

IMPROVING HONEY PRODUCTION IN WORKER BEES (*APIS MELLIFERA ADANSONI* L.) HYMENOPTERA: APIDAE) THROUGH ARTIFICIAL MODIFICATION OF THEIR FEEDING ACTIVITIES

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ABSTRACT

Modification of feeding activity, nursing care and undertaker behaviour were carried out among some colonies of honey bees *Apis mellifera adansoni* L to know the effect on honey production. Apiaries Numbers 1, 2 and 3 contain three replicates of experimental hives while apiary Number 4 contains control hives. All the hives were baited with honey to attract bees. In Apiary No. 1 (Hives A₁, A₂ and A₃) the bee colonies were fed with banana paste which contains amino acid dopamine. The foragers population count was 9324 ± 256 ($\bar{x} \pm \text{s.e.}$) and the honey produced weighed 16.24 ± 0.71 kg ($\bar{x} \pm \text{s.e.}$). In Apiary No.2 (Hives B₁, B₂ and B₃), some young nursing care worker bees were removed from the bee colonies, thus making the old foraging worker bees to perform nursing care duty. The foragers population count was 6714 ± 256 ($\bar{x} \pm \text{s.e.}$) while honey produced weighed 6.03 ± 0.71 kg ($\bar{x} \pm \text{s.e.}$). Dead bodies of insects and dirt were introduced into the hives in Apiary No.3 (Hives C₁, C₂ and C₃) to induce undertaker behaviour in the colony. Some of the old foraging worker bees assumed undertaker duty in these hives where the population count of the foraging workers was 5466 ± 256 ($\bar{x} \pm \text{s.e.}$) and the honey yield weighed 7.02 ± 0.71 kg ($\bar{x} \pm \text{s.e.}$). In the control Apiary (Hives D₁, D₂ and D₃), where the bee colonies were baited with honey only, foraging worker bees population count was 8670 ± 256 ($\bar{x} \pm \text{s.e.}$) and honey produced weighed 13.13 ± 0.71 kg ($\bar{x} \pm \text{s.e.}$). The differences between the mean foraging worker bees' population and consequently honey yield in the different treatments were statistically significant with the apiary where banana paste was introduced containing the highest. When pollen and nectar is abundant, the number of foraging worker bees determines the honey yield. Feeding of the bee colonies with banana paste slightly increased the population growth of the foraging worker bees and the honey yield.

Key words: Apiary, foragers, undertakers, nursing, colony

INTRODUCTION

Honey bees *Apis mellifera Adansonii* L. (Hymenoptera:Apidae) are known for their honey production and pollinating activities [1,2]. In Nigeria among the Yoruba tribes in Okeogun and the Tivs in Benue, beekeeping has been part of the normal agricultural enterprise [3,4],the beekeepers used fixed comb hives such as gourds, baskets, logs of wood and drums [4]. Honey productivity has been at a subsistence level [3, 4, 5]. Records from the survey carried out by independent researchers revealed that in Adamawa state, a beekeeper with an average number of 27 beehives made an average of \$1,119.29 from the sales of honey and beeswax [6]. Similarly, in Ekiti state where a beekeeper has an average of 20 beehives, the average revenue realised from the sales of honey, beeswax and propolis were \$2,148.42 and \$1,027.29 for Langstroth and topbar hives users respectively [7].

Honey bees are social insects known with unique features of division of labour [8]. A bee colony consists of one queen, several hundred drones and 30,000 to 75,000 workers [9,10].

The number of honey bees in a colony is regulated by a multitude of variable factors, which includes meteorological conditions such as light, wind, temperature, and other factors like foraging activities, pests and diseases and the queen reproductive potential [11].

There is a high influence of colony population on honey production and colonies with appreciable population of bees produce more honey than colonies with a sparing population [1, 12]. Worker bees population is usually large in bloom season provided there is a suitable temperature and food supply while in the time of low pollen season, there is limitation to egg production and worker population size is small [1]. The ability of a colony to maintain a high population of foraging worker bees for high honey yield depends on genetical and physiological attributes of the colony as well as response threshold to chemicals and social inhibition encountered by the bees.

Research work had shown that juvenile hormone is linked to task performance; it has been proposed to be the driving factor, pushing workers to become foragers [13]. There is a need for a local research to boost honey productivity in Nigeria and other tropical countries [2, 12].

MATERIALS AND METHODS

The research was set up in the Teaching and Research Farm of the Faculty of Agriculture, Obafemi Awolowo University, Ile – Ife. Four apiaries were set up on the 6th of December 2006 in different locations on the farm about 1,500 metres from each other. Each apiary contains four hives arranged irregularly within a distance of 5 to 20 metres from each other depending on shade and other physiognomic conditions. Each of the bee colonies in all the apiaries was baited with 50 ml of honey. Some of the hives in each apiary were colonized within 57 days (December 6 to February 21,

2007) and twelve colonized hives were selected, three from each apiaries. The hives were labelled A₁, A₂, A₃, B₁, B₂, B₃, C₁, C₂, C₃, D₁, D₂ and D₃. Hives D₁, D₂, D₃ were constituted as control hives. The colonies in Apiary Number 1 (Hives A₁, A₂ and A₃) were fed with 25ml of banana paste weekly. In Apiary Number 2 (Hives B₁, B₂ and B₃), nursing care function was induced in the foragers by occasionally removing some of the developing young nursing care workers in the brood comb with forceps. In Apiary Number 3 (Hives C₁, C₂ and C₃) undertaker behaviour was induced by dropping dead insect parts regularly in the hives while in Apiary Number 4 Hives D₁, D₂ and D₃ they were allowed to grow naturally.

The census of the foraging workers in the hive was carried out during the wet and dry season March 2007 to October, 2007 and November 2007 to January 2008 respectively using the Capture marked -Recapture method which began 70±5 days after hive colonization. Capturing and marking of bees was done between the hours of 1500 to 1800 and recapturing was carried out the following day between the hours of 1500 to 1800. This counting exercise was repeated at intervals of 70±5 days until the hives were harvested making it possible for the population of successive generation of foraging workers in each hive to be estimated.

All the hives including the bees were weighed and cropped on the 1st of February 2008. Honey extracted from all the combs in each hive was weighed. The remnant honey was extracted from the comb by using a warm solution of 60g/15litres of Omo-brand detergent for 24 hours to dissolve it and weighed.

The mean of foraging worker bees population and honey yield were calculated and chi-square test was employed at 95% significant level to test for significant differences between the various means obtained for the population growth of foraging worker bees and honey produced,.

RESULTS

Within the replicate hives in each apiary there were no significant differences in the population of foraging worker bees recorded and the weight of honey produced. In Apiary number 1 (hives A₁, A₂ and A₃) the mean population of foraging workers of *Apis mellifera* was 9321 ± 256 (Mean ± s.e) and the mean weight of honey produced was 16.24±0.71 kg (Mean ± s.e) (Tables 1 and 2). In this hives the bees were fed with banana paste.

Similarly, the mean population of foraging worker bees in the control Apiary Number 4 (Hives D₁, D₂ and D₃) was also high 8670 ± 256 (Mean ± s.e) and the mean honey produced was 13.13 ± 0.71 kg (Mean ± s.e). (Tables 1 and 2) against the mean population of foraging workers in hives B₁, B₂ and B₃ and hives C₁,C₂ and C₃ where foraging worker bees were converted to non- foragers, these were as low as 6714 ± 256 (Mean ± s.e) and 5467 ± 256 (Mean ± s.e) respectively (Table 1). The mean honey yield in hives B₁, B₂ and B₃ was 6.03 ± 0.71 kg (Mean ± s.e) while in Hives C₁, C₂ and C₃, the mean honey produced was 7.02 ± 0.71 kg (Mean ± s.e) (Table 2).

Comparing the four apiaries there were significant differences between the mean foraging workers population at significance level of $P < 0.005$, $F_c = 1028.50$ and the mean honey produced at $P < 0.005$ significance level $F_c = 238.82$.

Population growths of foraging worker bees from March 2007 to January 2008 were as shown by figures 1-4, mean of weights of honey produced (Fig. 5) and the relationship between the population growth and honey produced was as shown in figure 6.

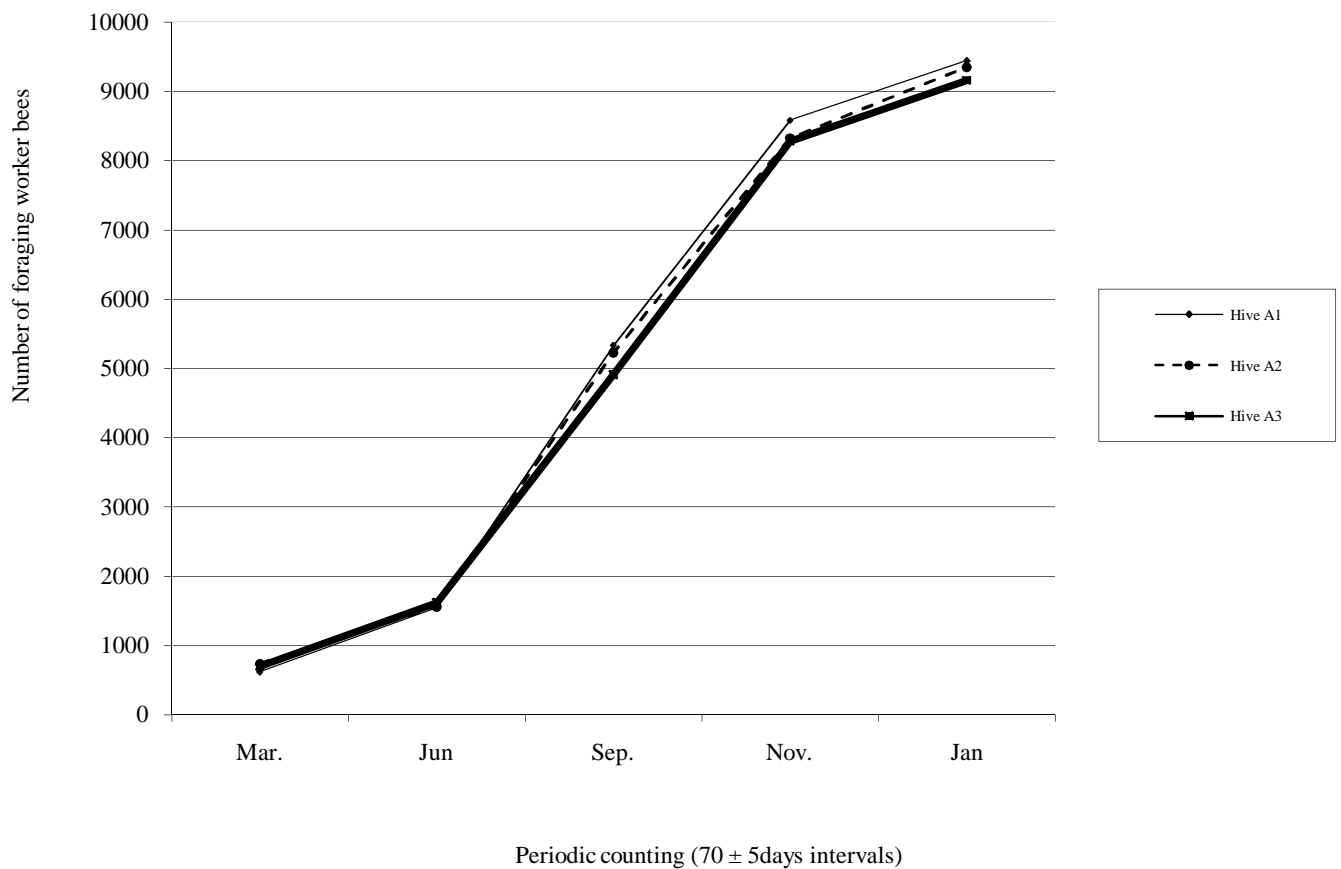


Figure 1: Population growth of the foraging worker bees in hives A₁, A₂ and A₃ during the dry and wet seasons (March.2007 to January 2008)

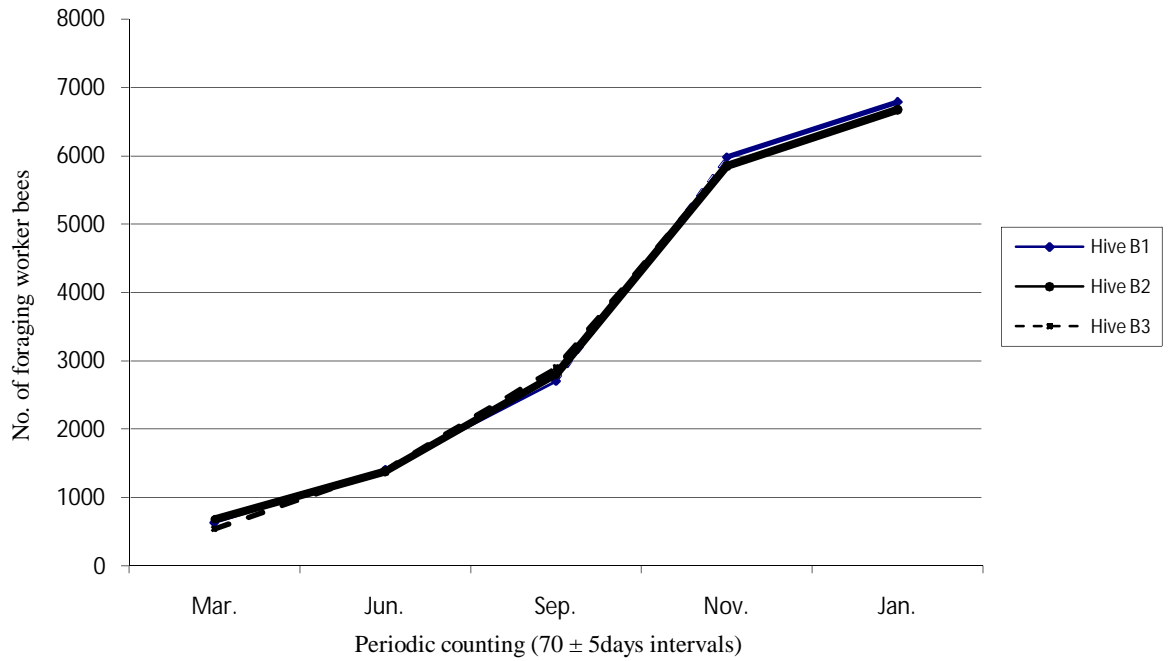


Figure 2: Population growth of the foraging worker bees in hives B₁, B₂ and B₃ during the dry and wet seasons (March.2007 to January 2008)

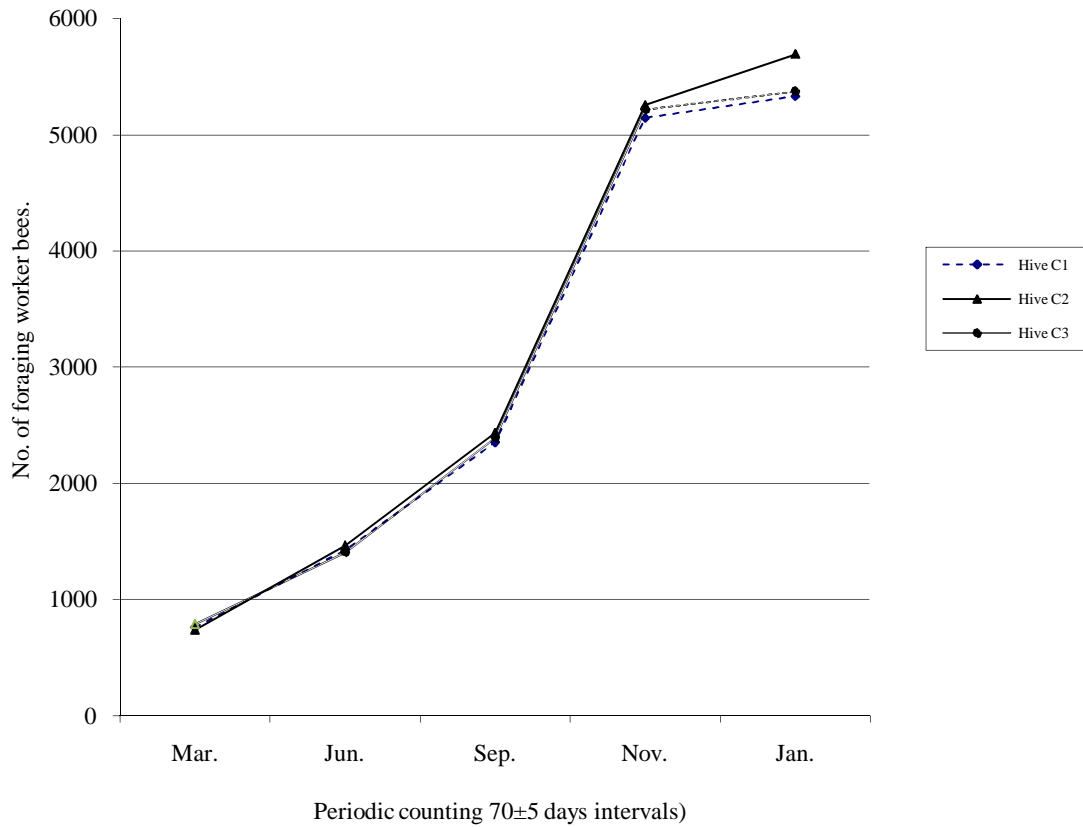


Figure 3: Population growth of the foraging worker bees in hives C₁, C₂ and C₃ during the dry and wet seasons (March, 2007 to January 2008)

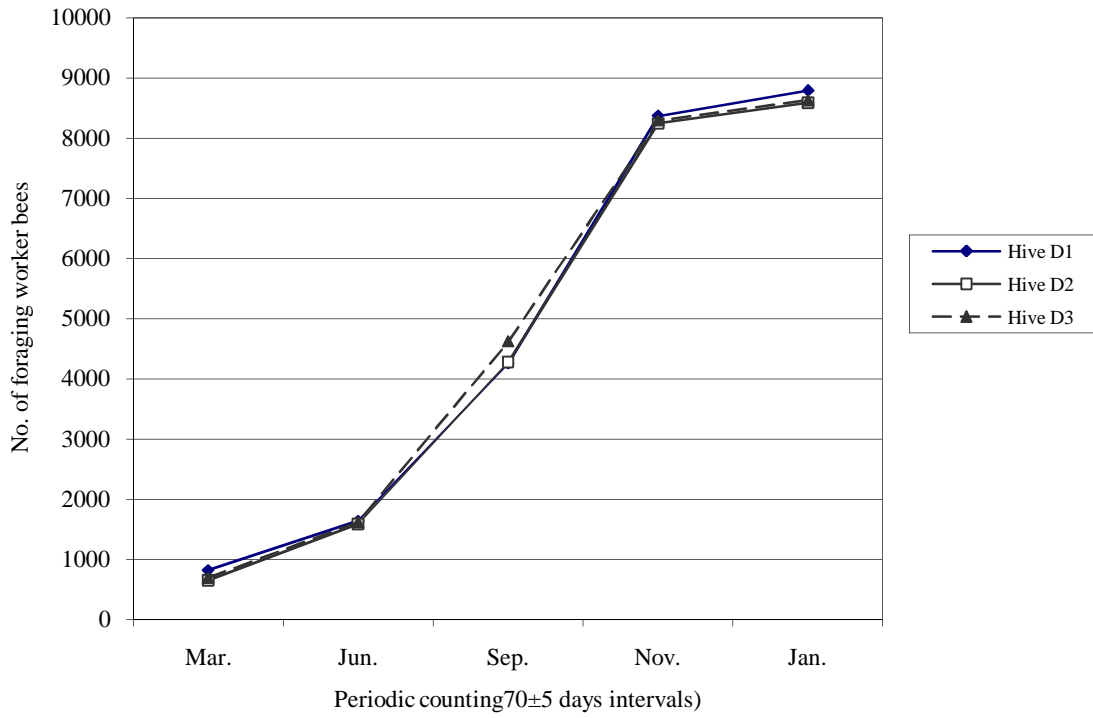


Figure 4: Population growth of the foraging worker bees in hives D₁, D₂ and D₃ during the dry and wet seasons (March.2007 to January 2008)

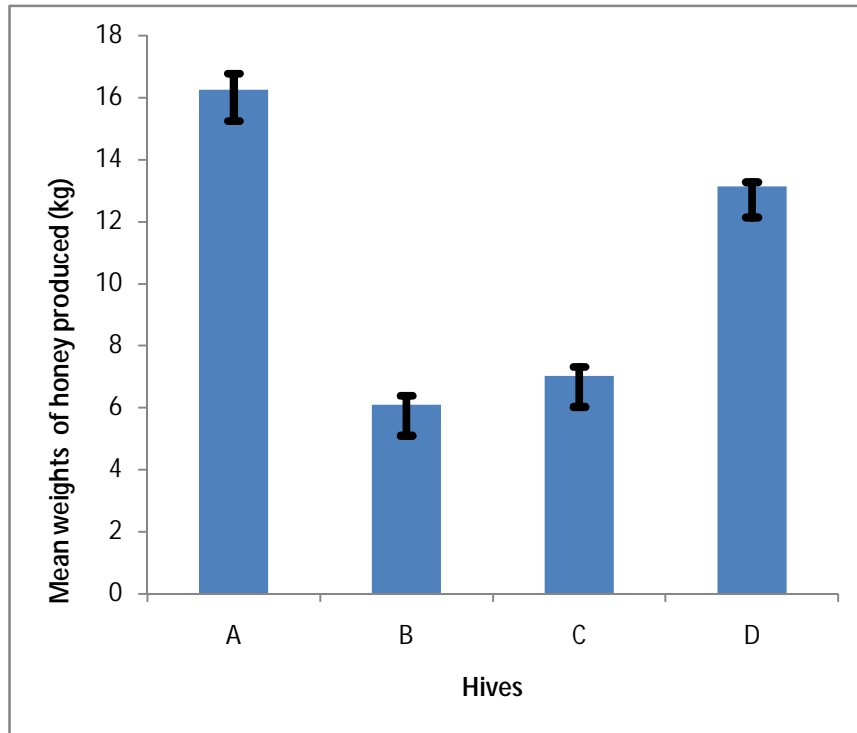


Figure 5: Mean of weights of honey produced and standard errors

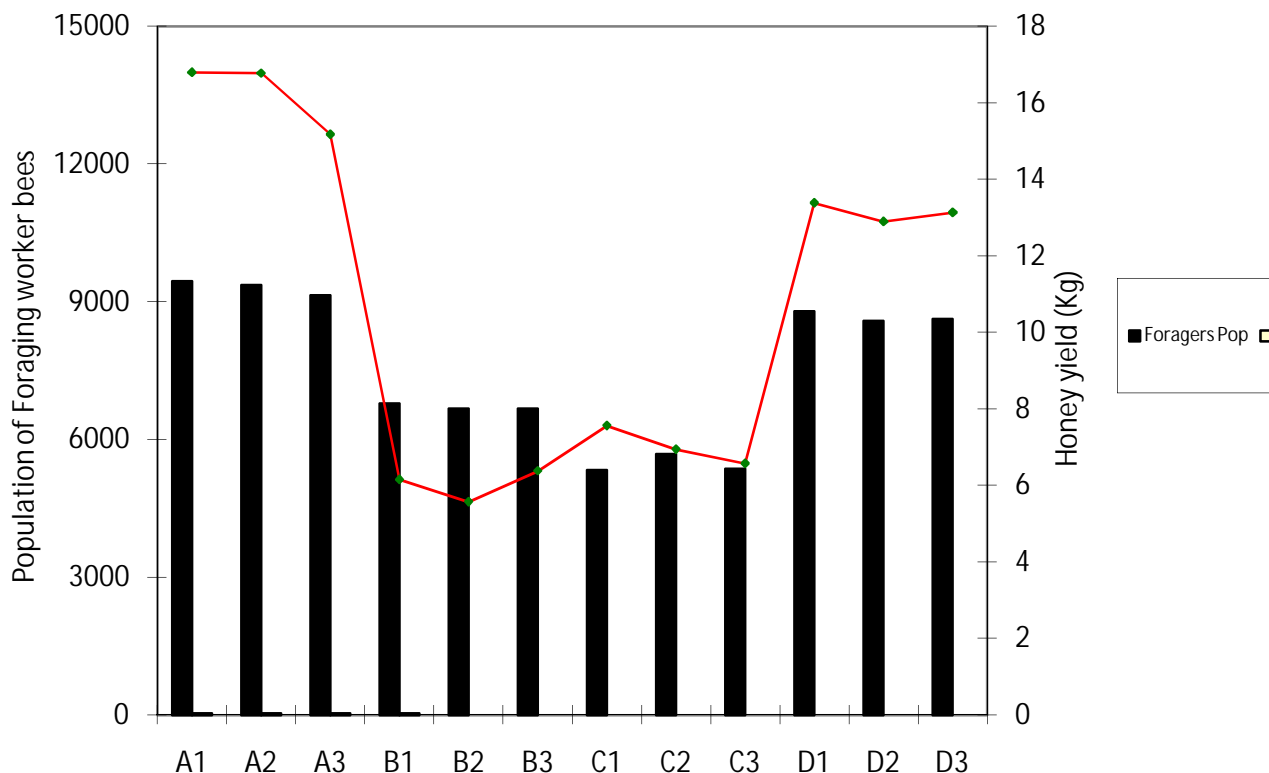


Figure 6: Relation between the foraging worker bees' population and honey yield

DISCUSSION

The response of the bee colonies in hives A₁, A₂ and A₃ to administration of banana paste syrup from March 2007 to January 2008 might be responsible for the high population density of foraging worker bees. Research work had shown juvenile hormone are linked to task performance and they had proposed it to be the driving factor, pushing workers to become foragers [13]. This juvenile hormone contains octamine dopamine and banana paste has been found to be a rich source of the amines [14, 15]. The fed colonies were able to sustain a continuous and rapid growth during the period of low pollen and the records showed a significant difference compared to population growths in other hives. The significant difference between the colonies fed with amines and the natural control groups suggested that feeding amines to bees might have a role in inducing foraging behaviour.

There was a very low population of foraging worker bees recorded in hives C₁, C₂ and C₃ due to the introduction of dead bodies of ants and termites and tiny pieces of plant

materials into the hives. These substances induced some of the foraging workers to return to the hives and assume undertakers' duty of cleaning.

This observation revealed that the bee colony has workers (undertakers) that clean and remove dirt and small dead bodies in the hives. However, they cover and glue those with big size to the hives. The colony always maintains a balance such that all forms of workers are available.

Similarly, there was a very low population of foraging worker bees recorded in hives B₁, B₂ and B₃. This was in response to reversion of foraging to nursing care duty, when some of the young worker bees 'nurses' that clustered around the brood combs in the hives were removed and some of the old foraging workers returned to the hives and assumed the nursing care duty. This observation revealed that a colony is always maintaining a balance such that all forms of workers are available in the colony and the co-operative brood care duty is not neglected while at the same time the foraging duty did not suffer.

Growth pattern of the population of foraging worker bees was more rapid in the colonies where workers were fed with amines than the natural colonies and colonies where reversion were carried out. The population growth of the foraging worker bees has direct relationship on the honey produced: the higher the population, the higher the honey produced.

CONCLUSION

To obtain a good honey yield in our indigenous hives the foraging worker bees' population must be very high. Even though every bee colony has a large population of foraging workers, there are some factors that do reduce the population such as low pollen and nectar in the field. In order to manage and sustain the large population of these foraging workers for maximum honey yield during blossom season to the period of dearth, there is a need to feed the bees with substances containing amine. Similarly, there are some factors that can reduce the foraging activities such as presence of dirt in the hives, which need to be removed. In conclusion, the study revealed that colonies of *Apis mellifera adansoni* fed with banana paste had slightly more foragers population (about ten percent higher than in the control colonies) and about 20 percent more honey produced more than the control or natural colonies. Therefore, the findings of this study will provide basic information for local beekeepers on how to sustain bee colonies during the period of low pollen and boost foraging activities in order to increase honey production.

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Table 1: Estimation of Foraging worker bees population and the mean at 70±5days interval using capture and recapture method (Lincoln index).

Apiary	Hive	1 st Pop Count 24/3/07	2 nd Pop Count 10/6//07	3 rd Pop Count 1/9//07	4 th Pop Count 11/11/07	5 th Pop Count 21/1/08	Mean foragers Pop.
No.1(A)	A ₁	621	1540	5338	8585	9450	9321
	A ₂	735	1560	5231	8384	9362	
	A ₃	704	1623	4914	8333	9151	
No.2(B)	B ₁	633	1410	2704	5979	6789	6714
	B ₂	684	1386	2808	5852	6675	
	B ₃	546	1407	2900	5868	6680	
No.3(C)	C ₁	760	1427	2354	5143	5336	5467
	C ₂	740	1464	2434	5254	5693	
	C ₃	787	1404	2390	5216	5371	
No.4(D)	D ₁	820	1636	4264	8371	8794	8670
	D ₂	645	1580	4278	8244	8586	
	D ₃	690	1612	4620	8289	8631	

Table 2: Estimation of honey and comb yield in the experimental and control hives by Weighing Method.

Hives	Weight of hives + the bees (Kg)	Weight of hives with bees removed	Weight of bees (kg)	Weight of empty hives (kg)	Weight of combs (kg)	Weight of honey yield (kg)
A ₁	58.00	44.70	13.30	14.25	16.35	16.79
A ₂	61.07	48.08	12.99	14.06	17.21	16.77
A ₃	58.21	45.54	12.67	14.46	13.28	15.17
B ₁	46.23	33.36	12.87	14.21	13.21	6.15
B ₂	46.75	33.98	12.77	14.5	14.11	5.57
B ₃	47.93	35.14	12.79	14.28	15.56	6.38
C ₁	49.73	37.76	11.97	14.21	15.70	7.56
C ₂	48.25	36.41	11.84	14.75	15.47	6.94
C ₃	47.66	35.77	11.89	14.20	15.10	6.57
D ₁	55.82	42.59	13.23	14.17	15.21	13.38
D ₂	55.53	41.89	13.64	14.35	14.9	12.89
D ₃	55.15	42.00	13.15	14.25	15.07	13.13

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