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Honey Bee Performance under Different Vegetation and Land Use Types and Conditions

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Abstract

The location of bee hives plays an important role in the success and profit maximization of honeybee production business. This study was carried out to evaluate the performance of bees in different locations characterized as hill tops, residential areas with limited vegetation, farmland and thick forest in Osun and Ondo States, South-western Nigeria. Fifteen bee hives were randomly placed approximately 50 m apart at each location and monitored during the wet (May-September 2017) and dry (November-March 2018) seasons. The total harvest of colonies was carried out in all the hives at the end of the study period. The results show that hives located on hill tops and residential areas had the highest colonization efficiency of over 60% while the forest location gave poor in hive colonization (<20%). FUTA 1, Oke-isimi and Ilara as residential area, hill top and farmland had significantly ($P < 0.05$) higher average wax production at 11.65 ± 0.14, 11.74 ± 1.5 and 10.62 ± 2.0 kg and average honey at 7.8 ± 0.09, 6.97 ± 0.93 and 5.77 ± 1.09 l respectively. The production of honey wax and honey showed positive and significant correlation with bee hives colonization (r= 0.945, 0.948 respectively). The number of pests discovered at the bee hive sites determined, to some extent, the performance of the bee colonies. Soldier ants, termites and mites were recorded in almost all the colonies especially where the performance was poor. In order to derive maximum profit from honeybee production, adequate attention must be given to the location of hives in terms of availability of highly diverse flowering plants, absence or low population of bee pests, most especially, soldier ants, termites and small hive beetle.

Key words: Honey bees, bee hives, land use types, Southwest, Nigeria.

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Introduction

Honey bees (*Apis* spp, Family Apidae) are important insects to both man and his environment in the form of honey production and in the pollination of flowers. Different species of bees, including the honey bees, are responsible for massive propagation of many plant species dispersed across huge land areas, collecting nectar and pollen grains from flowers to nourish their colony and simultaneously transfer pollen between flowers. This role ensures the propagation, multiplication and conservation of more than 80% of the world's flowering plants (Wang *et al.*, 2013; Ollerton *et al.*, 2011). This value of honey bees in crop pollination is significant to increasing national food production and regeneration of plant

species. Also, it is one of the factors that influence seed production of agricultural crops as shown in increased seed yield and plant productivity in Ethiopia (Admasu and Nuru, 2002). The role of bees in plant propagation brings about genetic variation among plant species since their activities bring about transfer and mixing of pollens.

Plants are the sources of food for honey bees. The pollen from flowering plants provide the bees with nutrients needed for proper growth and production (Alaux *et al.*, 2010; Brodschneider and Crailsheim, 2010; Di *et al.*, 2013; Roger *et al.*, 2017). This makes an area with diverse flora species significant to the well-being of the pollinators but poor food supply increases the susceptibility of the bees to pests and parasites causing poor production (Naug, 2009). The natural enemies affecting the survival, reproduction and productivity of honey bees include pests and diseases which reduce the pollinating roles of honey bees and consequently their economic value. The nutritional state of bee colony is directly related to its overall health (Potts *et al.*, 2010, Archer *et al.*, 2014) and the highly nourished bees are capable of resisting stress, parasites and diseases (Szymas and Jedruszuk, 2003). Therefore, the ever-blooming plants of interest such as flowering bushes and woody perennials are of considerable importance for propagating hardy and disease resistant bees. However, urbanization characterized by the development of socio-economic infrastructure and anthropogenic activities, especially slash-and-burn smallholder farming, have encroached into the former intact forests.

Honey bees' productivity relates to the amount of honey and other bee products that can be produced which are indicators of the economic gain of honey bee business (Melaku *et al.*, 2008). Honey production and sales have always been a lucrative business requiring little time and efforts as almost everything is done by the bees themselves from foraging to honey production.

This study compared the influence of different locations and habitat conditions: the ideal forest areas and areas with limited vegetation characterized as suitable and unsuitable on the performance of honey bees.

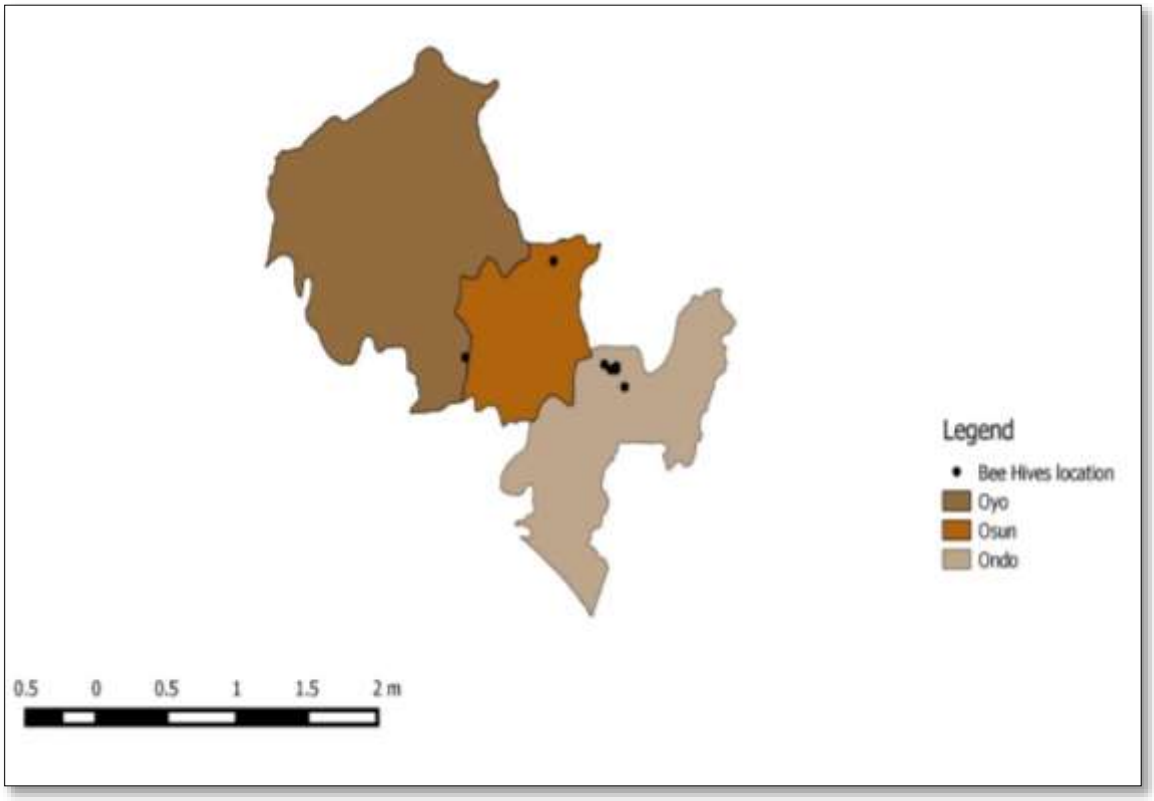

Fig. 1: Map of the states showing the locations of the bee hives

If there is no information on the site in Oyo State, it should be removed from the map.

Materials and Methods

Study location

The study was carried out at various locations in two states of Southwestern Nigeria between May 2017 and March 2018. The locations are Ondo State: Obele, Ilara, Oke Isimi, FUTA 1, FUTA 2 and Ondo road and Osun State: Iree (Fig. 1). The seven locations were divided into four terrain groups: Hill top (Oke-isimi, Iree), Farm land (Ilara), residential area with limited vegetation (Obele, FUTA I, FUTA II) and Forest (Ondo road) (Table 1). Fifteen wooden hives were placed in each location and the performances of the bee colonies were monitored all through the study period.

Colonization

Hives were baited with bee wax and left to be colonized. The hives were checked from time to time and cleaned for colonization success. The rate of colonization was calculated for each site as follows:

Table 1: Description of the bee hives locations

$$\text{Rate of colonization (\%)} = \frac{Colonised\ Hives}{No\ of\ Hives\ per\ site}$$

Honey and wax yield

At the end of the period, bee hives located in each site were harvested to obtain honey and wax. The total yield of honey and wax over the dry and wet seasons were quantified in litres and kilograms respectively.

Pests and diseases

Once in two weeks, the colonies were carefully checked for the presence or activities of pests and incidence and documented.

Statistical analysis

The data of bee hives' performance in terms of colonization, honey and wax production were analyzed with one-way ANOVA and the means compared with Turkey follow-up test. The relationships between colonization rate and wax and honey production were established with Pearson's correlation statistics.

Bee hives location	GPS reading	Vegetation type
Oke Isimi	N 7.31875º, E 005.1772º	Hill Top
Obele	N 7.30036º, E 005.17091º	Residential areas with few vegetation.
FUTA 1	N 7.30011º, E 005.1772º	Residential areas with few vegetation.
FUTA 2	N 7.29935º, E 005.13786º	
Ilara	N 7.33011º, E 005.0925º	Plain farmland
Iree	N 7.9342º, E 004.73056º	Hill top
Ondo road	N 7.19848º, E 005.2367º	Thick Forest zone

Results

Table 2 shows the efficiency of colonization of the bee hives in the different locations. All the bee hives located at Oke Isimi were colonized (100% colonization) followed by FUTA 2 (86.7% colonization) while Ilara, Iree and FUTA 2 had 66.7, 60.0 and 53.3% colonization respectively. Less than half of the bee hives located at Obele were colonized (40% colonization) while only 13.3% of the bee hives located at Ondo road had bee colonies.

Table 2: The colonization of bee hives placed at different locations in Ondo and Osun States

Hives location	No of hives	No Colonized	% efficiency
Oke Isimi	15	15	100.0
Obele	15	6	40.0
Futa 1	15	13	86.7
Futa 2	15	8	53.3
Ilara	15	10	66.7
Iree	15	9	60.0
Ondo road	15	2	13.3

Fig. 2 shows the wax yield from the bee hives placed in various locations in Ondo and Osun States. FUTA 1 and Oke-Isimi had the highest bee wax yield at 11.74 and 11.65 kg respectively which did not differ significantly from 10.62 kg obtained at Ilara location. The quantity of honey extracted from the bee hives in various locations is shown in Fig. 3. The bee honey yield from the hives showed that Oke-Isimi, FUTA 1 and Ilara produced the highest quantities at 7.82, 6.97 and 5.77 l respectively.

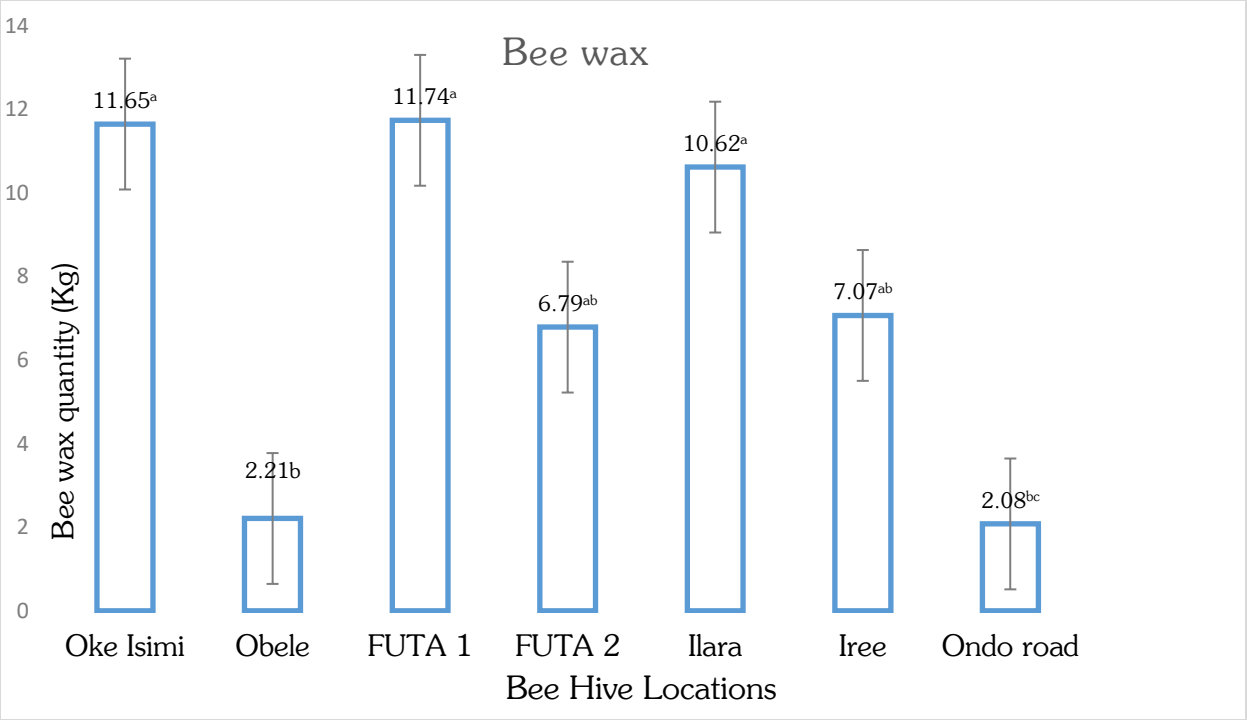

Fig. 2: Bee wax quantity produced in the bee hive locations.
Values with different superscripts are significantly different ($p<0.05$).

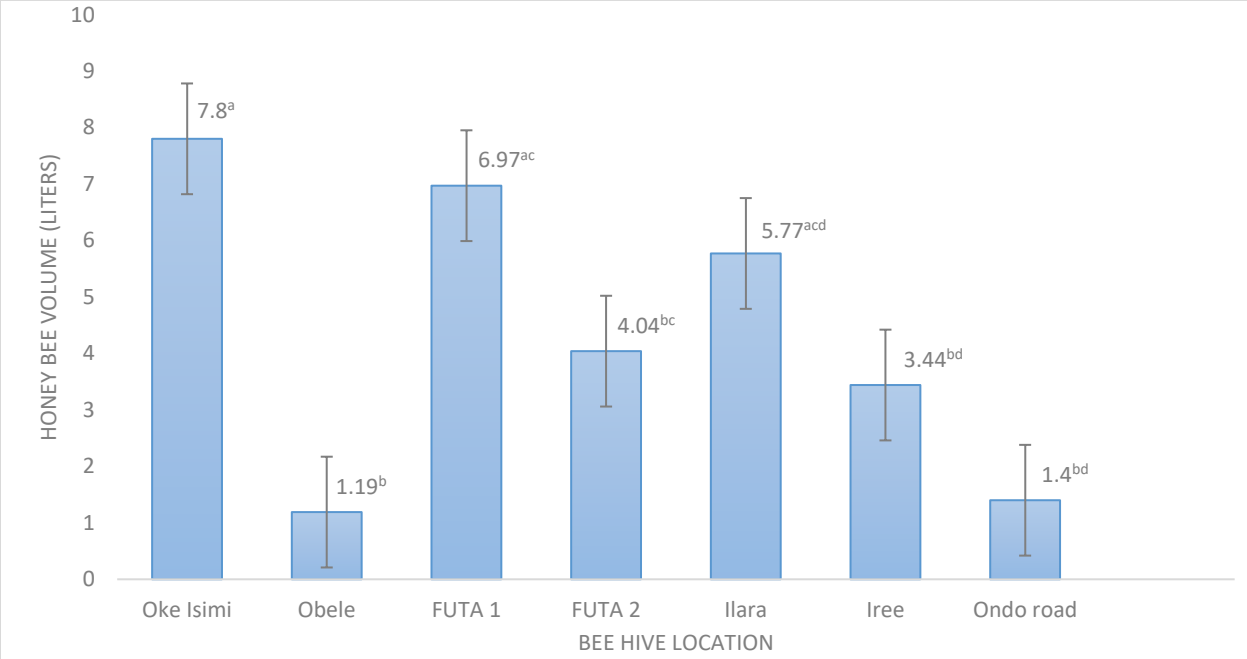

Fig. 3: Bee honey quantity in liters across all the bee hives locations.
Values with different superscripts denote significant difference.

The relationships between the rate of colonization and wax production (r = 0.945) and honey production (r = 0.948) are very strong and positive (Fig. 4).

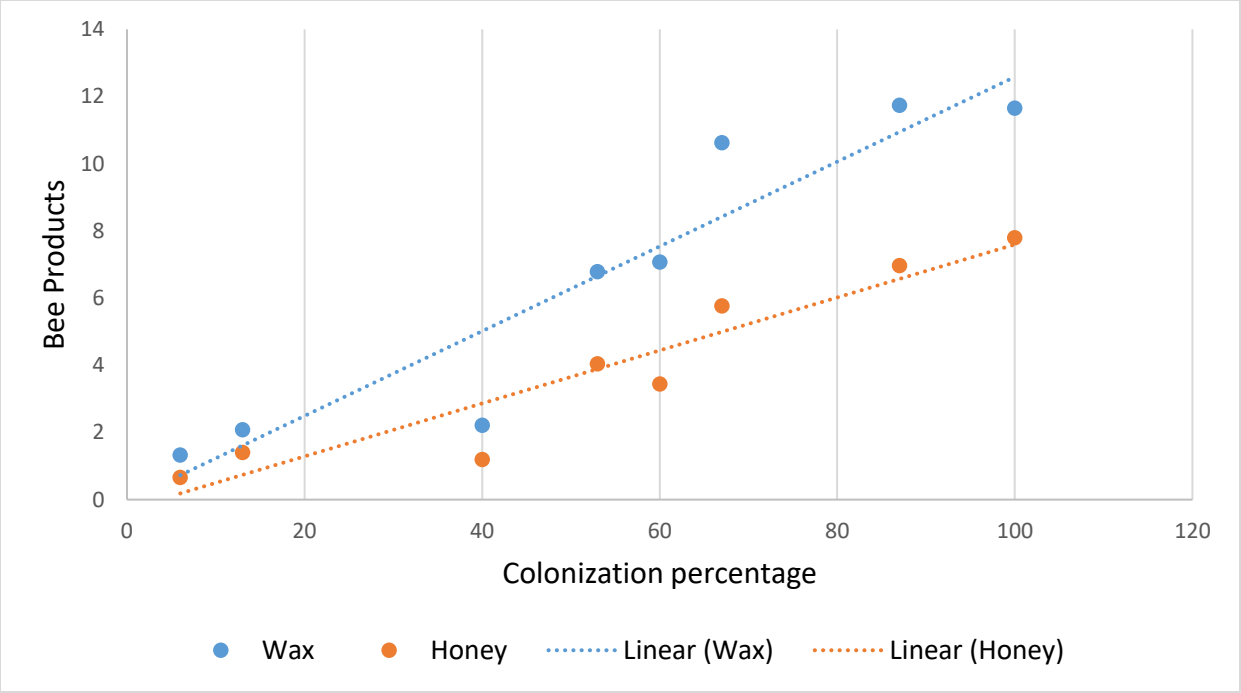

Fig. 4: Correlation analysis between colonization efficiency and bee products

Table 3 shows the incidence of pests and diseases in the bee hives at all locations. Soldier ants and termites were the most frequent pests and enemies of honey bees in six of the locations and the one (1) location in which mites and tick maggots were found also had termites or soldier ants while silk worm disease occurred in two (2) of the locations.

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Table 3: Pests and diseases in the bee hives at different locations in Ondo and Osun States

Hive Locations	Description	Pests
Oke Isimi	Hill top	Mites, Termites
Obele	Housing sandwiched with vegetation	Silk worm disease
FUTA 1	Housing sandwiched with vegetation	Soldier ants, Tick maggots
FUTA 2	Housing sandwiched with vegetation	Soldier ants, Termites
Ilara	Farmland	Termite/Silk worm disease
Iree	Hill top	Termites
Ondo road	Forest	Soldier ants

Discussion

The honey bees appear adaptable to different habitat types and can tolerate disturbance to some extent. This, however, does not mean that they do not have the preferred habitats. As expected, the areas with good floristic composition is of importance and preference to bee colonies and with this level of diversity, honey bees' production and products are maximized (Mohammed *et al.*, 2006). The colonization rate was higher for hives located at Oke-Isimi, FUTA 1, Ilara and Iree habitats characterized as hill top, residential areas with vegetation and farmland. It has been shown in many studies that honey bees adapt well to different vegetation zones as measured by the

rate of colonization and successful honey production even in arid regions that do not support crop cultivation (Bradbear, 2000). Ethiopia is an example with as low as 3% forest coverage (JICA, 2008) and still ranks as the third largest producer of natural honey (FAOSTAT, 2012).

The successful colonization of honey bees at hill tops, residential areas and plain farmland in this study can be attributed to the absence or low population of the natural enemies and the exposure to direct sunlight which can help prevent some pests such as small hive beetle (Kaiser and Ernst, 2016). Some natural pests impact honey bees more than the others, for example, the mites appear mild as opposed to soldier ants, while termites have more of indirect impact where they attack the wooden hives rather than the bees themselves.

Successful honey bee colony is judged by the amount of bee products obtained from the hives (Bukovinszky *et al.*, 2008). This study shows that Oke Isimi, FUTA 1 and Ilara had similar high quantities of both wax and bee honey which differed significantly from the other locations. The locations of the hives appear important to the production of these products. Although the hives located on hill tops would appear to be protected from disturbances caused by anthropogenic activities as opposed to those located in human surroundings and farmland where activities could pose disturbance and threats to bees, nevertheless the bees thrived in these locations but were better in the less-disturbed hill top. Human settlements naturally control and eliminate soldier ants and termites while farmlands are occupied from time to time and farm management practices often involve using cultural and chemical methods to eliminate pests, and these factors explain why bees thrived well in places where their natural pests are controlled. Although the thick forests should have been the best locations for honey bee hives as a result of diverse floristic composition which consequently should result in colony success (Westphal *et al.*, 2006) but the poor performance of the hives located in the forest in this study could be as a result of large population of soldier ants and termites. Elliot (2009) noted that predation and parasites, among other factors, are the challenges to obtaining good yield from bee keeping in the natural habitats.

The rate of hive colonization is directly proportional to production of honey and wax in this study as indicated by strong and positive relationships. The hives with 100% colonization (Oke-Isimi) had the highest amount of honey and wax while the least colonized hives had the lowest amounts of the bee products. The condition of bee hive location in terms of nearness to food and water influenced honey and wax production. Thus, the accessibility of colonies located on the farmlands, hilltops and near human settlements to constant food and water sources is indicated by the composition of flora resources present at these sites. These flora resources have been mentioned as food sources for honey bees (Larinde *et al.*, 2014) and their availability correlates with high bee yield (Burkle and Irwin, 2009; Kim and Thorp, 2001).

Conclusion

Heavily colonized hives translate to more bee products which mean more economic gain from bee keeping. The profit motive requires that hives are located in areas with diverse floristic composition to ensure regular food supply, minimal disturbance from human activities including pesticide application especially on the farmlands. The knowledge of bee parasites and predators as well as their control are very important factors to be considered for the desired bee colony success.

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