Original Article

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The Effects of Time and Beehive Entrance on Colony Establishment of African Honeybees, *Apis mellifera adansonii*

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Abstract

The issue of poor colony establishment of the African honeybees (*Apis mellifera adansonii*) is one of the major challenges facing the apicultural sector. In this study, three top bar beehives assigned treatments A (with one entrance on the right edge of the base of the beehive); B (with one flight entrance at the middle of the beehive wall) and C (with two beehive entrances on the beehive wall and right edge of the base of the beehive) were constructed and installed on 31st May, 2016 in the apiary in Nnamdi Azikiwe University, Awka for the first time. Each treatment was replicated three times in a completely randomized design. Colonization, absconding, beehive weight gain, population of honeybees and number of combs constructed were monitored during the study period. Our results revealed that August to October were the colonization months in the study area. The result of the hypothesis tested revealed that monthly colonization rates of the colonies were not significantly different ($P>0.10$). Also, the modified beehive entrances (4x1cm) did not significantly affect percentage of colonization ($P=0.18$), mean time of colonization ($P>0.05$), absconding rate ($P>0.05$), beehive weight gain ($P>0.05$) and the mean number of combs constructed ($P>0.05$). However, the beehive entrances significantly affected the population of the African honeybees ($P<0.05$). It was recommended that beekeepers within Awka, South-eastern, Nigeria should install swarm trap in their apiaries prior to the month of August. The beehive with two entrances on the beehive wall and right edge of the base of the beehive were first colonized by honeybees and significantly enhanced the population of African honeybees hence recommended.

Key words: Time, Beehive entrance, Colony establishment, Honeybees

INTRODUCTION

Recently, the issue of food insecurity, poor health conditions, escalated unemployment rate and recession in Nigeria has drawn the attention of researchers. Research showed that apiculture is a viable and profitable venture that provides essential food, helps in health care, generates financial empowerment and employment for Nigerians (Ama-ogbari, 2014; Dike and Onwuka, 2016). Apiculture is the act of rearing, breeding and managing honey bee colonies in artificial hives such as traditional and modern beehives for optimum productivity of honey and its by-products (Aduke, 2012). It involves the culturing or manipulation of honeybees for the benefit of man and also has the capabilities of building up any nation (Ononye and Akunne, 2015a). Apiculture is considered to be the most suitable off farm business in Sub-Saharan Africa (Edet *et al*., 2012) which provides opportunity for impoverished or low-income people to supplement their earnings by the sale of harvested bee products such as honey and beeswax at a suitable market (Gallmann and Thomas, 2012).

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The African honeybees (*A. m. adansonii*) are the predominant honeybees' species in Africa (Abdullahi *et al*., 2011) is mostly reared in Nigeria. Globally, honeybees are highly valued resource (VanEngelsdorp and Meixner, 2011) reared for its good quality of honey, beeswax, bee pollen, propolis bee venom and royal jelly (Dike and Onwuka, 2016). Honeybees are extremely important creatures to humans because of their ability to pollinate flowers (Bayir and Albayrak, 2016). More so, honeybee venom has been reported as a veritable tool in the world of biomedicine and projected to be an effective biological technique that needs to be properly harnessed in human health restoration (Ononye and Akunne, 2015b).

However, the nature of hives used in both traditional and modern methods of rearing honeybees differs greatly. The types of beehives used in traditional beekeeping are associated with several deficiencies such as low productivity, loss of colonies and poor processing of hive products. This is why top bar beehives are now used in modern beekeeping as an improvement over the traditional method (Babarinde *et al*., 2012). It is pertinent to note that human efforts to help the honeybee thrive under human control in beehives can directly boost honey and other beehive products to benefit all. Honey production by wild honeybees could not meet up with the high honey demand in Nigeria, hence the need to rear and manage honeybees in artificial hives for optimal production of honey and other beehive products (Akunne *et al*., 2015).

Maintaining honeybees in a suitable beehive is a promising method for trapping them and enhancing their performance. But till now, farmers find it difficult to select and construct suitable hives for their beekeeping activities (Magnum, 2001). Even though more farmers are interested in rearing honeybees as a way to increase their income (Alamu *et al*., 2014), they are constrained with several factors such as lack of knowledge on the best time to install hives, type and number of beehive entrances to adopt so as to obtain better colony establishment. Inappropriate skill bee management practices, colony absconding, poor design of modern beehives, low honey yield and bee pests are the main problems that impede the full use of apiculture resources (Kumsa and Takele, 2014). In addition, a major problem affecting many beginner apiculturists is failure of hives to colonize (Babarinde *et al*., 2015).

Few available literature studies reported that hives colonization by honey bees in Africa are influenced by hive types (Ande *et al*., 2008), tree shade management (Kugonza *et al*., 2009), polythene and lime applications to top bars (Babarinde *et al*., 2010), apiary management (Okwee-Acai *et al*., 2010), hive dimension and entrance (Babarinde *et al*., 2012) and hive wood colours (Adedeji and Aiyeloja, 2014). Seventy five percent of these articles reported low rate of colonization and high absconding rate (Adedeji and Aiyeloja, 2014) with paucity of information on the effects of time and modified beehive entrances on colony establishment. This paper therefore reveals the effect of time and modified beehive entrances on the colony establishment of African honeybees in Nnamdi Azikiwe University, Awka Anambra State, South-Eastern Nigeria.

MATERIALS AND METHODS

Study area

This experiment was carried out in the Apicultural Research Unit of the Department of Zoology, Nnamdi Azikiwe University, Awka from May to December, 2016. Awka lies within coordinates 6°12_N and 7°04_E (Onyido *et al*., 2011) while the Apicultural Research Unit of the Department of Zoology lies within E: 291046.427, N: 691554.263 (Akunne *et al*., 2016).

Beehive construction

Modified top bar beehives were used for the experiment. The beehive comprise of the bottom board i.e. the base of the beehive (length=53.34cm, width=35.56cm), main cover (length=55.88cm, width=38.1cm), brood chamber (length=52.07cm, width=36.83cm, height=24.9cm). They

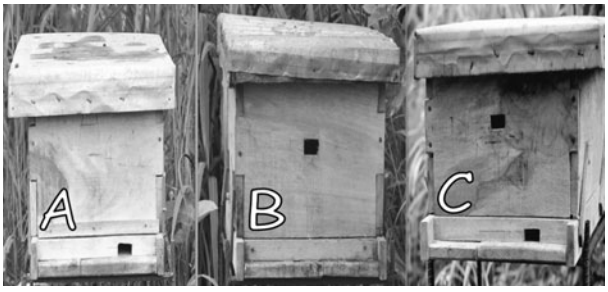

Fig. 1. Beehive treatments ("A" stands for Treatment A; "B" stands for Treatment B while "C" stands for Treatment C).

were constructed with hard woods. Each hive comprise of 8 top bars of 2cm width and beehive entrance of 4x1cm.

Installation of the beehives

A total of 9 beehives were grouped as A, B and C. Each group was replicated three times. The group A (control) had one entrance at the right edge of the bottom boards, B had one entrance at the middle of the beehive wall, while C had one entrance at both the right edge of the bottom board and the middle of the beehive wall (Fig. 1). Each beehive was baited with 40g beeswax smeared on the top bars, entrance, brood chamber and main cover and then installed at the apiary with a metallic stand (46cm high). The beehives were mounted 4m apart from each other while the entrances faced the East. After installation they were inspected on daily basis but colonized beehives were inspected fortnightly.

Data collection

The colonization rate, absconding rate, colonization time, beehive weight gain, population of honeybees and number of combs constructed were monitored during the study period. Initial and final beehive weights were determined using a Mechanical Dial Spring Scale (Hana SP-50kg/110lbs, Graduation 200g/8oz, Big Boss, China) between 6:00hrs to 8:00hrs biweekly.

Before weighing the colonized beehives, the beehive entrances were blocked with a piece of foam and then positioned on the weighing balance.

The number of adult bees observed at the entrance of each beehive treatment were counted and recorded. The population of adult honeybees was determined biweekly for a period of 8 weeks using Extension Research and Liasion Services (ERLS) formula adapted by Babarinde *et al*. (2010).

$$\text{Bees population} = \frac{\text{BNFE X 80X 1000}}{100}$$

Where

BNFE = Bees number at entrance with assumption that every bee at entrance represents 1000 bees in the colony and worker were 80% of total colony population.

Statistical analysis

Data collected from beehive weight gain, population of honeybees and number of combs constructed were subjected to analysis of variance (ANOVA) while sample means were separated using Duncan's Multiple Range Test at $P<0.05$. Monthly colonization, percentage colonization and absconding rates were subjected to T-test of significance using SPSS computer package (version 20) (IBM Corp., 2011) while Microsoft Excel (2007), was used to plot the graphs.

RESULTS

The result of this study revealed that colonization did not occur from the month of May to July, which marked the beginning of rainy season. However, two hives representing 40% colonized in August while one hive each representing 20% colonized in the months of September and October (Fig. 1). The results indicated that August to October were the colonization months in the study area. There was no significant difference between the monthly colonization rates of the beehives during the study ($P>0.05$).

The overall result showed that out of nine beehives installed in the apiary, only three colonies were properly established indicating poor colonization during the study period. It was observed that African honeybees colonized in treatments B and C (Plate 2) but no colonization was

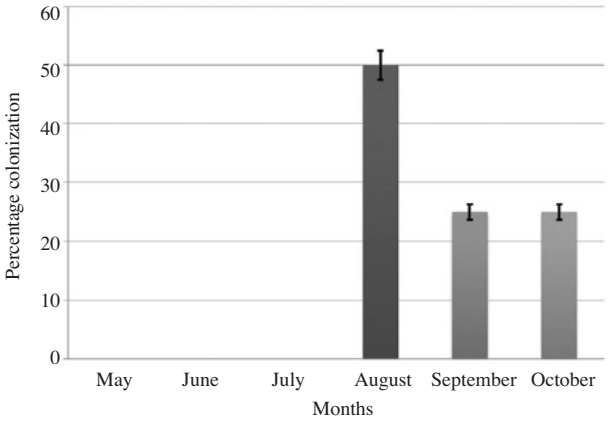

Fig. 1. Colonization rates of African honeybees between May to October, 2016.

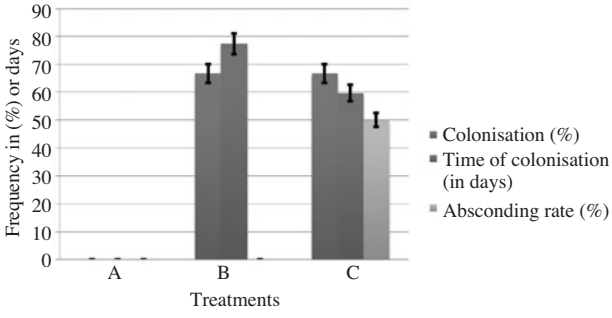

Fig. 2. Effects of modified beehive entrances on the colonization rates, time of colonization and absconding rates of African honeybees.

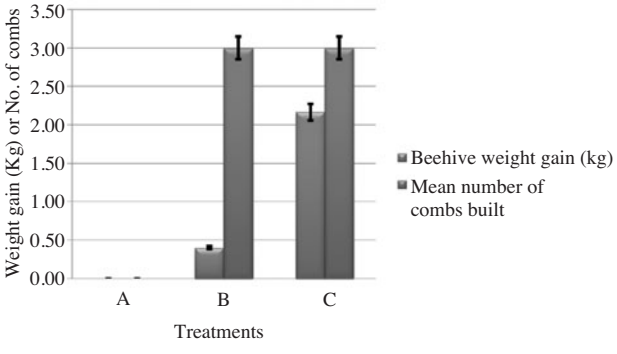

Fig. 3. Effects of modified beehive entrances on the beehive weight gain and comb constructed by the African honeybees.

observed in treatment A (control) during the study period (Fig. 2). However, treatments B and C had equal percentage colonization (66.67%). The T-test result revealed that the modified beehive entrances did not significantly affect percentage colonization (P>0.05). Furthermore, treatment C was the first to colonize with the shortest mean

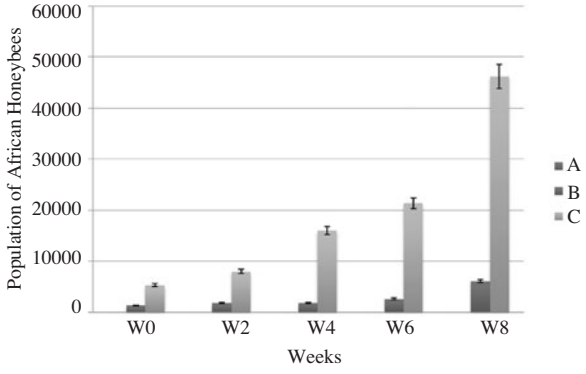

Fig. 4. Biweekly Population of African honeybees in treatments A, B and C.

Fig. 5. Colonized Beehive treatments (Treatment B and C respectively).

time of colonization (59.67 days after installation) while treatment B had the longest (77.3 days after hive installation) (Fig. 2). The mean time of colonization did not significantly differ between the beehive treatments (P>0.05). Conversely, no absconding was observed in treatments A and B while treatment C recorded 50 % absconding rate (Fig. 2). However, the absconding rate did not vary significantly between treatments (P>0.05).

The result also revealed that the highest beehive weight gain was recorded by treatment C (2.16kg) followed by treatment B (0.40kg) but least in the treatment A (0.00kg). There was no significant difference between the beehive weight gains (P>0.05). The treatments B and C had equal mean number (3.00) of combs constructed. There was no significant difference between the mean numbers of combs constructed in the treatments (P > 0.05) of the beehive treatments (Fig. 3).

In addition, the highest population of African honeybees was recorded in treatment C (46,188) followed by

treatment B (6,110) (Fig. 4). However, beehive entrances significantly affect the population of the African honeybees ($P<0.05$). This indicates that the treatment with two beehive entrances at the wall and bottom board enhanced the colony development of honeybees. Also the population of the honeybees does not vary significantly between weeks ($P>0.05$) (Fig. 4).

DISCUSSION

This present study showed that the colonization time of African honeybees in Awka is from August to October. Hence colonization of honeybees may not occur between May to July which is usually the rainy season in the area. However, this observation is in line with those of Adedeji *et al*. (2014) who reported that colonization by honeybees occurred around October in the Niger Delta region of Nigeria. This finding suggests that the best time for beehive installation in Awka is between May and July. Meanwhile Adedeji *et al*. (2014) stated that the best period for hives placement in the Niger Delta region is between August and September. In the study by Ojating and Ojating (2004) beehive colonization occurred in September, February, April and May. They also stated that the first beehive was occupied by a swarm of bees on 3 September 2002, i.e. nine months after the baited hives were placed in the apiary. It was inferred from their study that the rate of hive occupancy was highest at Okuku one year after the hives were baited and sited under the trees. The implication is that a beginner beekeeper using Langstroth frame hives in Okuku has to continue to bait hives for at least a full year before having a reasonable number of bee colonies. The reason for the differences in result could be attributed to the variations in the climatic variables in the study areas. Season has been observed as a major factor influencing beehives' colonization in Nigeria and keeping beehives in most sanitary conditions and withdrawal of non-colonized hives in raining season are good preventive measures against deterioration and attack (Adedeji *et al*., 2014).

Generally, colonization was poor in the study area as only three out of nine beehives installed had good colony establishment at the end of the study. The poor colonisation of hives by natural swarms could be attributed to a low population of the natural/feral swarms present in the environs of the study area. This is in a way related to the limited occurrence of people who practice beekeeping in the country (Kugonza *et al*., 2009) especially in Southeastern, Nigeria. Oyerinde and Ande (2006) also reported low bee colonization levels in the various Local Government Areas of Kwara State (Nigeria) which was attributed to low age level of modern beekeeping practice in the State.

The study area also had an incidence of bush burning a year prior to this recent study which destroyed so many colonized hives and possibly reduced the population of wild bees that may have been trapped. Mohammed *et al*. (2015) reported that indiscriminate bush burning leads to bees' death or escape in an area while (Okunlola and Adeyemo, 2015) mentioned bush fire as a factor that constraints the sustainability of beekeeping in Nigeria. This is because the fire is smoldering and all the proponents of the plants required for conserving our honeybees are being destroyed in large proportion (Ojeleye, 2015a; Ojating and Ojating, 2004). Bush burnings make colonies to migrate to distant lands and the colonies hardly come down to occupy hives baited with attractants. Such baited hives normally remain fallow, unoccupied by bees for a long period (Ojating and Ojating, 2004).

Furthermore, literature revealed that colonization month (s) differed in various derived savannah communities of western Nigeria as reported by Babarinde *et al*. (2010) - January, (Babarinde *et al*., 2011) - March - April, (Babarinde *et al*., 2012) - April (Adedeji and Aiyeloja, 2014) - February - April and (Adedeji *et al*., 2014) - October at Imeko, Ogun State 2013 but colonization extended to February, 2014 when all hives were fully colonized. All these months of colonization in Nigeria are within dry season. Since honeybees are associated to a specific month for habitats colonization, their chances of colonizing habitats in other months are rather limited. It becomes important to draw a calendar to indicate appropriate month(s) to construct and mount beehives (Adedeji *et al*., 2014).

The findings revealed that the beehive entrance did not significantly affect the percentage colonization and mean time of colonization of African honeybees in Awka. Similarly, Babarinde *et al*. (2012) reported that beehive types having various entrances did not significantly (P>0.05) affect colonization period. This result indicated that colonization is not dependent on the entrance of beehives. The 50% absconding observed in treatment C may be an indication that the honeybees prefer one entrance for proper colony establishment in the study area. In contrast, Kugonza *et al*. (2009) reported that the absconding rate of *Apis mellifera* colonies was significantly influenced by hive type and location in the apiary. Literature revealed that African bees have a natural tendency to abandon (absconding) their hives completely (Buckley *et al*., 2004). Similarly, up to 50% absconding rate has been reported in central Uganda (Kamatara, 2007).

The beehive weight gain is not dependent on modified beehive entrances as observed from the results. Previous studies on the effect of hive dimension and entrance on hive weight gain by Babarinde *et al*. (2012) revealed that hive type did not affect weight gain throughout the experimental period. In this study the beehive weight gain recorded ranged from 0.4~2.17kg which fall within the range (0.3~2.5kg) reported by (Babarinde *et al*., 2012). The number of combs constructed was also not significantly affected by the beehive entrance of the beehives indicating that comb building is not dependent on modified beehive entrance.

The treatment C recorded significantly higher population of honeybees than other treatments. This indicates that reproduction was enhanced by the beehive entrances. The findings of (Babarinde *et al*., 2012) also confirms this observation. The two entrances could have also enhanced movement of foragers hence ensuring steady supply of food in the colony.

In conclusion, the results of this study revealed that August to October were the colonization months in Awka. It is therefore recommended that bee farmers within Awka, South-eastern, Nigeria should install beehives in their apiaries prior to the month of August. Also, modified beehive entrances did not significantly affect percentage colonization, mean time of colonization, absconding rate, beehive weight gain and the mean number of combs constructed but significantly affected the population of the African honeybees. The beehives with two beehive entrances on the beehive wall and right edge of the base of the beehive were the first to be colonized by the honeybees and significantly enhanced the population of African honeybees hence recommended. Further researches should be carried out on the effect of time and modified beehive entrance on the pre colonization pests of honeybees and production of honey, propolis and beeswax.

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LITERATURE CITED

Abdullahi, G., H. Sule, I. A. Chimaya and M. D. Isah. 2011. Diversity and relative distribution of Honeybees foraging plants in some selected reserves in Mubi region, Sudan Savannah zone of Nigeria. Adv. in Appl. Sci. Res. 2(5): 388-395.

Adedeji, G. A., and Aiyeloja, A. A. 2014. Preference and suitability of Nigerian grown *Gmelina arborea* Linn. Roxb. and *Vitex doniana* sweet woods for beekeeping in Imeko, Nigeria. International Journal of Scientific and Engineering Research, 5(5): 1484-1493.

Adedeji, G. A., Aiyeloja, A. A., Larinde, S. L., and Omokhua, G. E. 2014. Effect of seasons on colonisation and suitability of *Triplochiton scleroxylon* K. Schum.wood for beekeeping in rivers state, nigeria. nature and science, 12(8): 117-122. http://doi.org/10.1017/CBO9781107415324.004.

Aduke, F. 2012. University education and poverty alleviation as mechanisms for enhancing youth development in Nigeria. International Journal of Psychology and Counselling, 4(1): 1-5. http://doi.org/10.5897/IJPC10.042.

Akunne, C. E., Akpan, A. U., and Ononye, B. U. 2016. A che-

cklist of nectariferous and polleniferous plants of African honeybees (*Apis mellifera adansonii* L.) in Awka, Nigeria. Journal of Apiculture, 31(4): 379-387. http://doi.org/10.17519/apiculture.2016.11.31.4.379.

Akunne, C. E., Mogbo, T. C., Ewuim, S. C., Ufele, A. N., Abajue, M. C., and Okafor, K. C. 2015. Relationship between ambient and top-bar hive temperature in Relation to optimal production of honey in fallow and cassava plots at science village, Nnamdi Azikiwe University Awka, Nigeria. Journal of International Academic Research for Multidisciplinary, 3(3): 95-100.

Alamu, O. T., Omoayena, B. O., and Amao, A. O. 2014. Flight activity of African honeybee in response to changes in colony size and weather variables during honey flow period in the Northern Guinea Savanna, Nigeria. International Journal of Applied Research and Technology 122, 3(3): 122-130.

Ama-ogbari, O. C. C. 2014. Apiculture as an aspect of Nigeria's economic history. Knowledge Review, 30(1): 1-9.

Ande, A. T., Oyerinde, A. A., and Jibril, M. N. 2008. Comparative study of the influence of hive types on bee colony establishment. International Journal of Agriculture and Biology, 10: 517-520.

Babarinde, S. A., Akanbi, M. O., Adebayo, T. A., Olaifa, I., Odewole, A. F., and Alagbe, E. A. 2010. Effect of polythene and lime applied to top bars hive on colonization, weight gain and pest infestation. Annals of Biological Research, 1(4): 61-66.

Babarinde, S. A., Akanbi, M. O., Akinpelu, F. A., Oyelade, B. G., and Oyelami, B. 2011. Impact of canopy type on honey Bee (*Apis mellifera adansonii*) (Hymenoptera:Apidae) colony performance and pest infestation. African Scientist, 11(3): 169-174.

Babarinde, S. A., Odewole, A. F., Oyegoke, O., and Amao, O. 2012. Impact of hive dimension and flight entrance on hive colonization, pest infestation and hive weight gain in *Apis mellifera adansonii* (Hymenoptera: Apidae). Munis Entomology and Zoology, 7(1): 634-641.

Babarinde, S. A., Olaleke, S. A., Akinyemi, A. O., Adebayo, T. A., and Olaifa, J. I. 2015. Evaluation of four apicultural products for hive. African Journal of Food, Agriculture, Nutrition and Development, 15(2): 9826-9837.

Bayir, R., and Albayrak, A. 2016. The monitoring of nectar flow period of honey bees using wireless sensor networks. International Journal of Distributed Sensor Networks, 12(11), 1-8. http://doi.org/10.1177/1550147716678003.

Buckley, A. Saville, N., Carroll, T. and Rita, G. 2004. An introduction to beekeeping, progressive interventions, the enterprise development agency.

Dike, N. O., and Onwuka, E. 2016. Entrepreneur perception and growth of beekeeping in Abia. Journal International of Physical Human Geography, 4(3): 1-11.

Edet, D. I., Oladele, A. T., and Bekom, R. 2012. The impact of coloured lights on night-time colony management of the African honey bee (*Apis mellifera adansonii*). Agriculture and Biology Journal of North America, 3(13), 506-509. http://doi.org/10.5251/abjna. 2012.3.12.506.509.

Gallmann, P., and Thomas, H. 2012. Beekeeping and honey production in southwestern Ethiopia. Ethiopia: Honey Bee Investigation, 1-24.

IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0. Armonk, NY: IBM Corp.

Kamatara, K. B. 2007. Days to colonization and absconding of different hives in Central Uganda. Cited by Kugonza (2009); Beekeeping practice and theory. Fountain Publishers Ltd., Kampala, Uganda. 106p.

Kugonza, D. R., Kamatara, K. B., Nabakabya, D., and Kikonyogo, S. 2009. Effects of hive type and tree shade on colonization rate and pest prevalence of honeybee (*Apis mellifera*) colonies in Central. Africa Journal of Animal and Biomedical Sciences, 4(2): 87-92.

Kumsa, T., and Takele, D. 2014. Assessment of the effect of seasonal honeybee management on honey production of Ethiopian honeybee (*Apis mellifera*) in modern beekeeping in Jimma Zone, Research Journal of Agriculture and Environmental Management, 3(5): 246-254.

Magnum, W. 2001. Top-bar hives in the USA. Bees for Development Journal, 58: 3-5.

Masari, B. U. 2015. Beekeeping for honey production in Nigeria: SMEDAN Experience. A Paper presented during the 2nd Biennial Nigeria Beekeeping Conference held from November 9-12, 2015 at Oshogbo, Osun State Nigeria p23.

Mohammed, J. U., AbdulfataiShitu, A., and Ibukunoluwa, A. A. 2015. The implication of bush burning and pesticide application on the ecosystem of honey collection in Nigeria. A Paper presented during the 2nd Biennial Nigeria Beekeeping Conference held from November 9-12, 2015 at Oshogbo, Osun State Nigeria p6.

Ojating, I., and Ojating, O. I. 2004. Beekeeping in Okuku, Nigeria. Bees for Development Journal, 70: 10-11.

Ojeleye, B. 2015a. Bush burning and sustainable beekeeping in Nigeria A Paper presented during the 2nd Biennial Nigeria Beekeeping Conference held from November 9-12, 2015 at Oshogbo, Osun State Nigeria p22.

Ojeleye, B. 2015b. Roles of beekeeping in entrepreneurship development. A Paper presented during the 2nd Biennial Nigeria Beekeeping Conference held on November 9-12, 2015 at Oshogbo, Osun State Nigeria p22.

Okunlola, O., and Adeyemo, Y. 2015. Can beekeeping be sustained in Nigeria? A Paper presented during the 2nd

Biennial Nigeria Beekeeping Conference held on November 9-12, 2015 at Oshogbo, Osun State Nigeria p25.

Okwee-Acai, J., Anyanzo, T. A., Aroba, J., Vuchiri, J. K., Onzivua, T., and Okullo, P. 2010. Effects of apiary management on colonisation and colony performance of African honey bee (*Apis mellifera*) in the North-Western Agro-ecological zone of Uganda. Livestock Research for Rural Development, 22(86). Retrieved 19 February 2017 from http://www.lrrd.org/lrrd22/5/okwe22086.htm.

Ononye, B. U., and Akunne, C. E. 2015a. Apiculture: A tool for nation building. A Paper presented during the 2nd Biennial Nigeria Beekeeping Conference held on November 9-12, 2015 at Oshogbo, Osun State Nigeria p. 16.

Ononye, B. U., and Akunne, C. E. 2015b. Apitoxin as a veritable tool in contemporary biomedicine. In Biosciences Research: Health/Medical Perspective, ICBR2015-HM006 (p. 18).

Onyido, A. E., Zeibe, C. C., Okonkwo, N. J., Ezugbo-Nwobi, I. K., Egbuche, C. M., Udemezue, O. I., and Ezeanya, L. C. 2011. Damage caused by the bean bruchid, *Callosobruchus maculatus* (Fabricius) on different legume seeds on sale in Awka and Onitsha Markets , Anambra State , South Eastern Nigeria. African Research Review, 5(21): 116-123.

VanEngelsdorp, D., and Meixner, M. D. 2011. A historical review of managed honey bee populations in Europe and the United States and the factors that may affect them. Journal of Invertebrate Pathology, 103(2010), S80-S95. http://doi.org/10.1016/j.jip.2009.06.011.