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EFFECTS OF HABITAT AND BEEHIVE TYPE ON THE YIELD OF HONEY IN HONG LOCAL GOVERNMENT AREA OF ADAMAWA STATE, NIGERIA.

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ABSTRACT

The study examined the effects of habitat and beehive type on the yield of honey in Hong Local Government Area of Adamawa State. Habitat potentials that could guarantee possible apicultural industry have not been examined in the study area. Data on list of plant species (trees and shrubs plants) utilized by honeybees were obtained through ocular assessment and total count method. Information on the micro-climatic factors were gathered from the Department of Meteorological Services, Adamawa State University, Mubi. Yield of honey was recorded from different bee hives for 2 years. Data on species of plants visited by honeybees were subjected to descriptive statistics (*occasionally, **frequently and *** very frequently visited), while that on woody plant species diversity was analyzed using Simpson Diversity Index. Multiple regressions were used in the assessment of effect of micro-climatic factors, woody plant species diversity on the yield of honey. A total of 19 trees belonging to 12 families and 13 shrubs belonging to 7 families were visited either occasionally, frequently and very frequently by honeybees in the study area. Results of woody and herbaceous plant species diversity indicated 0.807638712 and 0.903150826 respectively. Woody plant species diversity (11.297**) and temperature (0.527*) contributed more than other factors {P<0.05}. R.Square (65.9%) indicated high coefficient of determination between the determinant factors. Total honey yield of 94.30kg and 60.40kg were obtained for first and second years respectively. Langstroth and clay pot hives had the highest (38.39kg) and lowest (8.50kg) yields in the first year; while Israeli top-bar (25.30kg) and clay pot (4.50kg) were noted in the second year. Further research on plants visited by honeybees and their nectar status has been recommended.

Keywords: Habitat, effects, beehives, honey yield

INTRODUCTION

Varieties of habitats have been exploited by the honeybees and the choice of these habitats play an important role in their survival. Honeybees exist everywhere as long as there are forage resources for them. Each habitat has a particular influence on the apicultural activities and major differences in floral habitat could exist at different seasons. Honeybee seasons are generally similar with respect to habitats, but local variations are determined by proximity to the predominant plant species and its richness (Mutsaers, 1995). Nectar flow in a given habitat is dependent upon the species of plants available. The colonies of

honeybees are fond of forming clusters in low temperatures and maintain it at the edge of these clusters above 9^0C with low normal activities. However, temperatures at 30^0C or above with relative humidity of 50% to 75% encourages nectar flow and pollen flow (Marieke, 1992).

Plant species diversity and climatic factors (rainfall, temperatures and relative humidity) have significant roles towards the yield of honey in any given area. Although each factor could contribute towards the yield of honey, plant species density seemed to have greater effect than any other factor (Akosim *et al*, 2007). Too low (8^0C) and too high (above 50^0C) temperatures as well as relative humidity below 50% can affect laying of eggs, cause destruction of the larvae and make honeybees in-active (Marieke, 1992). Precipitation is also an important factor that accounts for the survival of plant population/diversity. Precipitation does not only affect the distribution patterns and abundance of honeybee species, but also play an important part in species richness (Wanda, 2003). There are several honeybee products (beeswax, propolis, pollen, royal jelly, beebread, mead, organic honey, venom and honey) but honey seems to be the most favoured among others. Propolis, royal jelly and bee venom are used for various purposes (Okonta, 2011). Out of the estimated world honey consumption, 90% is eaten directly as food while 10% is utilized in various ways and other domestic products. The value and importance of honey has been underestimated in the past due to lack of awareness and information on its antibiotic and medicinal properties (Ojeleye, 1999).

Enough scientific information regarding the habitat potentials for beekeeping is necessary for the determination of viability of beekeeping industry in the study area. However, detailed survey that can yield data on floral resources (trees and shrubs plants) utilized by honeybees, their diversities as well as ecological factors are yet to be ascertained in the study area (Mohammed, 2006), hence the need for this study which assessed the effects of habitat and hive efficiency on beekeeping.

METHODOLOGY.

Study Area

The study area is Hong local government area of Adamawa State. It lies between latitudes 10^0 00'N and 10^0 50'N, longitudes 12^0 50'E and 13^0 46' of Greenwich Meridian (Kefas, 2016) (Figure 1). Mean monthly temperatures ranges from 20.03^0C to 30.8^0C while relative humidity varies from 18% to 21% in January and March and reaches its peak (above 64.9%) between August and September. Annual rainfall ranges from 67mm to 223mm and lasts for 5-6 months (Minisry of Agriculture, Mubi Zonal Office, 2013). Among the dominant woody plant species in the study area are : *Acacia senegal, Acacia nilotica, Acacia tortilis, Ficus species, Ziziphus mauritiana, Danielia oliveri, Adansonia digitata, Khaya senegalensis, Nauclea latifolia, Diospyros mespiliformis, Parkia biglobosa Balanites aegyptiaca, Sterculia setigera, Terminalia albida, Ziziphus spina-christi, Sena siamea, Annona senegalensis, Terminalia glaucescens, Guiera senegalensis, Tamarindus indica* and *Grewia venusta* while the abundant grass species are: *Cenchrus species, Sena obtusifolia, Sida acuta, Hibiscus asper, Tridax procumbens, Croton lobatus* and *Portulaca quadrifida* among other species. Some of the shrub, grass and tree species of the southern and northern guinea vegetation/zones are also found in this zone (Ikusemoran *et al.*, 2013)

Study Design and Data Collection

The study design followed the method described by Sutherland (1999) and adopted by Akosim *et al*, (2007). Data on woody plant species visited by honeybees and the intensity of visit were obtained through ocular/visual assessment of the plants as described by Kasina *et al* (2010). Assessment of diversity of woody plant species utilized by honeybees in the study area was done following the method outlined by Ampitan and Okoro (2012). Secondary data on rainfall, temperature and relative humidity for the period of 3 years (2011-2013) were collected from Department of Meteorological Services, Adamawa State University, Mubi. Yield of honey from various

hives (clay pot, Israeli top-bar, Kenya top-bar, Langstronth and woven grass) were obtained for 2 years in the study area following Rahman and Lawal (2003).

Statistical Analysis of Data

Descriptive statistics (use of tables, percentages and charts) were used in presenting the list and intensity of visit to plant species by honeybees in the study area. Simpson Diversity Index as described by Akosim *et al* (2007) was used in determining the species diversity in the study area. The mathematical formula is as follows

$D = \sum Pi^2$

i = 1. Where, D= Simpson Diversity index; Pi=proportion of the species, i.e $\frac{ni}{N}$

n_i= individual of the species in a sample of N

D has a maximum value of 1 in a monoculture species and becomes smaller as the community becomes more diverse.

Multiple linear regression was used in determining the effect of micro-climatic factors, woody and herbaceous plant species on the yield of honey in the study area. The formula is given as follows:

Y = bo b1x1 +b2x2 +b3x3 +b4x4 +b5x5 +Ut. Where,

Y= Yield of honey in kg; X1 = Rainfall (mm); X2 = Relative humidity (%); X3 = Temperature (^{0}C);

X4 = Herbaceous plant species cover (%); X5 = Woody plant species diversity.

b1 – b5 = Parameters ascertained, Ut = error term, bo = intercepts on Y axis

RESULTS

The diversity of plant species visited by honeybees and the intensity of visit in the study area (Table 1) indicates that a total of 19 trees belonging to 12 families were identified. 1, 2 and 16 of the species were visited very frequently, frequently and occasionally by bees respectively. A total of 13 shrub species belonging to 7 families were utilized by honeybees in the study area (Table 2). 2, 4 and 7 species were visited very frequently, frequently and occasionally by bees respectively. Results of effects of micro-climatic factors, woody plant species diversity and herbaceous plant species on the yield of honey in the study area (Table 3) indicated that woody plant species diversity and temperature contributed significantly more than other factors. Results of Simpson diversity index for woody plant species was 0.807638712 (Tables 4). Results of yield of honey in relation to habitats and hive types in the study area are shown in Table 5. A total yield of 94.30kg was recorded from all the hives during the first year (2012) while an average of 18.86kg per hive was obtained. Langstroth hives had the highest total yield of 36.20kg (38.39%) while the lowest yield of 8.50kg was recorded from clay pot (9.01%). In the second year (2013), a total yield of 60.40kg was obtained (12.08kg/hive). Israeli top-bar recorded the highest total yield of 25.30kg (41.88%) while the lowest yield of 4.50kg was recorded from clay pot (7.45%).

DISCUSSION

The species of plants visited by honeybees agrees with the statement of Reinhard (1997), who stated that many tree species were known for their apicultural values. The finding conforms to the report of Akosim et al (2007), who reported 4 shrub and 12 herbaceous species visited by honeybees in certain part of Adamawa State. The finding is also in strong agreement with Mwangi *et al* (2010), who reported that bee populations have been noted through foraging on plants, hedgerows bordering forests and related areas. It could be assessed that woody plant species do not only provide forage for the honeybees, they also serve as homes or shelter for teaming bee populations. Hence, woody plant species diversity is an important ecological requirement of honeybees in the study area.

Temperature in the study area ranges from 26.7^{0}C to 28.5^{0}C in cold season and rarely exceeds 45^{0}C to 50^{0}C in the hot season. Relative humidity ranges between 16% to 87%. Mutsaers (1992), observed that too low (8^{0}C) and too high (above 50^{0}C) temperatures as well as relative humidity below 50% can affect egg laying, destroy the larvae and abstract other activities in honeybees. The micro-climatic condition in the area is said to be suitable

for beekeeping. Wilson (2006), observed that amount of rainfall and temperature of an area exert a great influence on the life and output of honeybees.

The Simpson diversity index value of woody plant species is an indication of high diversity of forage species for honeybees. Maguran (2004), suggested that a variety of objective measures have been created to obtain the qualitative estimate of habitat for effective development. Both woody and herbaceous plant species in the study area have been found to be good forage resources for honeybees. Mwangi et al (2010), reported that bee population have been noted through foraging on hedgerows on plants bordering forest reserves in Kenya. Albert (2012), reported that diversity is a quantitative measure that reflects many different species in existence, which also quantify the biodiversity of a habitat.

The yield of honey in the study area seemed to be encouraging when compared to yields obtained elsewhere. Beetsma *et al* (2001), reported an average honey yield of 1.5kg to maximum of 10.0kg per beekeeper per colony in Cameroon. Michael (2012), reported an average honey yield of 8.3kg per hive from Eucalyptus plantation in South Africa.

CONCLUSION

The study focused on the effects of habitat and hive types on the yield of honey in Hong local Government area of Adamawa State, Nigeria. From the results obtained, it can be concluded that the study provided baseline information on the potentials of habitats and micro-climatic factors on yield of honey in particular and beekeeping in general. Yield of honey obtained did not vary with habitats, an indication that both the climatic factors and melliferous plants did not also vary between the habitats. Result of the study also showed higher yield comparable to what is obtained in East and South Africa can be obtained from the study area if modern beehives such as Langstronth, Israeli top-bar and Kenya top-bar are used in the area It could be concluded that there are adequate representative plant species that serve as forage requirements for bees and beekeeping in the study area. If given proper planning and management, yield of honey could be more while beekeeping in the study area would be a worthwhile business.

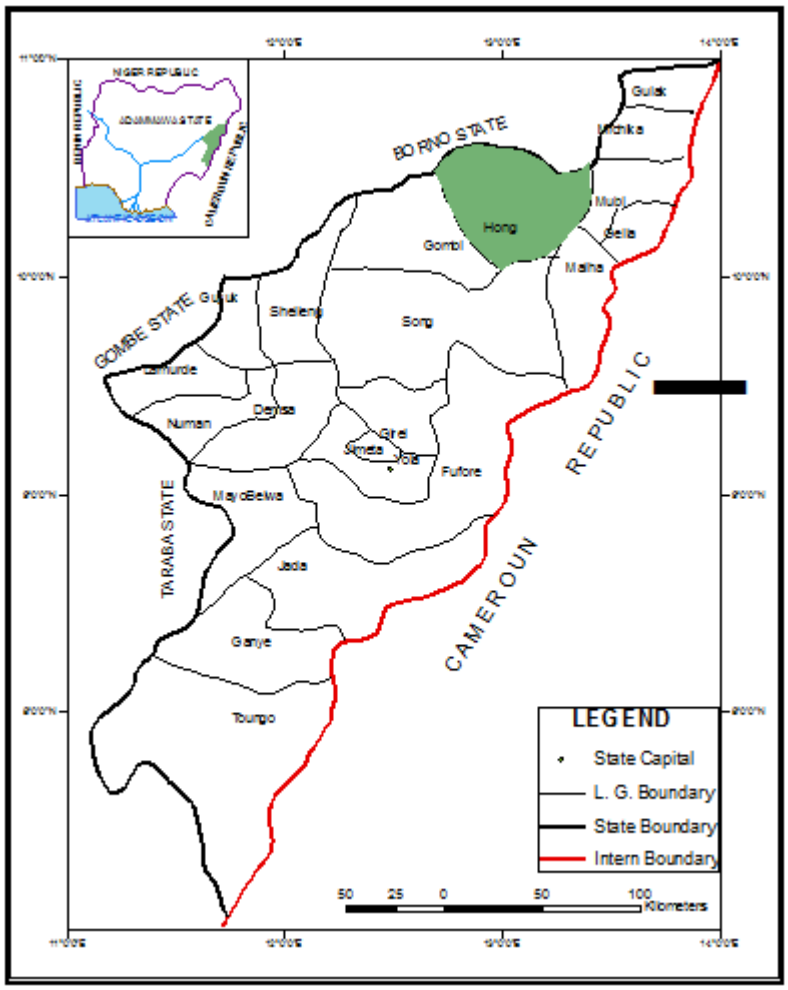

Figure 1: Map of Adamawa State Showing the Study Area (Hong Local Government Area)
Source: (Kefas, 2016)

Table 1: Species of tree plants visited by honeybees in Hong Local Government Area of Adamawa State, Nigeria.

S/N	Family	Scientific Name	Common/ Local name	Flowering Period	Intensity of Visit	
					Morning	Evening
1.	Annonaceae	*geissus leiocarpus*	African birch	All year round	*	*
2.	Balanitaceae	*Balanites aegyptiaca*		Nov-Jan	*	*
3.	Convolvulaceae	*Danielia oliveri*	African copaiba	Jan-March	***	***
		Detarium microcarpum	Tallow tree	July-Sept	*	*
4.	Dilleniacea	*Diospyros mespiliformis*	West African Ebony	Nov-Jan	*	*
5.	Fabaceae	*Ficus platyphylla*	Flake rubber tree	April-June	*	*
		Ficus ingens		March-May	*	
		Ficus thonningii		March-May	*	
6.	Guttiferae	*Haematostaphis barteri*	Blood plum	April-June	*	*
7.	Mimosoideae	*Acacia sieberiana*	White thorn	April-June	*	*
8.	Myrtaceae	*Nauclea latifolia*	African peach	July-Sept	*	*
9.	Opiliaceae	*Parkia biglobosa*	Locust bean tree	Feb-April	*	*
		Piliostigma thonningii	Camel's foot	June-August	*	*
10.	Smilacaceae	*Sterculia setigera*	Karaya gum tree	March-may	*	
11.	Tamaricaceae	*Tamarindus indica*	Tamarind	March-May	*	*
		Terminalia albida		March-May	***	***
12.	Vitaceae	*Vitellaria paradoxa*	Shea butter tree	Jan-March	*	*
		Vitex doniana	Black plum	March-May	*	*
		Ziziphus mauritiana	Jujube tree	August-Oct	**	**

* Occasionally visited ** frequently visited *** Very frequently visited
Source: Field Survey, 2012, 2013.

Table 2: Species list of shrub plants visited by honeybees in Hong Local Government Area of Adamawa State, Nigeria.

S/n	Family	Scientific name	Common/local name	Flowering period	Intensity of visit	
					Morning	Evening
1.	Anacardiaceae	*Annona senegalensis*	Wild custard apple	March-May	*	*
2.	Flacourtiaceae	Guiera senegalensis		All year round	**	**
		Gardenia aqualla		Feb-April	*	
		Grewia venusta		March-May	*	*
3.	Mimosoideae	*Acacia tortilis*		July-Sept	***	***
		Acacia atexacantha		Sept-Nov	*	*
4.	Opiliaceae	*Piliostigma thonningii*	Camel's foot	June-August	*	*
5.	Sapotaceae	*Sena siamea*	Siamese cassia	All year round	*	*
6.	Tamaricaceae	*Terminalia glaucescens*		March-May	***	***
		Tamarindus indica	Tamarind	March-May	*	*
7.	Vitaceae	*Ziziphus mucronata*	Buffalo thorn	March-May	**	**
		Ziziphus spina-christi	Christ's thorn	Jan-March	**	**
		Ziziphus mauritiana	Jujube tree	August-Oct.	**	**

Key

* Occasionally visited ** frequently visited *** Very frequently visited

Source: Field Survey, 2012, 2013

Table 3: Linear Regression of Micro-climatic Factors, Woody plant species Diversity and Herbaceous plant species Cover on the Yield of Honey in Hong Local Government Area of Adamawa State, Nigeria.

Variables	Parameter Estimate (Coefficients	Standard error	T-ratio
Intercepts	28.363	54.410	0.521
Rainfall	-0.038	0.047	-0.813
Relative Humidity	0.034	-0.180	0.192
Temperature	0.527*	1.623	- 0.386
Woody plant Species Diversity	11.297**	59.441	1.059
Herbaceous Plant Species Cover	-0.037	0.019	- 1.924

* = Significant at 5% {P<0.05}; ** = Significant at 1% {P<0.01}; R^2 = 65.9%

Regression Model

$Y = 28.363 + 0.038x_1 + 0.034x_2 + 0.627x_3 + 1121.434x_4 + 0.037x_5$

Rainfall negatively but did not significantly affect yield of honey in the study area. Relative humidity had a positive effect but did not significantly affect yield of honey in the study area.

Temperature positively and significantly {P<0.05} affected the yield of honey. Woody plant Species Diversity positively and highly significantly {P<0.01} affected yield of honey. Herbaceous plant Species Cover negatively but did not significantly affect yield of honey in the study area.

Table 4: Woody plant species Diversity in Hong Local Government Area of Adamawa State, Nigeria.

Species	**Frequency**	**Pi**	**$(Pi)^2$**
Tamarindus indica	26	0.00444368	1.97463E-05
Terminalia albida	25	0.00427277	1.82566E-05
Terminalia glaucescens	1,139	0.19466758	0.037895466
Diospyros mespiliformis	117	0.01999658	0.000399863
Balanites aegytiaca	76	0.01298923	0.00016872
Vitelleria paradoxa	30	0.00512733	2.62895E-05
Vitex doniana	1	0.00017091	2.92106E-08
Ziziphus mauritiana	49	0.00837464	7.01345E-05
Ziziphus mucronata	27	0.0046146	2.12945E-05
Ziziphus abyssinica	6	0.00102547	1.05158E-06
Ximenia Americana	12	0.00205093	4.20632E-06
Parkia biglobosa	22	0.00376004	1.41379E-05
Piliostigma thonningii	297	0.05076055	0.002576634
Anogeissus leiocarpus	118	0.02016749	0.000406728
Ficus platyphylla	6	0.00102547	1.05158E-06
Ficus ingens	3	0.00051273	2.62895E-07
Ficus thonningii	4	0.00068364	4.67369E-07
Commiphora africana	1	0.00017091	2.92106E-08
Combretum fragrans	98	0.01674927	0.000280538
Combretum aculeatum	12	0.00205093	4.20632E-06
Combretum macronata	12	0.00205093	4.20632E-06
Sterculia setigera	17	0.00290549	8.44185E-06
Haematostaphis barteri	5	0.00085455	7.30264E-07
Danielia oliveri	3	0.00051273	2.62895E-07
Acacia sieberiana	5	0.00085455	7.30264E-07
Acacia ataxacantha	7	0.00119638	1.43132E-06
Acacia tortilis	1,813	0.30986156	0.096014188
Acacia seyel	11	0.00188002	3.53448E-06
Acacia macrostachya	21	0.00358913	1.28819E-05
Acacia enhrenbergiana	148	0.02529482	0.000639828
Guibourtia copallifera	1,338	0.22867886	0.05229402
Gardenia aqualla	55	0.0094001	8.83619E-05
Grewia mollis	5	0.00085455	7.30264E-07
Grewia tenax	2	0.00034182	1.16842E-07
Guiera senegalensis	205	0.03503675	0.001227574
Sena siamea	57	0.00974192	9.49051E-05
Securidaca virosa	35	0.00598188	3.57829E-05
Sclerocarya birrea	1	0.00017091	2.92106E-08
Leucaena leucocephala	16	0.00273458	7.4779E-06
Euphorbia poissonii	24	0.00410186	1.86253E-05
Rytigynia senegalensis	2	0.00034182	1.16842E-07
	5851	1	0.192361288
		Simpson's diversity index	**0.807638712**

Table 5: Yield of Honey (in kg) for 2 years (2012 and 2013) in Hong Local Government Area of Adamawa State, Nigeria.

Period/Year	Hive Types	Hive No.	Total Yield in kg	Percentage (%)
2012	Clay pot H1	3	8.50	9.01
	Israeli top-bar (H2)	3	12.20	12.95
	Kenya top-bar (H3)	3	28.40	30.12
	Langstroth (H4)	3	36.20	38.39
	Woven grass (H5	3	9.00	9.53
Total			**94.30**	**100.00**
Mean			**18.86**	
2013	Clay pot H1	3	4.50	7.45
	Israeli top-bar (H2)	3	25.30	41.88
	Kenya top-bar (H3)	3	7.70	12.76
	Langstroth (H4)	3	13.80	22.85
	Woven grass (H5	3	9.10	15.06
Total			**60.40**	**100.00**
Mean			**12.08**	

Source: Field Survey, 2012, 2013

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