsata, Apis florea*, *Episyrphis balteatus*, *E. scutellaris* and *lucilia spp* at the farm. Overall result showed that open pollinated trees have maximum and good quality of fruits. However, blowflies also showed great impact on mango pollination because higher quantity and better quality of fruits were recorded than close cage trees.

Discussion

Pollination is a process in which pollens transferred from the male part of the plant to female reproduction organs and a huge number of economically nutritive plants depend on different types of pollinators for pollination. Pollinator-dependent products are essential part of human diets (Eilers et al., 2011). Modern farming techniques have enabled higher yield of crops (Aizen et al., 2008, 2009), but significant decline have been observed in insect pollinators, primarily due to the isolation from natural habitats (Klein et al., 2006; Garibaldi et al., 2011). In most of the habitats, pollinating flies guarantee or enhance seed and fruit production of many plants such as medicinal, food and ornamental plants, Most of the flies were kept in production

seed banks and considered important part/life of Greenland. Due to the large gaps in the knowledge about the Diptera, there is a need to address the role of Diptera in pollination network. Diptera flies have potential to survive in variable ranges of temperature or environment (Ssymank et al., 2008; Munawar et al., 2011, Abrol, 2012). Here, the blowflies were studied as a pollinator of mango fruit, which is considered as the cheapest source of pollination. The results revealed that blowflies have significant effect on the mango yield.

A mango panicle contains around 200-4,000 flowers and a mature tree may has approximately 600-1,000 panicles (Manning, 1995). With a huge number of flowers, these flowers are attractive to insect pollinators. About 46 kinds of pollinators belonging to three orders, Coleoptera, Diptera, and Hymenoptera are capable of pollinating mangoes (Singh, 1988; Bhatia et al., 1995; Singh, 1997; Dag & Gazit, 2000). In native areas, many plants/trees have various pollinators but they visit variety of flowers (Waser et al., 1996). Plants have a generalized community mostly visit similar pollinators for pollination (Waser et al., 1996; Bluthgen et al., 2006). Mango flowers are of different kinds, and various insects are an important source of pollination for this fruit (Heard, 1999). These pollinators are very crucial for successful fruit set in mango (Free & Williams, 1976; Anderson et al., 1982; Richards, 2001; Carvalheiro et al., 2010). They are not only sensitive to change in their natural habitat and/or niche, but are also sensitive to pesticides (De Siqueira et al., 2008).

One of the main components of ecosystem is pollinator, like say main component of global biodiversity (Garibaldi et al., 2013). Pollinator has two types as one is domesticated and other is wild pollinators, and both are very important for the pollination of plants. Our result showed that open trees produced maximum yield, followed by covered trees with blowflies and without insects. These results are consistent with the previous study, who revealed that insects increase

the yield of fruits by amplifying pollination (Mingjian et al., 2003). Previous studies also demonstrated that diversity of pollinators has greater impact on the yield of fruit trees and environmental hazards have declined the different types of pollinators (Jones & Emsweller, 1934; Fajardo et al., 2009). Our results showed that blowflies have great potential for the pollination and to increase the yield of mango. This study explains the impacts of blowflies on pollination of mango fruits.

Conclusion

The results revealed that weight and size of the mango fruit was significantly reduced in the trees covered without insects than the mango trees covered with the blowflies. However, we detected fruits with maximum weight and size in the open pollinated mango trees where more number of pollinators visit the trees for pollination and resulted in the better quality and quantity of mango fruit. We concluded that blowflies have the potential for pollination in *M. indica*. So this research will be helpful in future and applicable at farm level where honey keeping in the orchard is difficult for pollination because of environment and high cost. We speculated that blowflies are the best, cheaper source of pollination as a replacement of honey bees and other pollinators which are difficult to purchase and maintain in the orchards for pollination. This study also showed that irregular type of inflorescence have maximum number of flowers, buds and fruits, so the breeders could focus on to develop the variety of *M. indica* having more number of irregular types of inflorescence..

References

Abrol DP, 2012. Pollination in Cages. *In Pollination Bi*ology *Springer* Netherlands, 353-395.

Aizen MA, Garibaldi LA, Cunningham SA, Klein AM. 2008. Long-term global trends in crop yield and production reveal no current pollination shortage but increasing pollinator dependency. *Current Biology* 18: 1572–1575.

Aizen MA, Garibaldi LA, Cunningham SA, Klein AM. 2009. How much does agriculture depend on pollinators? Lessons from long-term trends in crop production. *Annals of Botany* 103: 1579–1588.

Anderson DL, Sedgley H, Short JRT, Allwood AJ. 1982. Insect pollination of mango in northern Australia. *Australian Journal of Agricultural Research* 33: 541-548

Bhatia R, Gupta D, Chandel JS, Sharma NK. 1995. Relative abundance of insect visitors on flowers of major subtropical fruits in Himachal Pradesh and their effect on fruit set. *Indian Journal of Agriculture Science* 65: 907-912.

Blu¨thgen N, Menzel, F, Blu¨thgen N. 2006. Measuring specialization in species interaction networks. *BMC Ecology* 6: 9-13.

Carvalheiro LG, Seymour CL, Veldtman R, Nicolson SW. 2010. Pollination services decline with distance from natural habitat even in biodiversity-rich areas. *Journal of Applied Ecology* 47: 810–820.

Clement SL, Hellier BC, Elberson LR, Staska RT, Evans MA. 2007. Flies (Diptera: Muscidae: Calliphoridae) are efficient pollinators of *Allium ampeloprasum* L. (Alliaceae) in field cages. *Journal of Economic Entomology* 100: 131–135.

Dag A, Gazit S. 2000. Mangopollinators in Israel. *Jounal of Applied Horticulture* 2: 39-43.

De Siqueira KMM, Kiill LHP, Martins CF, Lemos IB, Monteiro SP, Feirosa EA. 2008. Comparative study of pollination of *Mangifera indica* L. in conventional and organic crops in the region of the Submédio São Francisco valley. *Revista Brasileira de Fruticultura* 30: 303–310.

Eilers EJ, Kremen C, Greenleaf SS, Garber AK, Klein A.M. 2011. Contribution of pollinator-mediated crops to nutrients in the human food supply. *PLoS ONE* 6: e21363, doi: 10.1371/journal.pone.0021363.

Endress PK, 2001. The Flowers in Extant Basal Angiosperms and Inferences on Ancestral Flowers. *International Journal of Plant Sciences* 162: 1111-1140.

234 Evenhuis NL, Pape T, Pontand AC, Thompson FC. 2008. Biosystematic Database of World
235 Diptera, Version 10. http://www.diptera.org/biosys.htm
236 Fajardo Jr, AC, Medina JR, Opina OS, Cervancia CR. 2009. Insect Pollinators and Floral
237 Visitors of Mango (Mangifera indica L. cv. Carabao). *The Philippine Agricultural*
238 *Scientist* 91: 34-38.
239 Free JB, Williams IH. 1976. Insect pollination of *Anacardioum occidentale* L., *Mangifera indica*
240 L., *Blighia sapida* Koening and *Persea americana* Mill. *Tropical Agriculture* 53: 125-
241 139.
242 Gallai N, Salles JM, Settele J, Vaissiere BE. 2009. Economic valuation of the vulnerability of
243 world agriculture confronted with pollinator decline. *Ecological Economics* 68: 810–821.
244 Garibaldi LA, Steffan-Dewenter I, Winfree R, Aizen MA, Bommarco R, Cunningham SA, Klein
245 AM. 2013. Wild pollinators enhance fruit set of crops regardless of honey bee
246 abundance. *Science* 339: 1608-1611.
247 Garibaldi LA, Steffan-Dewenter I, Kremen C, Morales JM, Bommarco R, Cunningham
248 SA, Carvalheiro LG, Chacoff NP, Dudenhöffer JH, Greenleaf SS, Holzschuh A, Isaacs
249 R, Krewenka K, Mandelik Y, Mayfield MM, Morandin LA, Potts SG, Ricketts
250 TH, Szentgyörgyi H, Viana B, Westphal C, Winfree R, Klein AM. 2011. Stability of
251 pollination services decreases with isolation from natural areas despite honey bee
252 visits. *Ecology Letters* 14: 1062–1072.
253 Greenrerc G. 1973. *Flies and Disease.* Vol. 2. Princeton University Press.
254 Hansen M. 1983. *Yuca* (Yuca, Cassava), pp. 114–117. *In* Janzen, D. (Ed.). *Costa Rican Natural*
255 *History*. The University of Chicago Press, Chicago, xi + 816.
256 Heard TA. 1999. The role of stingless bees in crop pollination. *Annual Review of*
257 *Entomology* 44: 183–206.
258 Heath 2015. Beneficial aspects of blowflies (Diptera: Calliphoridae). New Zealand
259 Entomologist, 7:3, 343-348, DOI:10.1080/00779962.1982.9722422.
260 Heath ACG. 1982. Beneficial aspects of blowflies (Diptera: Calliphoridae). *New Zealand*
261 *Entomologist* 7: 343–348.
262 Jarlan A, de Oliveira D, Gingras J. 1997a. Pollination by *Eristalis tenax* (Diptera: Syrphidae) and
263 seed set of greenhouse sweet pepper. *Journal of Economic Entomology* 90:1646-1649.

Jokes HA, Emsiveller SL. 1934. The use of flies as onion pollinators. *Proceedings American Society for Horticultural Sctence* 31:160-164.

Kleijn D, Baquero RA, Clough Y, Díaz M, De Esteban J, Fernández F, Gabriel D, Herzog F, Holzschuh A, Jöhl R, Knop E, Kruess A, Marshall EJP, Steffan-Dewenter I, Tscharntke T, Verhulst J, West TM, Yela JL. 2006. Mixed biodiversity benefits of agri-environment schemes in five European countries. *Ecology Letters* 9: 243–254.

Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, et al. 2007. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society of London B* 274: 303–313.

Klein AM, Vaissiere BE, Cane JH, Steffan-Dewenter I, Cunningham SA, Kremen C, Tscharntke T. 2007. Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B* 274:303-313.

Klein MA, Vaissière BE, James HCI, Cunningham SA, Kremen C, Tscharntke T. 2007. Importance of pollinators in changing landscapes for world crops. *Proceeding biological sciences* 274: 303–313.

Labandeira CC. 1998. How old is the flower and the fly? *Science* 280: 85-88.

Losey JE, Vaughan M. 2006. The economic value of ecological services provided by insects. *BioScience* 56:311-323.

Manning R. 1995. Honeybee pollination technical data. Western Australia Department of Agriculture, Bulletin No. 4298.

Mingjian W, Zi WDY, Jianguo D. 2003. The Investigation of the Varieties of Mango Insect Pollinator in Guangxi and the Preliminary Observation on the Habits and Characteristics of the Activities of Such Insects. *Journal of Guangxi Agriculture*, S1.

Mitra B, Banerjee D. 2007. Fly pollinators: assessing their value in biodiversity conservation and and food security in India. *Rec zoological. Survey of India* 107: 33-48.

Munawar MS, Raja S, Niaz S, Sarwar G. 2011. Comparative performance of honeybees (Apis mellifera L.) and blowflies (Phormia terronovae) in onion (Allium cepa L.) seed setting. *Journal of Agricultural Research* 49: 49-56.

Natural Research Council 2006. Status of Pollinators in North America, National Academic Press

294 Potts SG, Biesmeijer JC, Kremen C, Neumann P, Schweiger O, et al. 2010. Global pollinator
295 declines: trends, impacts and drivers. *Trends Ecology Evolution* 25: 345–353.
296 Richards AJ. 2001. Does low biodiversity resulting from modern agricultural practice affect crop
297 pollination and yield? *Annals of Botany* 88: 165–172.
298 SAS Institute 2002. The SAS System for Windows, Release 9.0, SAS Institute, Cary, N.C.
299 Shewell GE, 1987. Calliphoridae, p. 1113-1145. *In*: McAlpine, J.F., B.V. Peterson, G.E. Shewell
300 HJ, Teskey, JR, Vockeroth DM, Wood (Eds.). Manual of Neartic Diptera. Vol. 2. Ottawa,
301 Monograph/Agriculture Canada, 657p.
302 Singh G. 1988. Insect pollinators of mango and their role in fruit setting. *Acta Horticulturae* 231:
303 629- 632.
304 Singh G. 1997. Pollination, pollinators and fruit setting in mango. *Acta Horticulturae* 455: 116-
305 123.
306 Skevington JH, Dang PT. 2002. Exploring the diversity of flies (Diptera). *Biodiversity* 3: 3-27.
307 Ssymank A, Carol KA, Thomas P, Christian F. 2008. Thompson. "Pollinating flies (Diptera): A
308 major contribution to plant diversity and agricultural production." Biodiversity 9: 86-89.
309 Tjiptono P, Lam PF, Kosiyachinda S, Mendoza DB, Leong PC. 1984. Status of the mango
310 industry in ASEAN. *In* Mendoza, D.B., Jr. Wills, R.B.H. *(eds.)*. Mango: Fruit
311 development, postharvest physiology and marketing in ASEAN, 1-11.
312 Vargas J, Wood DM. 2010. Calliphoridae, p. 1297-1304. *In*: Brown, B.V., A. Borkent, J.M.
313 Cumming, D.M. Wood, N.E. Woodley & M.A. Zumbado (Eds.). Manual of Central
314 American Diptera. Vol. 2. Canada, Ontario, NCR Research Press, 728p.
315 Waser NM, Chittka L, Price MV, Williams NM, Ollerton J. 1996. Generalization in pollination
316 systems, and why it matters. *Ecology* 77: 1043–1060.
317 Zumpt F. 1965: .*Mytasts in M a n and Animals in the Old World.* Butterworths, London.
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Table 1. Total number of inflorescences and their types in different treatments

Treatments	Trees	Number and types of mango inflorescence			
		Conical	Pyramid	Irregular	Total
Closed	Tree 1	13.00	18.00	22.00	53.00
	Tree 3	15.00	34.00	20.00	69.00
	Tree 5	34.00	19.00	33.00	86.00
	Mean	20.67	23.67	25.00	69.33
Blowflies	Tree 1	19.00	21.00	21.00	61.00
	Tree 3	11.00	13.00	12.00	36.00
	Tree 5	20.00	34.00	20.00	74.00
	Mean	16.67	22.67	17.67	57.00
Open	Tree 1	45.00	50.00	30.00	125.00
	Tree 3	27.00	23.00	26.00	76.00
	Tree 5	23.00	43.00	20.00	86.00
	Mean	31.67	38.67	25.33	95.67

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340 **Figure Legends**

341 1. Mango tree was covered with muslin cloth

342 2. Effect of different pollination methods on the different types of mango flowers

343 3. Effect of different pollination methods on the bud formation/inflorescence

344 (a) 15 days after the treatments (b) 10 days after the treatments

345 4. Effect of different pollination methods on the number of fruits at marble stage

346 5. Effect of different pollination methods on the fruit size and weight at marble stage

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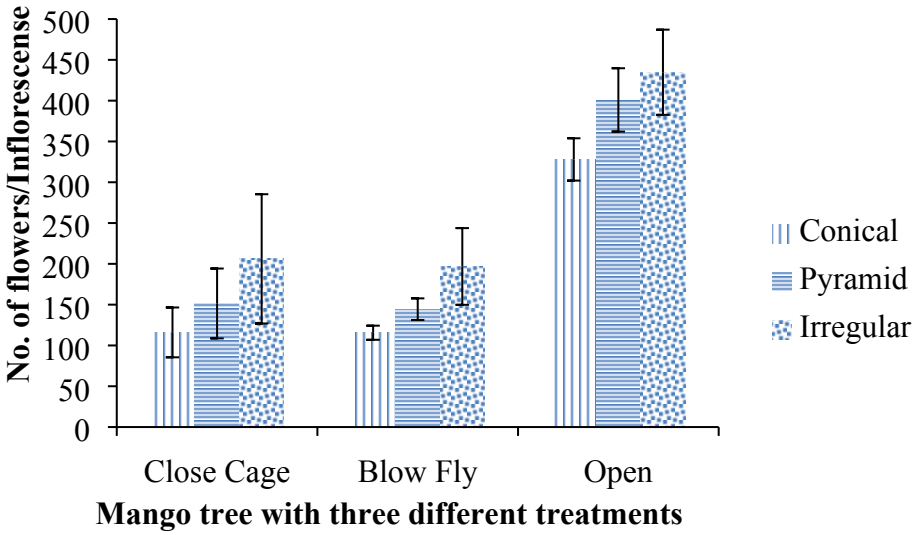
Figure 1. Mango tree was covered with muslin cloth



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367 **Figure 2.** Effect of different pollination methods on the different types of mango flowers
368 Mean values sharing similar letters did not differ significantly with in the treatments
369 (P≤0.05). Bars indicate the standard deviation (SD) of the observation
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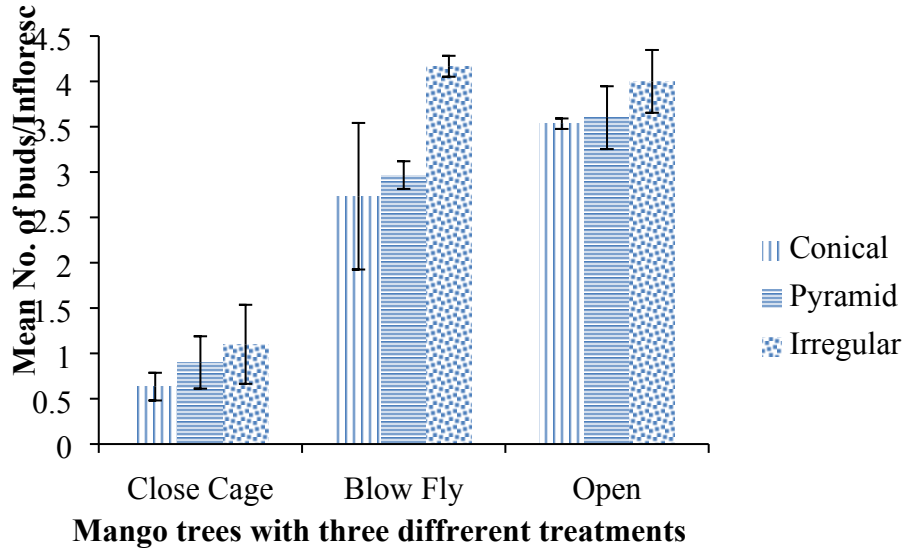

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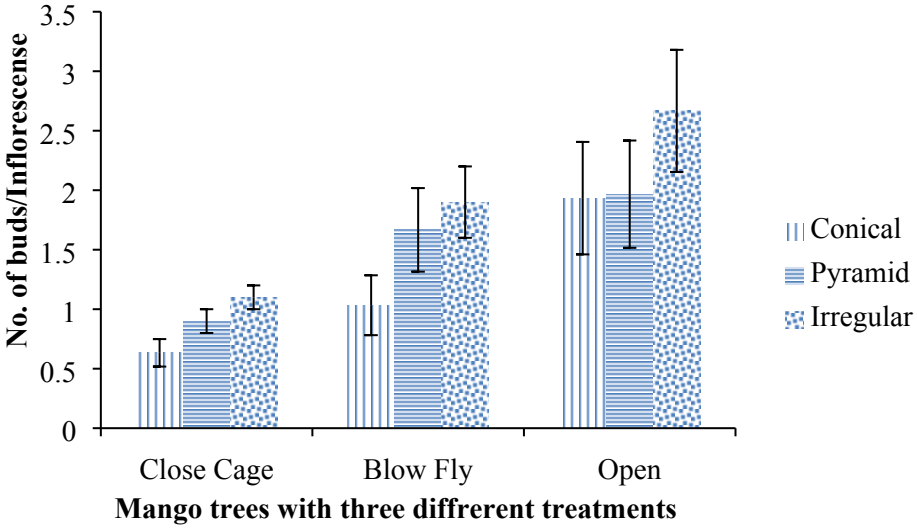
378 **Figure 3a**



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380 **Figure 3b**

381 **Figure 3.** Effect of different pollination methods on the bud formation/inflorescence
382 a). 15 days after the treatments (b). 10 days after the treatments
383 Mean values sharing similar letters did not differ significantly with in the treatments ($P \leq 0.05$).
384 Bars indicate the standard deviation (SD) of the observation
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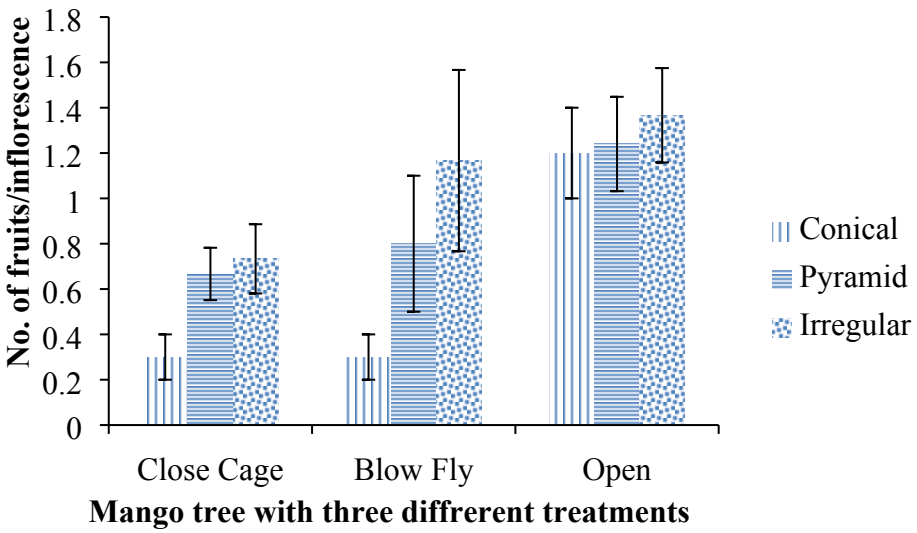

Figure 4. Effect of different pollination methods on the number of fruits at marble stage
Mean values sharing similar letters did not differ significantly with in the treatments ($P \leq 0.05$). Bars indicate the standard deviation (SD) of the observation

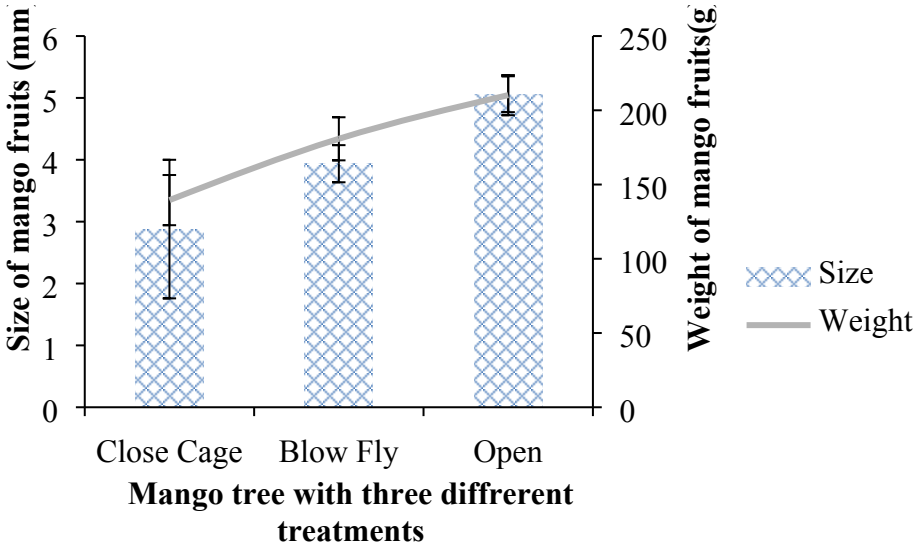

Figure 5. Effect of different pollination methods on the fruit size and weight at marble stage Mean values sharing similar letters did not differ significantly with in the treatments ($P \leq 0.05$). Bars indicate the standard deviation (SD) of the observation