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CORRELATION BETWEEN BIOMETRIC AND PRODUCTION PARAMETERS IN COLONIES OF *Melipona quadrifasciata anthidioides* Lepeletier (HYMENOPTERA: APIDAE)

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ABSTRACT

In meliponini colonies, biometric characteristics may be associated with production traits, thus the study of correlations is extremely useful as a tool for colony selection process. The aim of this study was to estimate the correlations between biometric and productive parameters of *Melipona quadrifasciata anthidioides.* We analyzed 128 colonies, from 60 parental colonies and two generations, F1 and F2. The following parameters were evaluated: queen and colony weight; number, length and width of brood disks; number, width, depth and volume of honey pots; number, width and depth of pollen pots; glossa size, and the estimate of the population and honey production. The queen weight was correlated with the number of brood disks (0.23) and the population (0.23), as well as the characteristic number of pollen pots was related to the length and width of brood disks and population (0.88, 0.54 and 0.52, respectively). The characteristic honey production was related to the number (0.93), width (0.50) and volume (0.47) of honey pots. The results showed that honey production is directly correlated with number, volume, width and depth of honey pots. On the other hand, the population size was correlated with the number of brood disks and pollen pots.

KEYWORDS: bee breeding; honey production; selection.

CORRELAÇÃO ENTRE PARÂMETROS BIOMÉTRICOS E PRODUTIVOS EM COLÔNIAS DE *Melipona quadrifasciata anthidioides* LEPELETIER (HYMENOPTERA: APIDAE)

RESUMO

Em colônias de melíponas, características biométricas podem estar associadas às características de produção; portanto, o estudo da correlação é de grande valia como ferramenta para o processo de seleção de colônias. O objetivo deste trabalho foi estimar as correlações entre os parâmetros biométricos e produtivos de *Melipona quadrifasciata anthidioides.* Foram analisadas 128 colônias, provenientes de 60 colônias parentais e duas gerações, F1 e F2. Os parâmetros avaliados foram: peso da rainha e colônia; número, largura e comprimento dos discos de cria; número, largura, profundidade e volume dos potes de mel; número, largura e profundidade dos potes de pólen; tamanho da glossa e a estimativa da população e da produção de mel. O peso da rainha apresentou correlação com o número de discos de cria (0,23), da população (0,23), da mesma forma que a característica de número de potes de pólen está relacionada com largura e comprimento dos discos de cria e população (0,88; 0,54 e 0,52, respectivamente). A característica produção de mel está relacionada com o número (0,93), largura (0,50) e volume (0,47) dos potes de mel. Os resultados mostraram que a produção de mel está correlacionada diretamente com as características de número, volume, diâmetro e altura dos potes de mel. Por outro lado, o tamanho da população demonstrou estar correlacionada com o número dos discos de cria e o número dos potes de pólen.

PALAVRAS-CHAVE: melhoramento de abelhas; produção de mel; seleção.

INTRODUCTION

Beekeeping is an activity of great importance due to its high economic potential, becoming a tool to increase the source of family income. This activity has also been practiced and spread in different educational and research institutions in an attempt to increase their productive potential.

In bees, most part of the productive characteristics are controlled by a large number of genes. Thus, the study of correlations is necessary because economically important characteristics are generally correlated (RINDERER, 2008). Furthermore, the correlation enables the measure of the direction of the relationship between two features, allowing the use of indirect selection, which in some cases produces high gains (CRUZ, 2001).

Quantifying bees' characteristics of economic interest often becomes difficult because it requires studies, on colony-level, of the characterisitcs that influence directly and indirectly (SOUZA et al., 2002). The features that have been investigated in the selection of meliponini colonies are queen weight, glossa length, colony weight, honey and pollen production (ALVES, 2010).

In the literature, the genetic correlation values refer to different characteristics of *Apis melífera* bees, and range from -0.06 to 0.75 in characteristics of hygienic behavior, pin-killed brood, removal rate of the *Varroa destructor* mite, defensiveness, honey, wax and royal jelly production, colony weight and glossa length (BIENEFELD & PIRCHNER, 1991; BOECKING et al., 2000; SOUSA et al., 2002; PEREIRA et al., 2006; COSTA-MAIA et al., 2011; FAQUINELLO et al., 2011; WIELEWSKI et al., 2012). However, information on miponini bees are nonexistent.

The need for increasingly exploring the potential of the colonies became the goal of most beekeepers who constantly evaluate the performance of their colonies in an attempt to maximize productivity and minimize costs and manpower. Therefore, the goal of this study was to investigate the correlations between biometric and productive parameters of *Melipona quadrifasciata anthidioides.*

MATERIAL AND METHODS

The study was conducted at the meliponary of the Research Group Insecta, Center of Agricultural Sciences, Biological, and Environmental Sciences (CCAAB), Federal University of Reconcavo da Bahia (UFRB) in Cruz das Almas - BA (12 º 39'20 "W and 39 º 07'23" S, altitude 220).

The study was conducted during the months of March 2010 to September 2011. We analyzed a total of 128 colonies, coming from 60 parental colonies and two generations, F1 and F2, and evaluated the following parameters: queen weight (QW), colony weight (CW), number of brood disks (NBD), brood disks width (BDW), brood disks length (BDL), number of honey pots (NHP), honey pots width (HPW), honey pots depth (HPD), honey pots volume (HPV), total number of pollen pots (NPP), pollen pots width (PPW), pollen pots depth (PPD), size of workers' glossa (GLO), and estimated population of the colony (POP).

The estimated population of each colony was obtained from the average number of brood cells per centimeter of honeycomb, adapted from BRITO et al. (2013):

Nc = dm x nhc x k

Where:

Nc = number of brood cells;

dm = mean diameter of the combs;

nhc = number of honeycombs;

k = 25 constant number of cells per area (number of cells / diameter of the comb) for the species *Melipona quadrfasciata anthidioides.*

The population estimate was obtained using the formula adapted from BRITO et al.2013.

Pop = (nc + nc / 2)

Where:

nc = number of brood cells existing in the colony.

The weight of the colony was obtained by the weight of the empty box (n = 15) and subtracted from the gross weight (brood disks, wax, geopropolis and bees), with the aid of digital scales and following the methodology used by ALVES et al. (2012).

For the evaluation of productive traits we computed the total number and diameter of brood disks (n = 5 disks / colony), the height, the outer diameter and the volume of honey pots (n = 15 / colony) and pollen (n = 15 /colony) by means of a graduated ruler. Honey pots volume was measured by suction of the pots, using disposable 20 mL graduated syringes.

To assess the length of glossa, we captured and sacrificed young workers (n = 15 / colony and 1920 bees / total) in ethyl acetate to facilitate glossa exposure. The removal was done with the aid of tweezers and stilettos. After removal, we placed the glossa in a container with alcohol 46 °GL for conservation of the material until its measurement. At the time of measurement, we placed the structures

in a *Petri* dish to which we added sufficient distilled water to rehydrate the material and to facilitate the measurement process, which was performed with the aid of magnifying slides and an Olympus SMZ 168 glass series with an increase of 0.5, and the Motic images Plus 2.0 software, according to the classification of VIANA & KLEINERT (2005). For the measurement process, we considered the measure from the glossa tip to the paraglossa base.

Data were analyzed using the computer program SAS (2004), and for the calculation of the correlations we used the Pearson's correlation coefficient.

RESULTS AND DISCUSSION

There was no significant correlation of BDW with any of the evaluated parameters (P> 0.01 and P <.05). The significant correlation results obtained among the evaluated traits are shown in Table 1.

We obtained positive and negative correlation values. Negative correlation values ranged from -0.36 to -0.19, and positive correlations, from 0.19 to 0.93 (Table 1).

The queen weight (QW) showed the same correlation value with the number of brood disks (NBD) and colony population (POP) (0.23). Therefore, the greater the queen weight the greater the amount of brood disks produced, increasing the colony population by the greater number of bee births due to a higher amount of cells present in a greater number of brood disks.

SCHAFASCHEK et al. (2008) stated that substances found in nectar and pollen stimulate an increase in laying by the queen, thus increasing the number of combs in an *Apis melífera* hive. However, in this study, we observed that the NPP was positively correlated with the brood traits such as BDW, BDL and POP (0.44, 0.37 and 0.27, respectively), and negatively correlated with NHP (-0.24). Likewise, PPW and PPD were negatively correlated with brood traits (NDB, BDW and POP), with values ranging from -0.25 to -0.36 (Table 1). These results seem to show that a greater number of pollen pots is more important than bigger pots for the colony to produce, and this trait was directly related to the brood disks size.

Table 1. Correlation values among the traits: queen weight (QW), number of brood disks (NBD), brood disks width (BDW), brood disks length (BDL), population (POP), number of honey pots (NHP), honey pots width (HPW), honey pots depth (HPD), honey pots volume (HPV), honey production (HP), number of pollen pots (NPP), pollen pots width (PPW), pollen pots depth (PPD), colony weight (CW), and size of workers' glossa (GLO), of colonies of *Melipona quadrifasciata anthidioides*

Traits	QW	NDB	BDW	BDL	POP	NHP	NPW	HPD	HPV	HP	NPP	PPW	PPD	CW	GLO
QW	-	0.23**	ns	ns	0.23**	ns	ns	ns	ns	ns	Ns	ns	ns	ns	ns
NDB	-	-	ns	ns	0.88**	0.20*	ns	ns	ns	ns	Ns	-0.27**	-0.36	0.31**	ns
BDW	-	-	-	0.88**	0.54**	0.20*	ns	ns	ns	-0.19*	0.44**	-0.36**	ns	ns	0.28**
BDL	-	-	-	-	0.52**	ns	ns	0.19*	ns	ns	0.37**	0.31**	ns	ns	0.24**
POP	-	-	-	-	-	ns	ns	ns	ns	ns	0.27**	-0.25**	-0.33**	0.29**	0.26**
NHP	-	-	-	-	-	-	0.25**	ns	0.18*	0.93**	-0.24**	ns	-0.29*	0.26**	ns
NPW	-	-	-	-		-	-	0.25*	0.69**	0.47**	Ns	0.38**	0.32**	ns	ns
HPD	-	-	-	-	-	-	-	-	0.46**	ns	Ns	0.28**	0.28*	ns	ns
HPV	-	-	-	-	-	-	-	-	-	0.50**	Ns	0.25**	0.27*	ns	ns
HP	-	-	-	-	-	-	-	-	-	-	-0.28**	ns	ns	0.22*	ns
NPP	-	-	-	-	-	-	-	-	-	-	-	ns	ns	0.18*	ns
PPW	-	-	-	-	-	-	-	-	-	-	-	-	0.49**	ns	ns
PPD	-	-	-	-	-	-	-	-	-	-	-	-	-	0.23*	ns
CW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ns
GLO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

** and* - significance at 1% and 5% probability
ns – non-significant correlation

From the moment food availability increases, both nectar and pollen, there is an increase in the harvest and storage of these products; besides, the queen increases laying aiming at colony growth. In addition, the construction of brood disks can be influenced by several factors, including population density and the presence of a queen (RIBEIRO et al., 2006; ALVES et al., 2009). On the other hand, according to EVANGELISTA-RODRIGUES et al. (2008), when there is food availability, the size of honey and pollen pots increases for further storage.

The number of individuals is important because, in populous colonies, there are usually many forager bees who collect more resources in times of flowering, allowing the defense against enemies and maintaining proper temperature for the development of the brood.

The POP was also highly correlated with the NDB, BDW and BDL (0.88, 0.54 and 0.52, respectively) (Table 1). However, HILARIO & IMPERATRIZ-FONSECA (2009) and ALVES et al. (2012) described that population growth depends not only on the number of disks, but mostly on their size; furthermore, other traits, such as age of the queen and colony management, may influence the size of the disks, thus compromising population size.

The characteristic honey production (HP) was strongly related to the number of honey pots (NHP), followed by its volume (HPV) and width (HPW) (0.93; 0.50 and 0.47, respectively). Therefore, bees, by detecting flowering proximity, enlarge the pot area in order to increase food storage capacity.

The amount of honey produced by the colony depends directly on the availability of food offered and on the workers' ability to collect this product. Therefore, the larger the number of pots, the greater will be the honey volume, which reveals the correlation between the number of honey pots and honey pots volume.

Honey production showed negative relationship with BDW (-0.19) (Table 1). This factor can be justified because the characteristic HP was estimated by evaluating the honey pots in the colony nest, and not directly at the honeycomb frame or in an effective assessment of the honey production during flowering. Thus, when the brood disk in the nest is larger, there is less space for food storage and, consequently, the number, volume and depth of honey pots tend to be lower. However, the evaluation of these traits of the honey pot are indicative measures for honey production.

We observed that the selection for HPW and HPD, i.e. larger pots, would increase HPV (with a correlation of 0.69 and 0.46, respectively), and hence HP of the colony (Table 1). According to ALVES et al. (2012), the formation of larger and wider pots reduces the space used and decreases honey intake by the workers in wax production, which leads to a larger amount of honey produced, revealing that honey production is directly related to the number and volume of honey pots.

Studies about *Apis mellifera* have shown that honey production is affected by the population (SZABO & LEFKOVITCH, 1989). In this study, we observed no correlation between POP and HP, corroborating the results found by ALVES et al. (2012) for the species *Melipona scutellaris*, confirming the influence of other traits on HP by Meliponidae bees.

There was a positive correlation between NHP produced and NBD (0.20) (Table 1). Thus, increasing the number of brood disks requires an increase in colony number of individuals, and hence an intensification in the construction of pots for products storage (EVANGELISTA-RODRIGUES et al., 2008).

The NPP was directly correlated with the BDW and BDL. These values mean that there is a great need for increased pollen collection for the formation of brood disks, because pollen serves as food for growing larvae. These results agree with those reported by FONSECA & KERR (2006), who confirmed that this relation is positive, and stated that the increased amount of brood induces the necessity of increasing pollen harvest, and on the other hand, reducing the number of brood leads to preferred nectar harvest.

However, the correlation between NPP and NHP was negative (-0.24). These two products are essential in the development of the colony, and from this result we found that there is a balance between the quantity of each one of them in the colony, thus, as the colony prioritizes collecting honey or pollen due to an immediate need, there is a pause in the harvest of the other.

The colony weight (CW) is a trait that should be used carefully in colony evaluation (ALVES et al., 2012) because some stingless bees, including the species used in this study (*Melipona quadrifasciata anthidioides*), are characterized by the deposition of large amounts of geopropolis (a mixture of resin and clay), directly influencing the CW, as well as the amount of brood disks, honey and pollen pots. However, the results showed that WC was related to the traits NBD, POP, NHP, HP, NPP and PPD, with values of 0.31; 0.29; 0.26; 0.22; 0.18; and 0.23, respectively (Table 1). Thus, this trait has been very useful in the selection of colonies, mainly because of its easy and fast measurement by the beekeeper.

Studies of development of *Apis mellifera* colonies with different protein foods, conducted by

PEREIRA et al. (2006), showed positive correlation among colony weight, honey area (r = 0.72) and brood area (r = 0.60).

The size of the glossa of workers (GLO) was related to the BDW, BDL and POP, with correlation coefficients between 0.24 and 0.28 (Table 1). However, studies on *Apis mellifera* have been carried out due to the importance of glossa as a nectar collector (SOUZA et al., 2009; PIGOZO & VIANA, 2010), becoming a factor in selection of superior individuals.

However, SOUZA et al. (2002) showed a significant positive correlation between the length of the *Apis mellifera* workers' glossa and their honey production (0.41). The results observed in this study, despite being about a different species, indicated that HP is related to other traits such as food availability.

It is noteworthy that, regarding the observed results, we should take into consideration the bee species, the box model and management used, due to the great variability of the environment besides the adaptability of the species (KERR, 2006). Thus, the study of correlations for different management situations is of great importance to inncrease knowledge (EVANGELISTA-RODRIGUES et al., 2008) and allows a more efficient targeting of breeding programs and bees selection.

CONCLUSION

The correlations showed that the honey production is directly related to the characteristics of number, volume, diameter and height of the honey pots. On the other hand, the size of the population is related to the number of brood disks and the number of pollen pots.

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