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Acceptance rate of Africanized honey bee larvae in hives maintained in the shade and under full sunlight in Northeast Brazil

ABSTRACT

In the Semiarid region of Northeast Brazil, adverse environmental conditions such as high radiation and temperature affect the balance of homeostasis of the colonies of Africanized honey bees (*Apis mellifera* L.). This research aimed to evaluate the rate of acceptance of Africanized honey bees larvae (Important stage of process of queen-rearing) in hives installed in the shade and under full sunlight in the semiarid climate of Northeastern Brazil. 10 colonies of honeybees (5 in the shade and 5 under full sunlight) were orphaned and prepared with young workers and food, having standardized biomass (equal population conditions) to receive frames containing 60-100 queen cell cups with larvae up to 24 hour-old. The acceptance percentage of transferred or grafted larvae to each colony was measured 72 hours after carrying out transfers and means were compared by the Student's t-test at 5% probability. The colonies under shade conditions showed acceptance rate of $68.82 \pm 17.03\%$, significantly higher ($P = 0.0044$) than the colonies subjected to direct sunlight with only $52.13 \pm 16.29\%$. Thus, for the production of queens and royal jelly of Africanized honeybees in the semiarid climate of Northeast Brazil, it is strongly recommended the installation of apiaries in shady locations.

Taxa de aceitação de larvas de abelhas africanizadas em colmeias mantidas em sombreamento e sob exposição solar direta no Nordeste Brasileiro

RESUMO

No Semiárido do Nordeste Brasileiro, as condições adversas do ambiente como alta radiação e temperatura afetam o equilíbrio da homeostase das colônias de abelhas africanizadas (*Apis mellifera* L.). Este trabalho objetivou avaliar a porcentagem de aceitação de larvas de abelhas africanizadas (etapa importante do processo de produção de rainha) em colmeias instaladas à sombra e sob radiação direta do sol na região semiárida do Nordeste Brasileiro. Para isso, 10 colônias (5 no sol e 5 na sombra) foram orfanadas e tiveram a biomassa padronizada para receber quadros portando de 60 a 100 cúpulas contendo larvas com até 24 horas de vida. O percentual de aceitação das larvas transferidas para cada colônia foi avaliado 72 horas após a realização das transferências e os dados foram comparadas pelo teste *t* de Student a 5% de probabilidade. As colônias sob condições de sombra apresentaram taxa de aceitação de $68,82 \pm 17,03\%$, sendo significativamente maior ($P = 0,0044$) do que as colônias submetidas à radiação direta do sol, com apenas $52,13 \pm 16,29\%$. Conclui-se que para a produção de rainhas e de geleia real de abelhas africanizadas no semiárido nordestino, torna-se extremamente recomendável a instalação de apiários em locais sombreados.

INTRODUCTION

Brazil has special characteristics of flora and climate, which associated with the presence of Africanized honeybees, give it a fabulous potential for beekeeping (FERREIRA *et al.*, 2012). In the Northeast region, honey production represents approximately one third of the national production, which is equivalent to 30% of Brazilian honey exports (GONÇALVES, 2004). Furthermore, the honey produced in the Northeast is much appreciated by the exporters, since it is originated from a rich natural flora free of pesticide contamination.

However, the climatic instability of the semiarid region of Northeast Brazil has compromised the productive success of beekeeping. For example, the high temperatures resulting from the strong radiation of this region and the frequent drought are often limiting factors for the thermoregulation of the colonies (ALMEIDA, 2008), causing physiological and behavioral changes in the individuals, as the migratory behavior or absconding, that adversely affects the productive performance of the bee colonies (DOMINGOS & GONÇALVES, 2014). Additionally, it is common among northeastern beekeepers the absence of the practice of queens replacement, activity that represents an important aspect of the honey productive chain (VILELA & PEREIRA, 2002, PEREIRA *et al.*, 2013). Most beekeepers in northeastern Brazil do not substitute queens in the colonies because they cannot master the process of queen-rearing. Some reports have mentioned an apparent difficulty in the handling of this technique, mainly in the transference of young worker larvae into cell cups made of wax or plastic (grafting). After grafting of larvae, they are transferred these queen cell cups to colonies previously prepared so that the bees sense that they do not have a queen and are induced to rear new queens. However, this process is sensitive to the influence of climatic factors and if the ambient conditions are not good, the transferred larvae may not be accepted by the colonies.

The technique of transferring larvae is an important and refined method for commercial production of royal jelly and queen rearing of *Apis mellifera*, therefore is important that beekeepers dominate it.

The practice to protect hives with vegetation in order to provide shade for the bees is an alternative beekeeping method that mitigates the adverse environmental effects very common to the semiarid region of Brazil, what significantly reduce the stress caused by high temperatures (LOPES *et al.*, 2011; SOMBRA, 2013) and this may be useful for improving the queen rearing in the semiarid. Thus, the production of breeding systems that provide a reduction of heat stress in animals from tropical countries is an interesting strategy to improve production. However, with regard to methods to avoid heat stress on honey bees proceedings related to new beekeeping alternatives are rare. In this experiment it was evaluated the rate of acceptance of Africanized honey bees larvae in hives installed in the shade and under full sunlight in the Semiarid climate of northeastern Brazil.

MATERIAL AND METHODS

The experiment was conducted under semiarid conditions in northeastern Brazil, at the Experimental Station Rafael Fernandes of UFERSA (Universidade Federal Rural

do Semi-Árido) in Mossoró-RN, Brazil (Geographical coordinates: 5°03'37" S, 37°23'50" W, at an altitude of 72 m).

Brood combs from hives of Africanized bees were removed and immediately covered with clean, damp cloth and carefully carried to the laboratory, thereby maintaining the quality of the larvae until the end of grafting. 24 hour-old larvae were transferred (grafted) following Doolittle's method (1899) from the brood comb cells to acrylic cups (artificial queen cells) containing one drop of royal jelly diluted in distilled water (proportion of 1:1) (see Figure 1). The hives were orphaned two days before each grafting and prepared with combs containing young worker bees and food. It is placed over a normal 10-frame Langstroth hive body. The ten-frame hive was filled with six brood frames, three feeder frames and one grafting frame (queen-cells frame).

Frames containing 60-100 acrylic cups were introduced in 10 colonies without queen (orphan), 5 of which were exposed directly to sunlight (control) and the other 5 colonies were maintained in the shade conditions (cover made from logs and leaves dehydrated trees and known in the Brazilian Northeast as "latada") (see Figure 2), totaling 2560 transferences at the end of the experiment (see Table 1).

Figure 1. Larvae transfer process. **A)** Colony for yielding larvae; **B)** Honeycomb with young larvae; **C)** Queen cell acrylic cups bathed with beeswax. At each cup a larva is placed on a drop of royal jelly diluted in water; **D)** Queen-cell frame being inserted into a colony without queen.

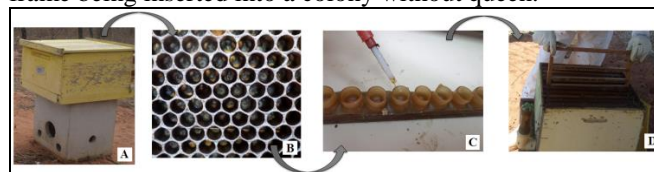


Figure 2. Beehives of Africanized bees (*Apis mellifera*) installed under sun and shade conditions (cover made from logs and leaves dehydrated trees) in the Caatinga (local native vegetation) in the semiarid region of Northeast Brazil.



The queen-cells frames were removed from the colonies 72 hours after the transferences (grafting). Thus, for each condition examined (exposition to shade versus sunlight) the total number of accepted larvae in the queen cell cups was counted and recorded for assessing the acceptance of larvae grafted. The means of the acceptance rates in percentage were compared by the paired using Student's t-test at 5% probability.

RESULTS AND DISCUSSION

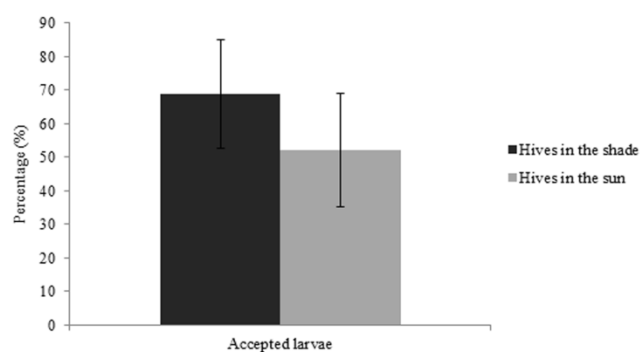
The Table 1 shows the number of transferences (graftings) and the acceptance percentage of grafted larvae in queen-cells frames in both groups of the experiment. The cups occupied by live larvae and filled with royal jelly were a general requirement for acceptance.

Table 1. Number of transferences (graftings) and acceptance percentage of transferred larvae in hives of Africanized honey bees maintained in the shade and under full sunlight in the semiarid climate of northeastern Brazil.

Hives in the shade			Hives in the sun		
Number of Transferences	Accepted larvae	Acceptance (%)	Number of Transferences	Accepted larvae	Acceptance (%)
100	56	56	100	32	32
100	72	72	100	54	54
100	69	69	100	58	58
100	63	63	100	55	55
60	34	56.67	60	21	35
60	43	71.67	60	35	58.33
60	47	78.33	60	39	65
80	51	63.75	80	46	57.5
80	60	75	80	31	38.75
60	36	60	60	44	73.33
60	53	88.33	60	42	70
60	28	46.67	60	36	60
60	56	93.33	60	21	35
60	58	96.67	60	45	75
60	39	65	60	10	16.67
60	18	30	60	20	33.33
60	48	80	60	40	66.67
60	44	73.33	60	33	55

Significant differences ($P = 0.0044$) in the percentage of total acceptance of grafted larvae were observed between the groups so that $52.13 \pm 16.29\%$ (662 larvae) and $68.82 \pm 17.03\%$ (875 larvae) of larvae were accepted for the colonies maintained in the shade and direct sunlight, respectively (see Figure 3).

Figure 3. Acceptance rate of grafted larvae in hives of Africanized honey bees maintained in the shade and under full sunlight in the semiarid climate of northeastern Brazil. The values are statistically significant by t-Student test at 5% probability.



The acceptance percentage of grafted larvae recorded here were higher than those reported by MOURO & TOLEDO (2004), GARCIA & NOGUEIRA-COUTO (2005), TOLEDO & MOURO (2005), ALBARRACÍN (2006), TOLEDO *et al.* (2010) for Africanized honey bees colonies and lower and/or similar to the results obtained by MEDEIROS *et al.* (2011) and PEREIRA *et al.* (2013). Therefore, our results showed that despite adverse environmental conditions, the process of transferring larvae to the production of royal jelly or queen rearing can be successfully carried in the semiarid climate of Northeast Brazil. Thus, this technique is recommended for the northeastern beekeepers when combined with the correct management of production, as the use the installation of colonies under shaded area.

The warm climate of the Brazilian semiarid region requires a greater effort of worker bees in thermoregulation, time that could be used in activities of growth and production of the colony (BRASIL *et al.*, 2013), so that the percentage of accepted larvae and the success of larvae transfers may be affected in the hives exposed to direct sunlight, as observed here. According to Seeley (2006), the cooling system or the thermoregulation is triggered when the nest temperature reaches about 36°C. However, when the temperature inside the colonies reaches 41°C occurs the migratory swarming or absconding of the Africanized bees (ALMEIDA, 2008). Thus, due to high temperatures common in semiarid region, the bee colonies need to invest frequently in thermoregulation of the hives.

In this research, the greater acceptance rate of grafted larvae presented for hives kept under shade conditions possibly indicate that under mild environmental conditions (shade), the honey bees are able to maintain the colony homeostasis more easily and with more accuracy (ALMEIDA, 2008; DOMINGOS & GONÇALVES, 2014), providing a suitable environment for the development of queens. Thus, our results demonstrated clearly the interference of high temperatures and intense radiation as limiting factors of the physiological and behavioral performance of Africanized honey bees exposed to direct sunlight, reinforcing the theory that the *A. mellifera* colonies are sensitive to climatic factors of Caatinga.

Therefore, the process of transferring larvae for queen-rearing or royal jelly production can be successfully carried in this region, when combined with the correct management of hives such as installation of bee colonies under shady area.

CONCLUSION

It is concluded that colonies installed in the shade have a higher acceptance rate of Africanized honey bees larvae than colonies under full sunlight. Thus, for the production of queens and production of royal jelly in the semiarid region of northeastern Brazil, it is strongly recommended to install apiaries in shady places.

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