WASD
OUTLOOK 2015
37
WORLD ASSOCIATION FOR SUSTAINABLE DEVELOPMENT

EFFECTS OF INCONVENIENT MEASUREMENTS OF LANGSTROTH HIVE ON THE SUDANESE HONEYBEE ACTIVITIES

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ABSTRACT

Purpose: Study aimed to highlight the variations of comb-space and bee-space by adapting the natural measurements to improve faults and rectify the existing equipments used by the natives.

Design/Methodology/Approach: Surveys were made to collect field data measurements from natural nests sites and Langstroth hive. Honeybee colonies were equipped as follow: Group (A) extrapolated results of natural nests sites. Group (B) extrapolated results from the native modern apiaries. Group (C) standard Langstroth hives.

Findings: Colonies of group (A) super passed the other tested colonies in all the colony activities and showed complete colony settlement 100% compared with colonies of group (B) and (C) which was showed settlement 75% and with less production. Colonies of groups (B) and (C) built badly and double constructed combs. Colonies of group (C) built an extra burr combs beside wax foundation sheets.

Originality/Value: Colonies promoting and settlement strongly correlated with extrapolated natural nests measurements.

Keywords: honeybee; Langstroth hive; comb; bee-space; natural nest; hive-space; Sudan.

INTRODUCTION

Traditional beekeeping is still wide spread throughout the Sudan. Modern equipments and methods were initiated in Sudan early 60th by Khalifa in the Department of Crop Protection, Faculty of Agriculture, University of Khartoum for educational purpose (Bee file, 1969). In the last years intensive research work has been conducted on the Sudanese honeybee race using modern beekeeping technology. As a result of these efforts great interest was initiated among different government departments and private sector. The pioneers of modern beekeeping found the Langstroth hive through the first efforts to replace the old methods which were made on a limited scale by some governmental departments. Many problems raised particularly modern equipment did not suit the indigenous race of honeybees. Koeniger (1976) claimed that most efforts to import western methods of beekeeping or western bees into the tropics have failed, because the procedure involved are in compatible with the characteristics of the tropical honeybees, so the present study aimed to highlight the variations of comb-space and hive-space by adapting the natural measurements to improve the faults so as to rectify the existing equipments used by the natives in order to eliminate undesirable measurements.

LITERATURE REVIEW

Natural nests

Hepburn et al. (2014) nesting sites of open- and cavity-nesting honeybees are reviewed in terms of nest sites, space and honeybee density. Space comprises building space for new combs and living space for clustering bees. Comb constructed per bee decreases with increased density and increases in colony size. Space and density affect wax production. During comb-building there are concomitant changes in population size, population density, nectar and pollen influx, all of which affect honeybee/comb interactions. Buschini (2005) species diversity and community structure of trap-nesting bees in three different habitats (Araucaria forest, swamp and grassland) were investigated in terms of abundance, richness, diversity and similarity of bee communicites. The largest abundance of individuals and species richness was found for the family Megachilidae. The most abundant species were *Centris tarsata, Megachile brasiliensis* and *Colletes* sp. Intermediate species were *C. tarsata, M. brasiliensis, Colletes* sp, *Epanthidium nectarinioides, Megachile* (*Dactylomegachile*) $sp_{1,}$ *Anthodioctes claudii, Megachile* sp_1 and *Megachile* sp_2. *Megachile* (*Austramegamegachile*) *fiebrigi, Xylocopa* (*Neoxylocopa*) *augusti* and *Megachile* (*Moureapis*) sp_1 were the rare species. Swamp habitat yielded the greatest abundance and diversity of bee species. The similarity between this habitat and grassland, in relation to their species abundance and also to their species presence-absence, was the greatest.

Bee-space

Mace (1984) thickness of worker combs was about an inch, with space for passage of bees of about 7/16th in. down to 5/16th in. As these distances may be slightly increased without troubling the bees, many beekeepers place the combs in the hives 1½ inches apart from centre to centre. Wongsiri and Pyramarn (1987) the bee-space is 3/8 in. different bee species have different body size and therefore also different bee-spaces which may be different between two combs "4 mm between honey cells and even 10 mm between freshly built waxes at the bottom of the comb". They reported that the bee-space of *A. mellifera* was 35 mm; *A.m. adavsonii* was 32 mm and *A. cerana* in north Bangladesh was 28 mm and south Bangladesh was 24 mm.

Hives

Gupta et al. (2014) bee hives vary in size and shape, modern beehives have been improved and modified by beekeepers from time to time since the inception of beekeeping which helped beekeepers to manage bees, also the introduction of bars, and the transition to wooden hives combined with wooden frames in the true movable-frame hive. Modernisation of the beekeeping sector should utilise other technologies that are more appropriate and more sustainable for the targeted beekeepers of particular region. Walton (1975) discussed the problems of the metrication of beekeeping equipment with particular reference to the Langstroth hive, and the size of the bee-space.

MATERIALS AND METHODS

Surveys were made during (2007–2008) to collect field data measurements from natural sites at two States: White Nile State and Western Darfur State (Jebel Marra Mountain).

Honeybee-space measurements

Comb-space: the technique of Svensson et al. (1988) was adopted for measuring comb-space in natural nest site of honeybee colonies:

1. Using a ruler placed across the colony at right angle to the comb, to measure the distance between combs at each end of the nest.
2. Using a vernior scale.

From the measured number of combs the comb-space was calculated as follows:

$$\text{The comb-space} = \frac{\text{The width of the colony}}{\text{number of combs} - 1}$$

Space between worker brood combs and stored honey combs: the space measured by a sharp knife, cut the first worker brood comb at the centre vertically or horizontally. The distance between the cut comb and the next comb at the edge of the cells was measured. Measurements took place at different points. This method was repeated with the next comb until we reach the last comb using a ruler.

Langstroth hive

The Langstroth hive measurements were carried out in (2008) at three areas in Khartoum, Kosti and Wad Medani.

Behavioural studies

Three different measurements were conducted to study some of the behavioural tendencies of the Sudanese honeybee colonies which were kept in Khartoum State Alkadaro locality and considered as artificial swarms with nearly equal population of bees, about five combs covered with bees (5 C/B). The tested colonies divided into three groups' four colonies/group. Groups (A) and (B) (All brood combs and stored food were removed), group (C) (provided with wax foundation sheets) through the following entries:

1. Colonies equipped with extrapolated natural Sudanese honeybee nests measurements.
2. Colonies equipped with extrapolated of inconvenient measurements of Langstroth hive (forced into unnatural conditions).
3. Colonies kept in standard Langstroth hive measurements.

Table 1 Show different measurements used under study

Groups	HM-frames (mm) Comb-space	Hive space (mm) Upper-space	Hive space (mm) Bottom-space	Wax foundation sheets
A	32.00	5.50	32.00	–
B	35.00	85.00	85.00	–
C	38.00	6.83	6.83	Sheets of imported wax foundation (25 cells/in^2)

In the mean time different Hoffmann-frames (HM-frame) self-spacing were prepared. Groups were prepared as explained below (Table 1).

Data collection

The colonies were regularly inspected at 12 day intervals, the experiment started at April/2008 and commenced at March/2009. The amounts of colony strength, brood reared (worker and drone), pollen stored and surplus honey produced were estimated and recorded. The following parameters were considered and the methods of estimation and calculation are described below:

1. *Brood rearing*: the technique of Jeffree (1958) was adapted to measure brood area separately and results were expressed in (sq.in).
2. *Colony strength (population)*: strength of colonies was estimated in terms of combs covered with bees (C/B) from both sides.
3. *Pollen grain collection*: the amounts of pollen grains stored in the cells were estimated according to Jeffree (1958) and results were expressed in (sq.in).
4. *Honey yield (production)*: the surplus honey was estimated in b/colony.

The differences between the values of the measurements and biological studies calculations were analysed using the analysis of variance.

RESULTS

Natural comb-space measurements: White Nile State and Western Darfur State, comb-space measurements showed that, the overall means were 32.49 ± 0.26 mm and 32.19 ± 0.33 mm, respectively, the measurements of the bee-space between the worker brood combs were 5.51 ± 0.09 mm and 5.67 ± 0.10 mm, respectively, the measurements of the bee-space between stored honey combs were 3.69 ± 0.08 mm and 3.70 ± 0.11 mm, respectively (Table 2).

Langstroth hive measurements: the internal width of the studied hives ranged between 375.00 and 400.00 mm with an average of 385.50 mm, and hive-space was found to be 0.00 to 25.40 mm with an average of 11.00 mm. It was observed that HM-frames measurements show considerable variations the width of end-bar HM-frame (comb-space) ranged between 27.00 and 39.70 mm with an average of 34.50 mm.

Behavioural studies

Population growth: the strength of colonies under study expressed in terms of combs covered with bees (C/B) is shown in Figure 1. The overall means of colony strength were (03.10 ± 01.69), (01.86 ± 00.67) and (01.10 ± 01.30) C/B for groups (A), (C) and (B), respectively, the populations

Table 2 Sudanese natural honey bee-space measurements (mm)

State	Region	Comb measurements'		
			Bee-space	
		Comb-space	*Between worker brood combs*	*Between stored honey combs*
White Nile	Al-Abassia	31.63 ± 0.26	5.66 ± 0.10	3.71 ± 0.09
	Kenana	32.46 ± 0.73	5.50 ± 0.21	3.57 ± 0.20
	Umhani	31.00 ± 1.47	5.38 ± 0.25	3.68 ± 0.30
	Mean ± SE	31.70 ± 0.27	5.51 ± 0.09	3.69 ± 0.08
Western Darfur (Jebel Marra)	Murtagelo	32.21 ± 0.38	5.30 ± 0.11	3.79 ± 0.13
	Galol	32.04 ± 0.33	5.26 ± 0.21	3.41 ± 0.21
	Korge	31.33 ± 1.20	5.32 ± 0.24	3.37 ± 0.59
	Mean ± SE	32.19 ± 0.33	5.43 ± 0.10	3.70 ± 0.11

Note: Figures after ± are standard errors of means.

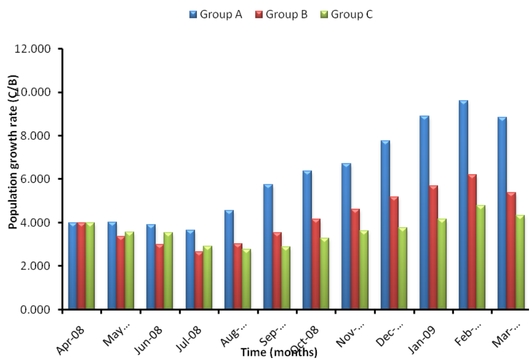

Figure 1 Monthly means of population growth of honeybee colonies under study

reared by colonies of group (A) were higher than groups (B) and (C), but the difference between the two groups (B and C) was not significant.

Worker brood: the amount of worker brood rearing of the tested colonies is shown in Figure 2. Brood rearing activity increased gradually until they reached their highest peak in February/2009. The overall means were (25.49 ± 14.70 dm^2), (10.48 ± 08.59 dm^2) and (06.03 ± 04.55 dm^2) for groups (A), (B) and (C), respectively, colonies of group (A) reared the largest number of workers during the whole experimental period. Colonies of group (C) significantly reared less amount of brood than the other groups.

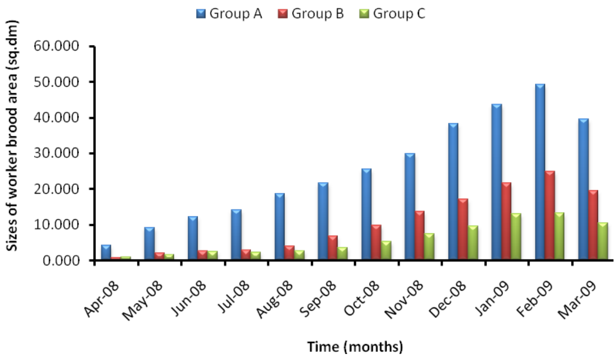

Figure 2 Monthly means of worker brood reared by honeybee colonies under study

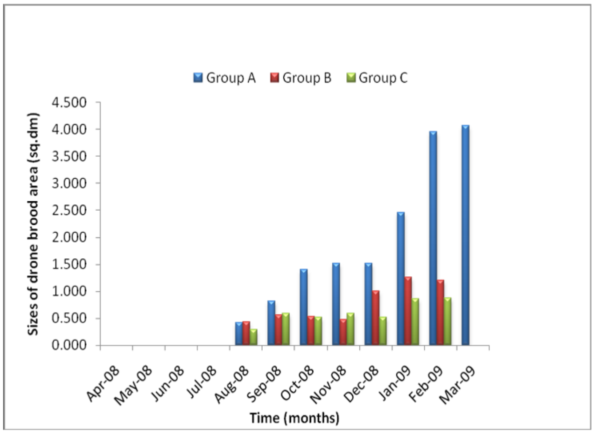

Figure 3 Monthly means of drone brood reared by honeybee colonies under study

Drone brood: the amount of drone brood reared by colonies under study is shown in Figure 3. The overall means were (01.34 ± 01.47 dm²), (00.46 ± 00.48 dm²) and (00.35 ± 00.34 dm²) for groups (A), (B) and (C), respectively, colonies of group (A) reared significantly the highest amount of brood. Colonies of group (C) which provided imported wax foundation sheets reared drone and stored honey in wax foundation sheets after they draw it.

Pollen grain collection: the amounts of pollen collected and stored by the colonies under study are presented in Figure 4. The overall means were (06.18 ± 2.19 dm²), (04.24 ± 01.17 dm²) and (03.64 ± 00.62 dm²) and for groups (A), (B) and (C), respectively, colonies of group (A) stored significantly more pollen than groups (B) and (C). Pollen stored by groups (B) and (C) were not significantly different.

Honey production: the honey produced by the tested colonies is presented in Figure 5. All the colonies under study showed gradual increasing till they reached their peak in March/2009. The overall means were (06.94 ± 05.81), (03.57 ± 02.94) and (03.06 ± 01.94) g/dm² for groups (A), (B) and (C), respectively, colonies of group (A) produced greater amounts of honey than the other groups.

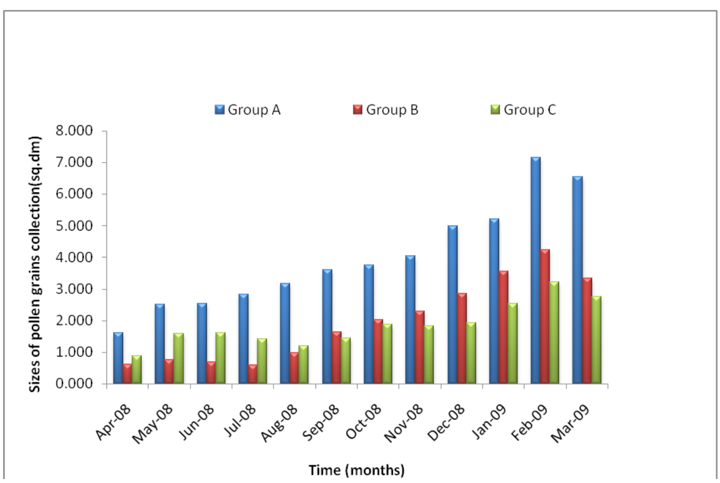

Figure 4 Monthly means of pollen grains collected by honeybee colonies under study

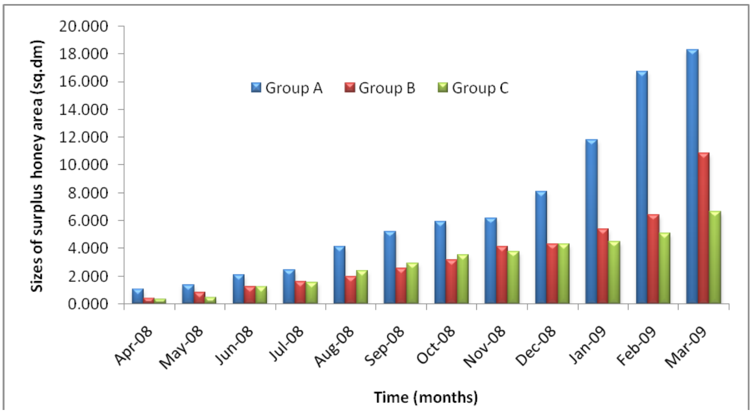

Figure 5 **Monthly means of surplus honey of honeybee colonies under study**

DISCUSSION AND CONCLUION

Natural honeybee construction measurements in relation to inconvenient measurements of Langstroth hive were showed slight dimensional differences are occurred between hive bodies, but the frame dimensions showed considerable variation which reflected bad behavioural tendencies of honeybees. This may be due to the apparent deficiency in the know–how about the importance of using the right measurements or to the inadequate information on beekeeping technology. The obtained results of this treatment showed that colonies of group (A) surpassed all other groups in the higher population density, amount of brood reared, amount of drone brood, collected and stored significantly greater quantities of pollen and higher amount of honey production. The high productivity of group (A) colonies due to they were equipped with extrapolated natural Sudanese honeybee nests measurements taken from field observations. Svensson et al. (1988) defined the comb-space as the space occupied by one comb plus the space between two combs. Naturally comb-space (width of end-bar) was found 32.0 mm (1.26 in.) in Sudan for both White Nile and Western Darfur States, this result in agreement with Guy (1975) and Fichtl (1994) African bees must be spaced 32.0 mm from centre to centre. Walton (1975) intentionally accepted end-bar width of 34.90 mm (1.37 in.). This appears to be slightly greater than the natural space used by Sudanese honeybee colonies. Walton (1974) New Zealand has adopted 33.0 mm as the width HM-frame. Also he added spacing of 32.0–33.0 mm between brood combs was best for Italian hybrid and Carniolan bees with few strains that had spacing of 35.0 mm. Taber and Owens (1970) the bee-space plus comb thickness increased with increasing population from 31.80 to 38.10 mm. The later including drone and honey combs, plate (1). The inconvenient measurements of frames end-bar width and the hive space above the frames and larger hive space underneath bottom-bar frames which was greater than Langstroth measurement supplied to group (B) colonies. The bees built small pieces of honey combs between the crown cover and the top-bars and between the sets of frames colonies with inconvenient comb-space, paid no attention about comb-space, hence double combs were built. Heavy clusters of the same group unlikely worked out one side and warp the comb out of the frame resulting in bad comb construction. Due to extra space below bottom-bar, many of the combs extended downward in few cm and small pieces of combs were built under the bottom-bar, this came in full agreement with Alborzi (1976) extending hive space below the brood chamber was to be unproductive and the extra space above the brood nest, furnished with light coloured combs plate (2). On the other hand, colonies of group (C) which were equipped with Langstroth hive standard measurement and provided with complete sheets of imported wax foundation resulted in poor productivity and absconding behaviour. These colonies built their combs beside the wax foundation on the same top-bar even the space was unsuitable for the whole comb thickness and comb-space leaving out the added wax foundation and did not accept wax foundation, in rare cases bees draw out one side of a sheet and leave the other side untouched, double and brace combs were often encountered plate (3). The findings of this treatment was in agreement with earlier reports that, to work with tropic bees involves specific problems which cannot be solved by transferring western techniques of beekeeping into the tropics (Koeniger, 1976; Ruttner, 1975). According to the present results, it can be recommended that Sudanese beekeepers should pay more attention towards the correct measurements of their equipment's for proper colony and apiary management. Rectifying of the existing equipment presents an opportunity to ease or eliminate undesirable measurements, so some changes should be necessary for Sudanese Langstroths hive.

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BIOGRAPHICAL NOTES

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