Relationship of floral morphology and biology of yellow melon hybrids with the attractiveness of pollinators

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Abstract: To increase the productivity of melon, new hybrids have been released. The aim of this study was to compare the differences in morphology and floral biology of two yellow melon hibrids and these could influence the attractiveness of the pollinators. The study was conducted in June 2010, at Embrapa Semiárido (Petrolina-PE), with hybrids BRS Araguaia and Tropical. To evaluate the morphology and anthesis ten flowers were selected of each floral type: hermaphrodite (H) and male (M). The floral visitors were observed simultaneously in the two hybrids, from 5h00a.m until 6h00p.m, in three non-consecutive days. In the morphology, it was found that the Tropical flowers have diameter of corolla higher in two floral types (M: x = 3.82±0.55cm, H: x = 4.74±0.52cm) compared to BRS Araguaia (M: x = 3.46±0.46cm, H: x = 3.77±0.45cm), although the differences were significant only for the hermaphrodites. The BRS Araguaia flowers presented significantly longer ($p<0.05$) (M: x = 2.20±0.23cm, H: x = 3.86±0.39cm) that the Tropical (M: x = 0. 96±0.30cm, H: x = 2.60±0.63cm). As for anthesis (05h30a.m.) there was no difference in relation to floral types and hybrids. The bees *Apis mellifera*, *Xylocopa grisescens* and species of Halictidae family were observed in the area. The visitation peak was recorded between 10h00a.m. and 11h00a.m. in both hybrids. Comparing the visitation in hermaphrodite flowers and production of fruit/plant, it was observed that the BRS Araguaia received more visits of *A. mellifera* and produced more fruit/plant (2.1) than the Tropical (1.43), indicating that the differences found in the hermaphrodite flowers may have influenced the bees behavior and thus productivity.

Key words: *Cucumis melo*, *Apis mellifera,* BRS Araguaia, Tropical.

Relação da morfologia e da biologia floral de híbridos de melão amarelo com a atratividade dos polinizadores

Resumo: Visando aumentar a produtividade do meloeiro, novos híbridos vêm sendo lançados no mercado. O objetivo desse trabalho foi verificar se há diferenças na morfologia e biologia floral de híbridos de meloeiro amarelo e se essas poderiam influenciar na atratividade dos polinizadores. O estudo foi realizado em junho de 2010, na Embrapa Semiárido (Petrolina-PE), com os híbridos Tropical e BRS Araguaia. Para avaliação da morfologia e biologia floral foram selecionadas 10 flores de cada tipo floral: hermafrodita (H) e masculina (M). Os visitantes florais foram observados concomitantemente nos dois híbridos, no período de 5h00 às18h00, em três dias não consecutivos. Quanto à morfologia, verificou-se que as flores do Tropical apresentaram diâmetro da corola maior nos dois tipos florais (M: x=3,82±0,55; H: x=4,74±0,52) em relação ao BRS Araguaia (M: x=3,46±0,46cm; H: x=3,77±0,45cm), sendo registrada diferença significativa para as flores hermafroditas. O BRS Araguaia apresentou flores significativamente mais compridas ($p<0,05$) (M: x=2,20±0,23cm; H: x=3,86±0,39cm) que o Tropical (M: x=0,96±0,30; H: x=2,60±0,63cm). Quanto à antese, esta ocorreu as 05h30min, não havendo diferenças em relação aos tipos florais e híbridos. Entre os visitantes florais foram observadas visitas de *Apis mellifera*, *Xylocopa grisescens* e espécies da família Halictidae na área. O pico de visitação foi registrado entre 10h00 e 11h00, em ambos os híbridos. Comparando a visitação nas flores hermafroditas e a produção de frutos/planta, observou-se que o BRS Araguaia recebeu maior número de visitas de *A. mellifera* e produziu mais frutos/planta (2,1) do que o Tropical (1,43), indicando que as diferenças encontradas nas flores hermafroditas podem ter influenciado o comportamento das abelhas e, consequentemente, a produtividade.

Palavras chave: *Cucumis melo* L., *Apis mellifera*, BRS Araguaia, Tropical.

Introduction

Melon (*Cucumis melo* L.) is the eighth most widely produced fruit in the world; it is among the ten major exported and consumed fruit "in natura" with an international market estimated in more than 1.6 millions of tons per year (Sales Jr., 2005). This oleracea has great economic importance for the Northeast region, accounting for more than 90% of Brazilian production, and the states of Rio Grande do Norte, Pernambuco and Bahia, the largest producers (Anuário Brasileiro de Fruticultura, 2011). Among the varieties, the yellow melon is the most cultivated in the region, followed by cantaloupe and green Spanish.

Diverse hybrids are introduced yearly in the market, hence there is an emergent necessity of research mainly concerning the production and quality of the fruits to fulfill the consumers' demands (Chaves et al., 2004). According to Sousa (2010), despite the economic importance of melon, the productivity of this crop varies between the producers, and most of the time it is low in relation to the high productive potential of this vegetable.

Among the factors that may influence productivity is the dependence of the melon pollination services, which are essential to achieve high initial fruit set and fruit yield in quantity and quality. These aspects are consequences of the requirements of pollination to reach high levels of initial fruit set, and high productivity and quality of the fruits. The honey bee (*Apis mellifera*) showed to be an efficient pollinator of melon, assuring high levels of productivity. Thus, the melon flowers need insect pollination to reach satisfactory levels of frutification (Sousa, 2009).

According to Freitas (1998), the pollinator efficiency of any floral visitor is closely related to floral morphology and biology, where flowers develop mechanisms as colored petals, odors and reward of nectar, pollen, essences and oils to attract visitors and obtain pollination. Couto (2006) comments that there is a match between floral traits and their pollinators more effective, being the color and shape of the corolla one of them. In this matter, the objective of this work was to compare the differences in floral morphology of two hybrids of melon yellow type and if these could influence the attractiveness of pollinators.

Material and Methods

The study was carried on in July of 2010, in conventional crops with mulching and drip irrigation, at Campo Experimental do Bebedouro of Embrapa Semiárido, in municipality of Petrolina, Pernambuco State, Brazil (latitude 09º09'S and longitude 40º22'W and altitude 350 m). Climatic data are presented in Figure 1 and show that in July was recorded low rainfall and lower temperatures.

For the experiment were used seeds of hybrid BRS Araguaia and Tropical, sowed on trays and transplanted to the field in May 2010. The experiments were performed from the 30th day of transplanted, when ten flowers of each floral type of both hybrids were selected for morphology and floral biology evaluation. The measurement of the diameter of the corolla and the height of the flowers were performed with an analogical caliper. The morphological data of the flowers and visitors were analyzed using the Mann-Whitney (P< 0.05) test.

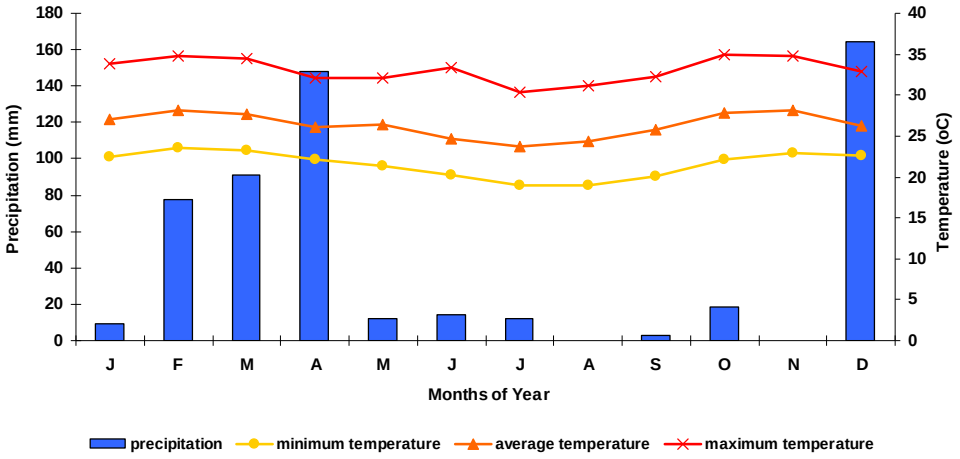

Figure 1 - Climatic data of the Estação Experimental of Bebedouro, in Petrolina, Pernambuco State, for the January to December 2010.

For the observations of the floral biology, flowers in pre-anthesis of both male and hermaphrodite were marked and accompanied in both hybrids to verify the anthesis period, floral senescence and floral visitors. The frequency was observed simultaneously in the two hybrids, from 05h00am until 06h00pm during three non-consecutive days, in a total of 39 hours of sampling effort.

At the end of the experiments, the productivity of the two hybrids was analysed. For quantitative analyse, fruits (n=4) were selected randomly and posteriorly transported to the Laboratório de Pós-colheita da Embrapa Semiárido where they were weight using a digital scale, and the analysis of the total soluble solids using a manual refractometer Atago was performed (0-32%).

Results and Discussion

The morphological analysis of floral types showed that the hermaphrodite flowers (Figure 2) have higher dimensions when compared with the male flowers in both hybrids. In this case, the difference was more pronounced for Tropical flowers. However, only for the diameter of corolla in BRS Araguaia was not registered a significant difference by Mann-Whitney test (Table 1).

Comparing the two hybrids it was verified that Tropical flowers have higher diameter of corolla in both floral types (male flower x=3.84 ± 0.55 cm; hermaphrodite flower x=4.74 ± 0.52 cm) when compared with BRS Araguaia (male flower x=3.46 ± 0.46 cm; hermaphrodite flower x=3,77 ± 0.45 cm), but only for hermaphrodite flowers there was significant difference (Table 1). Concerning the length of flower, the hybrid BRS Araguaia presented higher flowers (male flowers x=2.20 ± 0.23 cm; hermaphrodite flowers x=3.86 ± 0.40 cm) when compared with Tropical (male flowers x=0.96 ± 0.30 cm; hermaphrodite flowers x=2.6 ± 0.63 cm), differing significantly in both floral types.

Figure 2 - Lateral and frontal views of male (a-b) and hermaphrodite (c-d) flowers of melon. The arrows show the reproductive structures.

Table 1 - Mean values and standard deviation of the morphological characteristics evaluated in the floral types (male and hermaphrodite) of melon hybrids BRS Araguaia and Tropical, in Petrolina, Pernambuco State.

Characteristics (cm)	BRS Araguaia		Tropical	
	Flowers ♂ (n=10)	Flowers ♂♀ (n=10)	Flowers ♂ (n=10)	Flowers ♂♀ (n=10)
diameter of corolla	3.46±0.46 a A	3.77±0.45 a A	3.84±0.55 a A	4.74±0.52 b B
height of flower	2.20± 0.23 a A	3.86± 0.40 b A	0.96±0.30 a B	2.60±0.63 b B

Legend: ♂ = male; ♂♀= hermaphrodite.
lowercase letter- comparison between floral types of the same hybrid.
capital letter - comparison by type sexual between hybrids.
Mann-white test (p< 0,05).

Morphological floral characteristics as length and diameter of corolla are important features for pollinator attraction which needs compatible mouthparts to reach the nectariferous chamber where the nectar is stored, and

at the same time providing physical contact with the reproductive parts promoting the pollination. Larger flowers, as observed in the Tropical hibrid, could be more attractive to the pollinators, both for visual effect as by the availability of a larger area for landing (landing platform). On the other hand, in the higher flowers, such as observed in the BRS Araguaia hybrid, could be a greater accumulation of nectar, which could make your flowers more attractive to pollinators. However, this hypothesis can not be proven in the field, since the melon flowers produce small amount of nectar per flower, which hindered their quantitative evaluation with the aid of microsyringe and microcapillary.

As for the time of anthesis, there was no difference concerning the floral types; and it was registered around 05h30 am for both hybrids, agreeing with the observations made by other authors (Abreu et al., 2008; Kiill et al., 2011). With respect to the life time of each flower, it was approximately 13 hours and in this case there was no difference between floral types and hybrids as well.

During the observations it was verified the presence of specimens of *Apis mellifera, Xylocopa grisescens* and species of Halictidae family in the experimental area, although only *A. mellifera* has been observed on the flowers marked for the study. Concerning the visit pattern, it was registered similar results for both hybrids, with the peak at the period from 10h01 am until 11h00 am. Moreover, it was not registered visits of *A. mellifera* in the beginning of the morning and in the end of afternoon (Figure 3), agreeing with the observations made in the melon in the same region (Kiill et al., 2011; Siqueira et al., 2011). This same pattern was reported in Mexico (Reyes-Carrillo and Cano-Ríos, 2004; Reyes-Carrillo et al., 2006) and in Panama (Hoz, 2007), where the bees started their visit after 8h00 am, reaching the peak between 9h00 and 11h00 am.

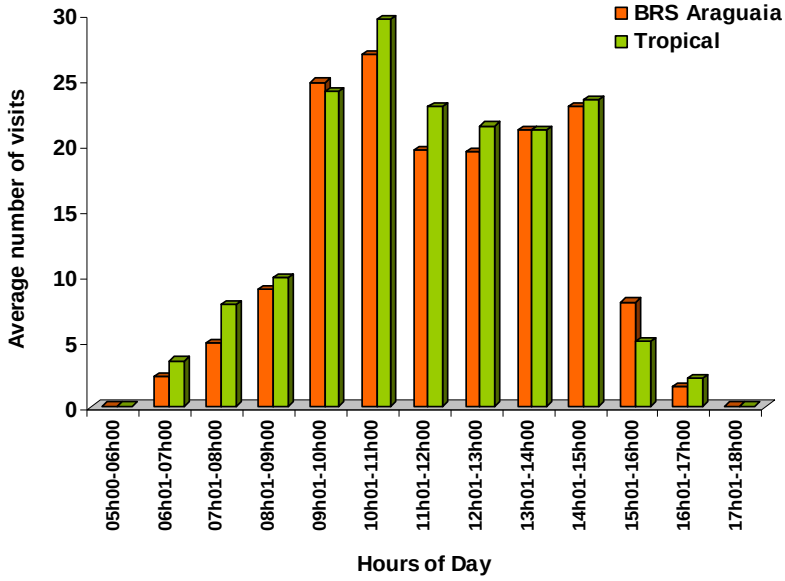

Figure 3 - Average number of visits of honey bees (*Apis mellifera*) over the observations in two hybrids of melon (*Cucumis melo*) evaluated at the Estação Experimental of Bebedouro, Petrolina, Pernambuco State.

Nevertheless, Sousa (2008) and Sousa et al. (2012) discussed that melon flowers are attractive for *A. mellifera* during the first hours in the morning when is registered a higher frequency of visitation. Ours results are not in agreement with these data. This difference may be related to climatic conditions in the region and to the season when the observation were made. In this study, the observations were made in June when the lowest temperatures are registered in the region (Figure 1). This may have influenced the pattern of the behavior of the bees which concentrated their visits during the warmest hours in the morning.

Comparing the visiting pattern of each floral type (Figure 4), it was verified that the hermaphrodite flowers received similar or higher number of visits than the male flowers, for both hybrids and during most time of analyses, agreeing with the observations made in the melon in the same region (Kiill et al., 2011; Siqueira et al., 2011). The contrary was observed only from 8h01 am until 9h00 am and from 09h01 am until 11h00 am for BRS Araguaia and Tropical, respectively, but all these differences were no significant ($p>0.05$).

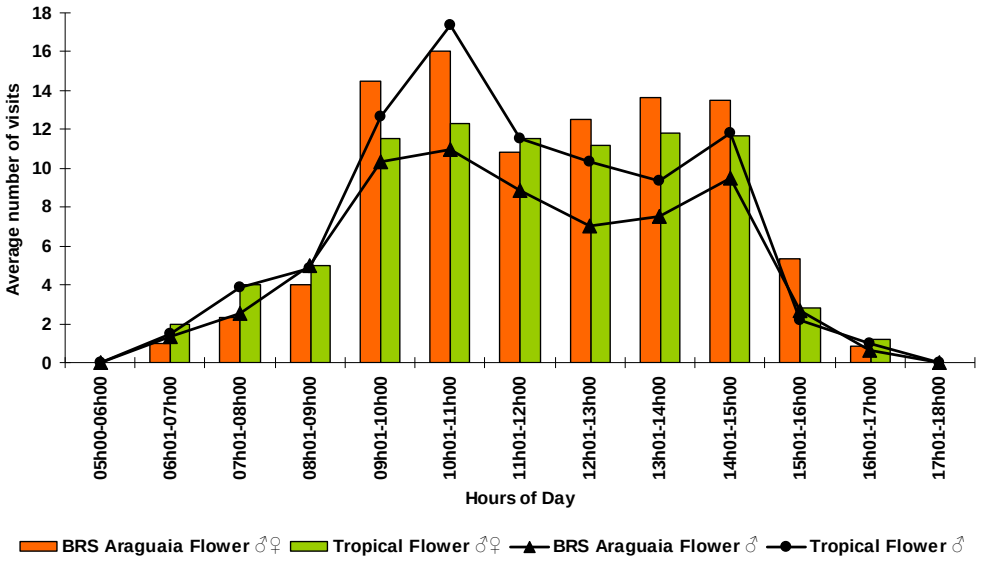

Figure 4 - Average visits number of *Apis mellifera* by floral type, by time, in two hybrids of melon (*Cucumis melo*) evaluated at the Estação Experimental of Bededouro, in Petrolina, Pernambuco State.

This difference between the flower types may be related to both the morphology as with the floral biology. In the first case, the hermaphrodite flowers to be taller, present nectariferous chamber with bigger volume to store nectar. As regards the floral biology, the hermaphrodite flowers of melon (Siqueira et al., 2011) and the others cucurbits (Ashworth and Galletto, 2002; Taha and Bayoumi, 2009) secrete more nectar than male flowers, making them more attractive. The fact that female flowers produce more nectar can be considered as a strategy of this specie to attract pollinators to this flower type, increasing the reproductive success (Ashworth and Galletto, 2002).

After analysis of only hermaphrodite flowers, it was observed that the BRS Araguaia flowers received more visits than the Tropical, but the differences were not significant (p>0,05). This difference may be linked with morphological characteristics, once BRS Araguaia hybrid have higher flowers, feature that involves a higher accumulation of nectar in relation to the height of the nectariferous chamber, as already mentioned. The similar fact was observed by Kiill et al. (2011) in the compare of three melon types. In this study the floral morphology influenced the visitor pattern of floral types and cultivars.

As regards to productivity (Table 2), it was observed that the BRS Araguaia hybrid presented 2.1 fruits per plant whereas Tropical presented 1.43. This higher production per area can be indirectly related to the visit pattern, which is one of the factors that may have taken a greater number of pollinated flowers and consequently higher production of fruit.

Table 2 - Evaluation of productivity, fruits per plant, average weight and Brix of two hybrids of yellow melon (*Cucumis melo*).

Characteristics	BRS Araguaia	Tropical
	Mean ± DP	Mean ± DP
Fruits/plant	2.1±0.01	1.43±0.12
Productivity (ton)	40.57±1.88	35.89±3.91
Mean of fruit weight (kg)	1.52±1.88	2.05±0.16
Total soluble solids (^{o} brix)	14.53±0.47	13.1±0.90

Conclusion

The morphological differences found in the hermaphrodite flowers of two hybrids may have indirectly influenced the attractiveness of *A. mellifera*, which in turn reflected in productivity.

Knowlegments

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