Installation of beehives in zucchini fields in Korhogo, Northern Côte d'Ivoire: Impact on the production parameters

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Abstract

Zucchini is a vegetable much consumed by population in Korhogo, because of its accessible price and its nutritional benefits. The objective of this study was to increase the production of this vegetable by optimizing pollination process through the use of beehives. For that, a beehive was installed to 50 m from an experimental plot housed in the vegetable patch of Peleforo Gon Coulibaly University (Korhogo) in order to colonize the study site. Another plot without beehive (considered like control) located more than 1.5 km from the first one, was selected. The diversity parameters including diversity, relative abundance and bees' activity were assessed once a week covering the flowering period. The production parameters such as the number of fruits, the average weight and the average fruit size were determined during harvesting period. The great number of bee specimens (65.02%) was recorded in the plot with beehive compared to the other without beehive (34.98%). The average number of fruits per elementary plot was significantly higher in the plot with beehive (10.2 ± 0.51) compared to the plot without beehive (6.5 ± 0.34). The presence of beehive significantly impacted positively the average weight and the average size of fruits harvested on the plot with beehive compared to the control plot. This study revealed that the installation of beehives nearby a zucchini plantation improves significantly the production parameters of this vegetable.

Keywords: beehive – vegetable – zucchini - production parameters – Korhogo.

1. INTRODUCTION

The market gardening constitute an important source of income for the population [1]. In Côte d'Ivoire, zucchini cultivation is booming in the north of the country. The production of zucchini was estimated at 19.372 tons in 2016 [2]. Indeed, zucchini is an herbaceous plant belonging to the family of Cucurbitaceae whose, the pollination is essentially entomophilous. Widely grown in Korhogo, this vegetable is an alternative to eggplant and cabbage in culinary preparations. Its production cycle very short, about 45 days, makes it an asset in the fight against food insecurity [3]. However, this production still low despite efforts to control pests. According to Enriquez et al. [4], zucchini cannot produce fruit in the absence of pollinating insects. Koné et al.,[5], showed that in the sub-prefecture of Korhogo, the main pollinator of zucchini was the honeybee ''*Apis mellifera*''. To improve the production of this vegetable, in addition to the pest management, an intensification of bees' activity on its flowers could be a good alternative. However, in Côte d'Ivoire, research regarding the impact of bees on zucchini production are rare. This study presents itself like a contribution to the increase of data in the relationship between bees' activity and production of zucchini. The global objective of the study consisted to highlight the impact of beehives on zucchini production parameters. Specifically, it's consisted (i) to assess the impact of beehives on diversity and abundance of bees within zucchini production area, (ii) to assess the impact of beehives on the weight and the number of fruits after harvesting.

2. METHODS

2.1. Study area

This study was conducted in two experimental plots located in Korhogo. The first one within the garden of University (UPGC) and the second in a farmer environment of Lokaha (a small village of Korhogo). Korhogo (between 8o26 - 10o27 N; and 5o17 - 6o19 W) is located to 600 km from Abidjan (economic capital city). This locality belongs to the Sudano-Sahelian dry tropical climate regime whose rhythm of the seasons is regulated by the displacement of the Intertropical Front [6]. This climate is characterized by two seasons: a rainy season extends from May to October with a maximum of precipitation in September and a dry season lasts from November to April, characterized by the harmattan that settles from December to February [7].

2.2. Experimental device

The variety of zucchini used for this study was ''Color F1 variety'', which is the main variety grown in Korhogo. In each study site, the experimental device was a Fischer block. Four blocks constituted of 5 elementary plots each, giving a total of 20 elementary plots for each site were selected. Each elementary plot measuring 1 m2 was separated from each other by an alley of 1m wide. Each elementary plot consisted of four (4) pockets spaced 0.7 m each. According to the density of three beehives per hectare recommended by [8], a beehive was placed at 50 m from the plot of the vegetable patch. The control plot located in a peasant environment was devoid of beehives. As recommended by [9] and [10], the control plot without beehive, was more than 1.5 km apart, in order to prevent the foraging activity of bees. During planting, a Kenyan beehive was prepared to capture a swarm of bees using beeswax as an attractant. The wax was heated before being applied to the inner walls of the beehive. Then, she was suspended on a tree at 2 m from the ground to facilitate the capture of bees. Ten days after the laying of the empty beehive, it was colonized by a swarm of *A. mellifera* (honey bee). It was then lowered and placed to 50 m from the plot, on a support of 1 m high.

2.3. Impact of beehive on the diversity, abundance and activity of pollinators

The diversity parameters such as diversity, relative abundance and activity of bees were evaluated once a week, covering all flowering period of zucchini. The observations were carried out every morning between 5am and 11am corresponding to the opening hours of zucchini flowers. Five open female flowers were randomly selected and each flower was observed for 10 minutes per time slot. For each observed flower, the number of individuals per species and the visit time of each individual were recorded.

2.4. Impact of beehive on zucchini production

At the harvest, the number of fruits from the control plot and the plot housing beehive was evaluated. In addition, the average mass of harvested fruits and their average size were measured for both types of plots.

2.5. Data Analysis

Analysis of variance (ANOVA) and the least significant difference (Duncan tests) post hoc comparison ($p < 0.05$) were performed with STATISTICA software (version 7.0). These analyses were used to evaluate the impact of beehive on zucchini production by comparing the different averages of production parameters (mass and number of fruits). These analyses were followed by the Newman-Keuls separation test at the 5% level.

3. Results

3.1. Impact of beehive on the diversity and relative abundance of bees

Only two species of bees, *A. mellifera* (Apidae) and *Lasioglossum interruptum* (Halictidae) were identified during the study. A total of 1744 bee specimens were recorded in both sites. The largest number of bees with 1143 specimens (65.02%) was recorded in the plot with beehive. In the other plot without beehive, only 610 bee specimens (34.98%) were recorded. The plot with beehive was most favourable to be colonize by *A. mellifera* (102.4 ± 6.27) compared to the plot without beehive (50.4 ± 2.75). There is a significant difference between mean abundance of *A. mellifera* per plot ($F = 57.57$; $p < 0.05$). At the opposite of *A. mellifera*, there is no significant difference between the average numbers of *L. interruptum* recorded to the both plots ($F = 0.26$, $p > 0.05$): with beehive (11.6 ± 0.61) and without beehive (10.6 ± 0.47) (Fig 1).

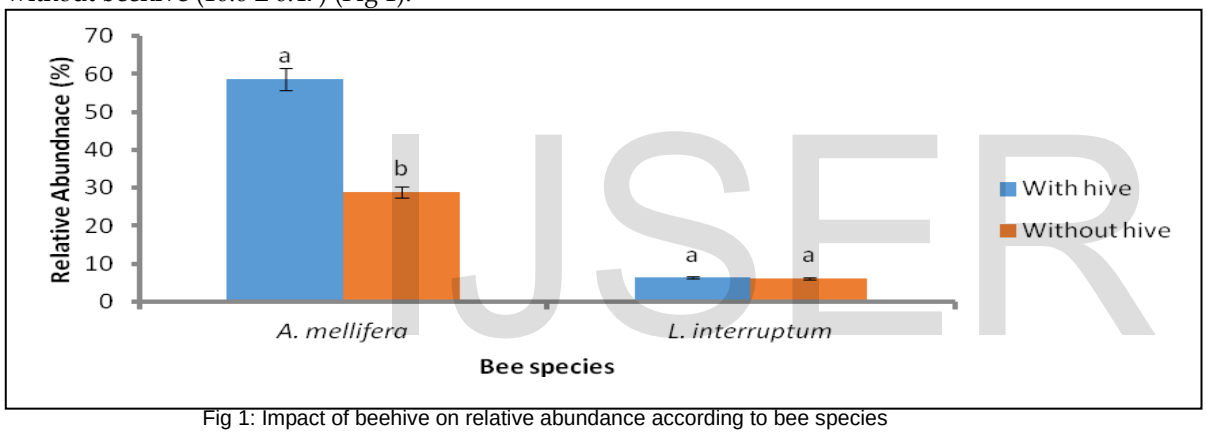

Fig 1: Impact of beehive on relative abundance according to bee species

3.2. Impact of beehive on daily bees' activity

- **Impact on activity of *A. mellifera***

On both plots, the peak of activity was recorded between 5am and 6am. Beyond this period, the activity decreased gradually to cancel at 10am. Honeybee activity was more intense in the plot with beehive compared to the control plot (Fig 2). Therefore, beehive has significantly impacted bees' activity.

- **Impact on activity of *L. interruptum***

The peak of activity of this species was also recorded between 5am and 6am on both plots. The activity of *L. interruptum* decreased rapidly to cancel at 9am (Fig 3).

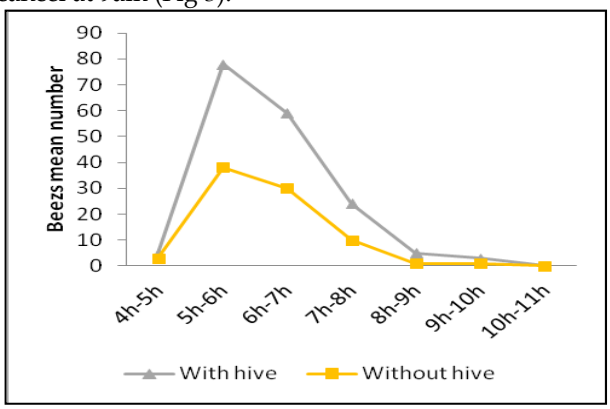

Fig 2: Impact of beehive on daily activity of *A. mellifera*

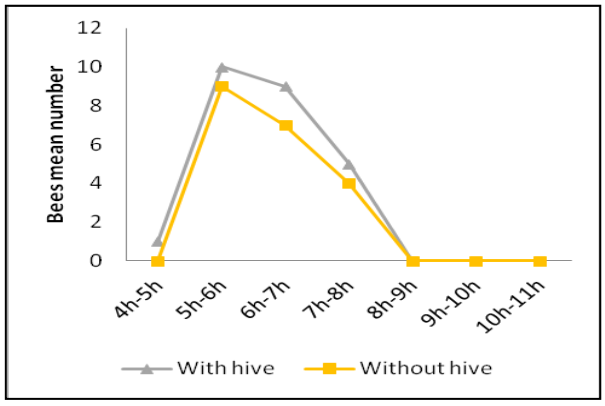

Fig 3: Impact of beehive on daily activity of *L. interruptum*

3.3. Impact of beehive on zucchini production

The average number of fruits harvested per plot was higher on beehive plot (10.2 ± 0.51) compared to the plot without beehive (6.5 ± 0.34) (F = 36.13; < 0.05). On beehive plot, the average mass of fruit was (1.13 ± 0.042) kg. However, on the plot without beehive, the average mass was (0.72 ± 0.048) kg. Statistical analysis showed that there is a significant difference between the mass of fruits per plot (F = 40.13; p < 0.05). The average size of fruits was (33.3 ± 0.39) cm on the plot with against (24.8 ± 0.85) cm on the control plot (Table 1). Statistical analysis showed also that the size of fruits was significantly impacted positively by the presence of beehive (F = 81.58; p < 0.05).

TABLE 1: IMPACT OF BEEHIVE ON ZUCCHINI PRODUCTION

Zucchini	Fruits number	Fruits weight	Fruits size
With beehive	10.20 ± 0.51a	1.13 ± 0.042a	33.3 ± 0.39a
Without beehive	6.5 ± 0.34b	0.72 ± 0.048b	24.8 ± 0.85b
F	36.13	40.13	81.58
Ddl	1	1	1
P	p < 0.05	p < 0.05	p < 0.05

4. DISCUSSION

This study allowed to assess the contribution of beehives in zucchini production increasing. Analyses of results revealed that the diversity of bees within zucchini plantation was not affected by the presence or the absence of beehives. Indeed, two bee species (*A. mellifera* and *L. interruptum*) have been identified on both plots. Similar results have been obtained by Artz et al. [11]. During their study, the authors recorded the same number of bee species in an environment with beehive and another without beehive. For the two bee species observed in this study, the presence of beehive significantly impacted the relative abundance of the honey bee. The honey bee can form colonies of 25,000 individuals [9]. This number could affect directly the number of individuals visiting neighbouring crops. These results are similar to those of Artz et al. [11]. The authors showed that in the presence of beehive colonized by *A. mellifera*, nearby zucchini plots, the specimens of honey bees were the most abundant in these plots. Walters and Taylor [9] showed also that beehive colonized by honey bee facility leads to an abundance of visits of this species to flowers relative to other bees in the environment. The analysis of daily activity of *A. mellifera* and *L. interruptum* allowed to locate the peak of activity of these two species between 5am and 6am. The presence of a bee on a flower is not fortuitous because It comes for pollen and / or nectar harvest. For zucchini, the production of nectar is probably intensified between 5 am and 6 am [12]. The analyses revealed that the activity of *A. mellifera* was more intense on the plot with beehive compared to the plot without beehive. This difference could be related to the presence of beehive. According to Walters and Taylor [9], the presence of beehive colonized by *A. mellifera* increase the number of visits per flower. The best parameters of zucchini production (the number of fruits, the mass and the size of fruits) were obtained on the plot with beehive. These results are similar to those of Knapp and Osborne [13] which showed that the number of fruits, the size and the weight of zucchini fruits increase proportionally with the abundance of bees on flowers. Several authors have shown also that the association of zucchini production with beekeeping leads an increase of yield by increasing the number of fruits as well as the weight of the fruits [9], [14]. Similar observations were also made by Ndola et al. [15] on the cucumber. These results are however different from those of Petersen et al. [16] who claim that beehive activity does not influence bee activity or the production of zucchini in New York. This difference could be explained by the immediate environment of the study plots. Indeed, Delaplane and Mayer [14] showed that sometimes bee colonies, placed for pollination of a given crop, find themselves foraging on other crops or on wild plants and surrounding weeds.

5. CONCLUSION

In this study, it appears that the installation of beehive nearby a plot of zucchini impacts positively bees' activity and the parameters of production such as the number, the size and the mass of fruits. In addition, the presence of beehive had any effect on the diversity of bees and their peak activity period in zucchini plots. Therefore, this study argues that it is possible to increase the production of zucchini by setting up beehive nearby the plots.

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