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Mini Review

Agroecosytem Dynamics on the Interactions between Passion Fruit (*Passiflora Edulis*) and Insect Pollinators

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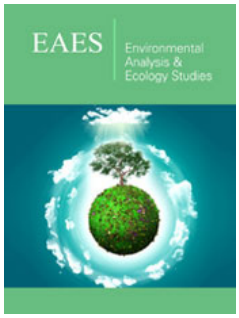

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Abstract

Agroecosystems attract numerous insect species for nesting, breeding and especially for pollination function. While studies have been done in other nations about the ecological factors that determine fruit set in passion crop, there is little work so far carried out in Kenya over the same. Apparently, in Kenya, no effort has been made to study the ecology of carpenter bee and its effectiveness in passion fruit set. The study involved small-scale purple passion fruit farmers in Mua hills in Machakos County, Kenya). These small-scale farmers carry out production on farms measuring 0.20ha to 3.00ha. However, due to high returns of purple passion fruit farming, farms with an average size of 0.10acres (0.04ha) were considered. Therefore, the study covered farmers with 0.04 to 1.00ha of their farm under purple passion fruit. This research aimed at solving the environmental problems of pollination limitation of passion fruit crop by using ecological principles to establish the effect of land use on the ecology of the crop and that of the carpenter bee.

Keywords: Agro-ecosystem; Passion crop; Carpenter bee

Introduction

The passion crop is one of the climbing plants that last longer and it has been a common fruit in Kenya since it was first introduced in the 1920's. Passion fruit farming in Kenya does well in the upper midland to upper highland zones. The most suitable altitude for its production ranges from 1200-2000 meters above sea level and it requires an optimum temperature between 18 °C to 25 °C and well-distributed annual rainfall of 900mm to 2000mm. It grows on a variety of soil with a pH range of 5.5-6.5 and should be reasonably deep and fertile. Passion fruit plant is grown in Thika, Kisii, Nyeri, Kiambu, Nakuru, Machakos, Uasin Gishu and Trans-Nzoia Counties in Kenya.

Literature Review

Natural pollination is related to an increase in production yields in crops such as sunflower (*Helianthus annuus*) and coffee (*Coffea arabica*), [1,2]. Pollination of Capsicum annum flowers by some specific insects has been shown to have a positive effect by enhancing fruit quality and seed set [3]. A study carried out in Kakamega forest, in the western region of Kenya, to evaluate the effectiveness of the stingless bee Hypotrigona gribodoi on the pollination of green pepper showed an improvement in fruit quality [4]. Studies on bottle-gourd (Lagenaria siceraria) in Kenya have shown how important a diverse pollinator community is, to maintaining the extraordinarily diverse forms of gourds [5]. The richness of pollinator species increases fruit set [6] because of complementary pollination among species [7,8]. In a well-pollinated flower, a rapid development of ovary occurs, and the fecundated seeds produce plant growth hormones, leading to a good fruit development [9]. Reduced agricultural yields and deformed fruit often result from insufficient pollination. Fruit set is the proportion of a plant's flowers that develop into mature fruits or seeds and is a key component of crop yield.

Problem Statement

There has been a constant human population increase in both the arid and semi-arid regions of Machakos County which has fostered the rapid expansion of agriculture to help meet the population needs. The sensitive ecosystems such as the hilly areas of Mua hills location have been encroached for horticultural farming. This has led to habitat destruction, degradation, and fragmentation - resulting in a loss of foraging, mating and nesting sites of insect pollinators. These factors are likely to cause pollinator decline and this study aimed at evaluating the effect of land use on diversity and abundance of carpenter bee in relation to passion crop production.

Objectives

A. To determine the diversity and abundance of carpenter bee in the agro-ecosystem

B. To correlate passion fruit set with the diversity and abundance of insect pollinators.

Study Area

Map of Machakos County locating Mua Hills sub-locations and farm owners where sampling was done.

Sampling Design

This study used a sweep net with an eversible stick and a diameter of 38cm to increase the collection radius. A single back and forth sweep covering a 1500 to 1800arc was considered as a single sweep. The researcher walked through the habitat and swept with the hand net with ease over the vegetation. This caused the insects to fly up only to land inside the net as anticipated. The time taken was not more than five minutes at any single plant or flowering patch and the collector did not have to re-visit the same patch again. Two 30 minutes surveys a day were carried out. The insects caught with a hand net were carefully put into a killing jar with 70% alcohol to be later identified at National Museums of Kenya (Figure 1).

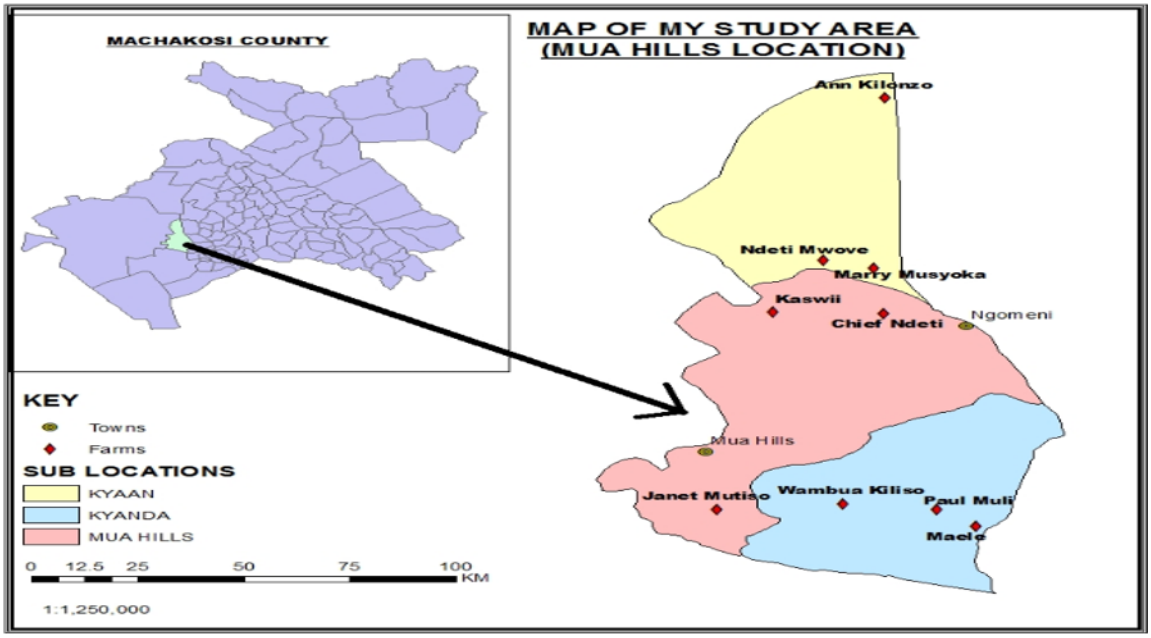

Figure 1

At each site, 15 pan traps were put out in areas where pollinators were likely to be found, especially where the vegetation was open and the pans could be seen from some distance and where there were flowers which the pollinators might visit. The position of each pan trap in the arrangement was randomly chosen. The spacing between pan traps was 5cm. The three groups of pan traps containing one of each color served as replicates. This experiment was replicated through time by repeating the same experiment two seasons apart.

The passion crop blossoms on selected stems were counted. Shortly before harvest, when most of the fruits were ripe, a second count was done. Passion fruit set was calculated as the ratio of the number of harvested fruits to the number of flowers. Pearson correlation was used as a measure of the strength and significance of a relationship between two variables; flowers and fruits.

Result

The results revealed that there was a positive and significant association between the abundance of the insects and the number of flowers ($r=0.513$, $p=0.001$) (Table 1). The results in Table 2 revealed that there was a positive and significant association between the abundance of the insects and the number of fruits ($r=0.504$, $p=0.002$).

Table 1: Correlation Analysis for Flowers recorded during the study.

Statement	Flowers		
Flowers	Pearson Correlation Sig. (2-tailed)	1	
Insect abundance	Pearson Correlation Sig. (2-tailed)	.513**	1
		0.001	

**Correlation is significant at the 0.01 level (2-tailed).

Table 2: Correlation Analysis for Fruits recorded during the study.

Statement	Flowers		
Flowers	Pearson Correlation Sig. (2-tailed)	1	
Insect abundance	Pearson Correlation Sig. (2-tailed)	.504**	1
		0.002	

**Correlation is significant at the 0.01 level (2-tailed).

Discussion

Fruit set was recorded highest in the lowland (semi-arid) compared with the other parts of Mua hills location, although it had the least diversity and abundance of insect pollinators. This is the only agro-ecosystem which had the carpenter bee, Xylocopa nigrita, and Xylocopa flavorufa. Such evidence is similar to scientific reports in other parts of the world [10-13]. The findings from this study confirmed that carpenter bee (*Xylocopa spp*) is the effective pollinator of Passion fruit crop. However, its habitat in this study seemed to be restricted to the lowland generating the question about whether land fragmentation could be a factor affecting its ecology. It was also worthy to noted that the lowlands of Mua hills has moderately high temperatures than its midland and this could possibly be another factor influencing fruit set in purple passion fruit in confirmation with a research done by Utsunomiya [14] on effect of temperature on fruit growth and quality.

In the Midland of Mua hills, it was observed that insect pollinator for purple passion fruit was A. mellifera and A. cerena. This could have affected the fruit set since studies have shown that neither honey bees (*Apis mellifera*) nor social stingless bees are effective pollinators [15,16], due to their small size, they take nectar without achieving pollen transfer such bees are sometimes referred to as "Thieves". Solitary and facultative social bees of the genus Xylocopa, the carpenter bees, are the effective pollinators of this crop because they present appropriate size and foraging behavior. To minimize the effects of insufficient pollination, the findings from this study suggest that the presence of carpenter bees in the landscape should then be enhanced.

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References

1. Ricketts T (2004) Tropical forest fragments enhance pollinator activity in nearby coffee crops. Conserv Biol 18(5): 1262-1271.
2. Greenleaf SS, Kremen C (2006) Wild bees enhance honey bees' pollination of hybrid sunflower. Proc Natl Acad Sci USA 103(37): 13890-13895.
3. Pesson P, Louveaux J (1984) Pollinisationet productions végétales. Editions Quae. INRA, Paris.
4. Kiatoko N, Raina S, Muli E, Mueke J (2014) Enhancement of fruit quality in Capsicum annum through pollination by Hypotrigona gribodoi inKakamega, Western Kenya. Entomological Science 17(1): 106-110.
5. Gikungu M, Maundu P (2004) Pollinatos of bottle-gourd (Lagenariasiceraria) observed in Kenya. International Journal of Tropical Insect Science 24(1): 79-86.
6. Winfree R, Aguilar R, Vazquez DP, LeBuhn G, Aizen MA (2009) A meta-analysis of bees' responses to anthropogenic disturbance. Ecology 90(8): 2068-2076.
7. Hoehn P, Tscharntke T, Tylianakis JM, Steffan Dewenter I (2008) Functional group diversity of bee pollinators increases crop yield. Proc R Soc London Ser B 275(1648): 2283.
8. Blüthgen N, Klein AM (2011) Functional complementarity and Specialization: The role of biodiversity in plant-pollinator interactions. Basic Appl Ecol 12(4): 282.
9. Cruz DO, Freitas BM, Silva LA, Silva EMS, Bomfim IGA (2005) Pollination efficiency of the stingless bee Melipona subnitida on greenhouse sweetpepper. Pesquisa Agropecuária Brasileira 40: 1197-1201.
10. Free J (1993) Crop Pollination by Insects, 2nd (edn), Academic Press, London.
11. Shipp JL, Whitfield GH, Papadopoulos AP (1994) Effectiveness of the bumble bee, Bombus impatiens Cr (Hymenoptera: Apidae), as a pollinator of greenhouse sweet pepper. Sci Hortic (Amsterdam) 57(1-2): 29-39.
12. Klein AM, Vaissiere BE, Cane JH, Steffan Dewenter I, Cunningham SA, et al. (2007) Importance of pollinators in changing landscapes for world crops. Proc R Soc B: Biol Sci 274(1608): 303-313.
13. Hajjar R, Jarvis DI, Gemmill HB (2008) The utility of crop genetic diversity in Maintaining ecosystem services. Agric Ecosyst Environ 123(4): 261-270.
14. Utsunomiya N (1992) Effect of temperature on shoot growth, flowering and fruit growth of purple passion fruit (Passiflora edulis Sims var. edulis). Scientia Horticulturae 52(1-2): 63-68.
15. Corbett A, Willmer PG (1980) Pollination of the yellow passion fruit: nectar, pollen and carpenter bees. Journal of Agricultural Science 95(3): 655-666.
16. Kasina (2010) Bee pollination enhances crop yield and fruit quality in Kakamega, Western Kenya. East African Agricultural and Forestry Journal 75(1): 1-11.