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Bees forage on bahiagrass spikelets

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Bahiagrass (*Paspalum notatum* Flüggé; Poaceae) is an important perennial grass principally planted as a forage crop for grazing, but also grown as a lawn grass in residential settings, public parks, and recreational gardens (Rojas-Sandoval 2018; Trenholm et al. 2018). Native to South America, bahiagrass is planted worldwide in tropical, subtropical, and warm temperate regions (Rojas-Sandoval 2018). Because bahiagrass is deep-rooted and can thrive in poorly fertile soils, it is used for erosion control in disturbed soil environments (Trenholm et al. 2018). This grass can tolerate drought and heavy grazing, and outcompetes other plant species and reduces their establishment (Wallau et al. 2019; Heuzé et al. 2021). In the southeastern US, although bahiagrass can be found in urban lawns, it is particularly grown as a lawn grass in the residential yards in suburban and rural areas. Recently, selected cultivars of bahiagrass were planted in southern US golf courses as a rough turfgrass (O'Brien 2019). Bahiagrass also is common along roadsides, banks of water bodies, ditches, and the edge of wood lines in the southeastern US. Bahiagrass is produced and planted as seeds as well as sod grown from stolons and rhizomes (Rojas-Sandoval 2018).

Spikelets of bahiagrass are 2.75 to 4.00 mm long (Rojas-Sandoval 2018). Both male and female floral structures occur on the bifurcated spike. Sexual reproduction is reported only on the diploid type of bahiagrass, whereas the tetraploid type also produces viable seeds. The diploid type of bahiagrass is wind-pollinated (Quarin et al. 2001; Cidade et al. 2007). The bahiagrass cultivars planted in Georgia and northern Florida, USA, are mostly diploid type (Wallau et al. 2019). In urban and suburban greenspaces, such as lawns, bees use floral resources from non-turfgrass hosts, such as white clover (*Trifolium repens* L.; Fabaceae) that occur naturally amongst turfgrasses (McIntyre & Hostetler 2001; Frankie et al. 2005; Baldock et al. 2015; Lerman & Milam 2016; Ogilvie & Forrest 2017; Joseph et al. 2020a). Because residential lawns are typically mowed every 7 to 14 d, they will not have spikelets, and if they do, they will be short-lived. In pastures and roadsides or other sites that are mown infrequently, spikelets can be available for some time. Nevertheless, it is important to understand whether turfgrasses, including bahiagrass, could serve as a resource for bees. Previously, honey bees (Jones 2014; Joseph et al. 2020b), bumblebees, and sweat bees (Joseph et al. 2020b) were reported to forage on the inflorescences of centipedegrass beginning in mid-Jul in the southeastern US. Likewise, bahiagrass produces spikelets beginning mid-Jul in the southeastern US (SVJ, unpublished data). Thus, the objective of the current study was to determine if bees forage on bahiagrass spikelets. If bees forage on bahiagrass spikelets, it may function as a supplemental floral resource for developing bee larvae and enhance the pollination services in adjacent landscapes.

This study was conducted in 2021 on 7 bahiagrass patch sites (site 1: 98.5 m^2 [33.263445°N, 84.284981°W]; site 2: 680.0 m^2 [33.263350°N, 84.286287°W]; site 3: 875.3 m^2 [3.262330°N, 84.285037°W]; site 4: 686.4 m^2 [33.264646°N, 84.284669°W]; site 5: 1620.1 m^2 [33.266675°N, 84.292011°W]; site 6: 2893.4 m^2 [33.260901°N, 84.296319°W]; site 7: 2016.1 m^2 [33.263781°N, 84.306264°W]) occurring naturally in the University of Georgia Griffin campus (sites 1–4), Research and Education Garden (sites 5, 6), and Westbrook Research Farm (site 7), all in Griffin, Georgia, Spalding County, USA. These sites were at least 30 m apart. The areas of the selected sites varied in size and shape because the areas were selected for the presence of bahiagrass spikelets in those sites. Other weeds, such as dandelion (*Taraxacum officinale* [L.] Weber; Asteraceae), white clover (*Taraxacum repens* [L.]; Asteraceae), and buckhorn plantain (*Plantago lanceolata* L.; Plantaginaceae), were naturally occurring in all the selected bahiagrass sites. These host plants covered 5 to 30% of the selected sites. The sites were not mowed for at least 14 d prior to the surveys. As part of the survey, the spikelets of bahiagrass or other host plants in the sites were observed closely by walking slowly through the area for 20 mins. The walking was not focused on any specific spot within the site; rather, it was performed at random directions within each site. During the walk, when a foraging bee was noticed on the bahiagrass spikelets or other host flowers for more than 3 s, collection was attempted using a sweep net. Collected bees were bagged individually, and the host plant information was recorded on the bag. This method was adopted from Joseph et al. (2020b). Each site was visited only once. Samples were emptied into clear plastic bags and temporarily stored in the laboratory freezer. The bees were curated by blowing dry air for 1 to 5 min using a hair drier before pinning. Later, the bees were identified to genus using dichotomous keys (Michener et al. 1994). In addition, the number of bees lost during targeted sweep netting and other bees observed on hosts for more than 3 s that we were unable to collect was quantified. These bees were identified to genus using the surveyor's experience. The host plant information of these bees was recorded during the survey. Sweep samples were collected between 9:00 AM and 1:00 PM on full sun d. The survey was conducted on 22 Jul 2021 in sites 1 to 4; on 23 Jul 2021 in sites 5 and 6; and on 26 Jul 2021 in site 7. Both the bees collected and lost after sweep netting were combined for analysis. To determine the effect of plant host on foraging bee abundance, the data were examined for normality assumptions and subjected to 1-way analysis of variance (ANOVA) using the general linear model procedure (PROC GLM) in SAS (SAS 2012) after log transformation (ln[x + 1]). The sites were the replications and were included in the model as a random effect. The means (number of bee specimens by genera collected or observed) were separated using the LSD test at $\alpha = 0.05$.

Our results showed that European honey bee (*Apis melifera* L.; Hymenoptera: Apidae), bumblebees (*Bombus* spp. Latreille; Hymenoptera: Apidae), and sweat bees (*Lasioglossum* spp. Curtis; Hyme-

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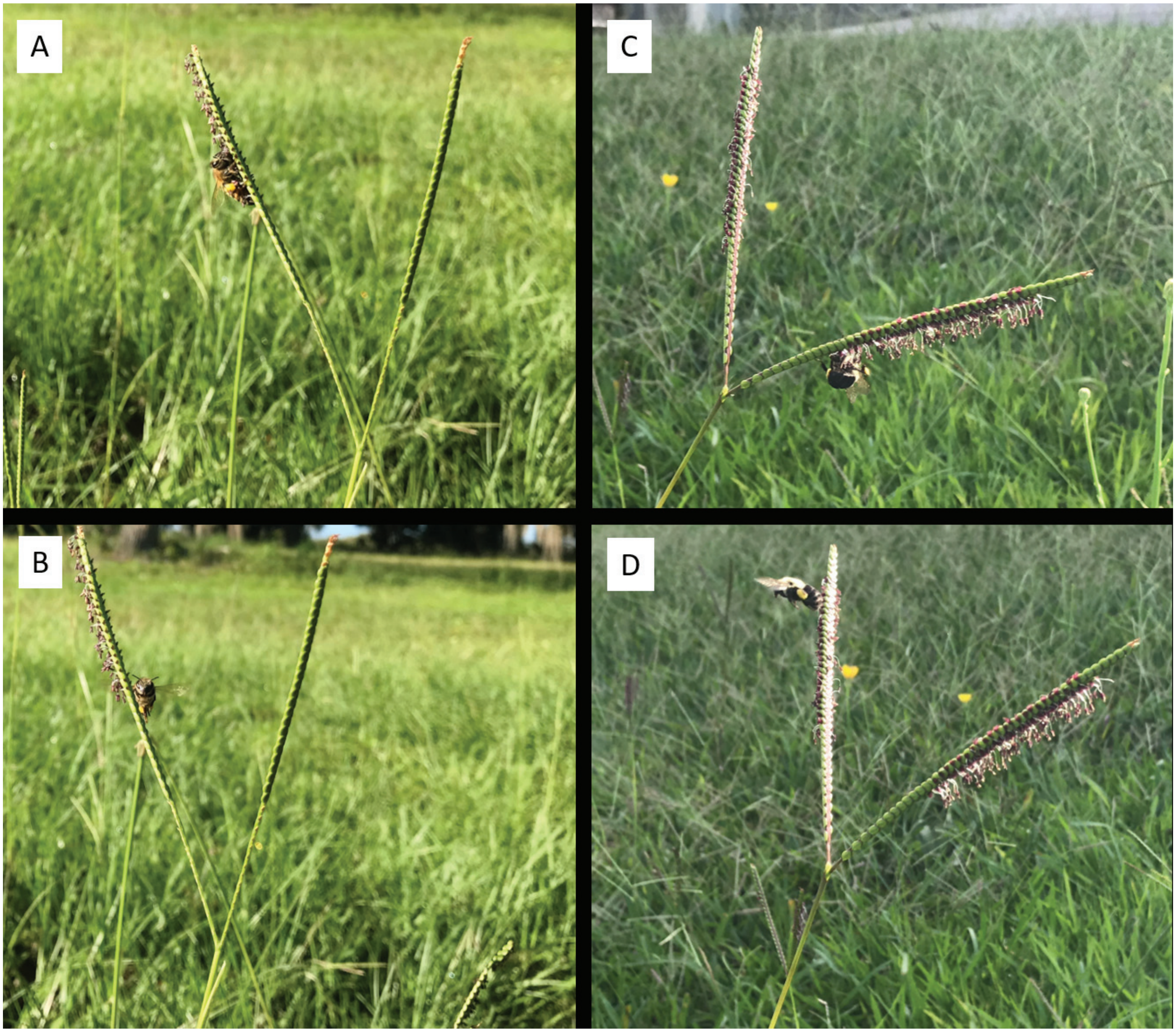

Fig. 1. (A, B) European honey bee, and (C, D) bumblebee foraging on bahiagrass spikelets.

noptera: Halictidae) forage on bahiagrass spikelets (Figs. 1, 2). A significantly greater number of foraging bumblebees were observed on white clover than on bahiagrass (F = 3.6; df = 3, 18; P = 0.033; Fig. 2B) but no differences were observed in bumblebees observed on dandelion, bahiagrass, or buckhorn plantain. In addition, the number of European honey bees (F = 0.8; df = 3, 18; P = 0.530; Fig. 2A), sweat bees (F = 0.6; df = 3, 18; P = 0.604; Fig. 2C), and total bees (F = 1.1; df = 3, 18; P = 0.362; Fig. 2D) observed foraging or captured were not different between hosts. When the bahiagrass spikelets were tapped with fingers, a plume of pollen grains was released from the anthers (SVJ and CBH, personal communication). Previous studies have found that *Lasioglossum* spp. are the most abundant bee genus collected from centipedegrass lawns (Joseph et al. 2020a, b) and other broad greenspace habitats (Fetridge et al. 2008; Lerman & Milam 2016; Zarrillo et al. 2016) in urban and suburban areas. On bahiagrass spikelets, only 1 *Lasioglossum* spp. was observed. *Bombus* spp. and *A. melifera* also were found foraging on centipedegrass inflorescence in residential lawns in central Georgia, USA (Joseph et al. 2020b), as observed in the current study on bahiagrass. Some bahiagrass growing in yards and pastures continuously produce spikelets, which could benefit the bee fauna.

Current results showed that bees forage on bahiagrass flora, although it is not clear if they collected the pollen from the bahiagrass. Typically, grass flora is not perceived as a pollen source for bees, because many grasses are wind-pollinated or are not allowed to produce floral resources due to frequent mowing. The current study in bahiagrass and previous studies in centipedegrass (Joseph et al. 2020a, b) show that grass inflorescence or spikelets may be a supplemental resource for bees. Thus, more research is warranted to (1) determine if bees effectively collect pollen grains from the bahiagrass spikelets during foraging bouts, (2) characterize the foraging behavior of bees on the grasses, and (3) determine if grass pollen meets bee nutritional needs.

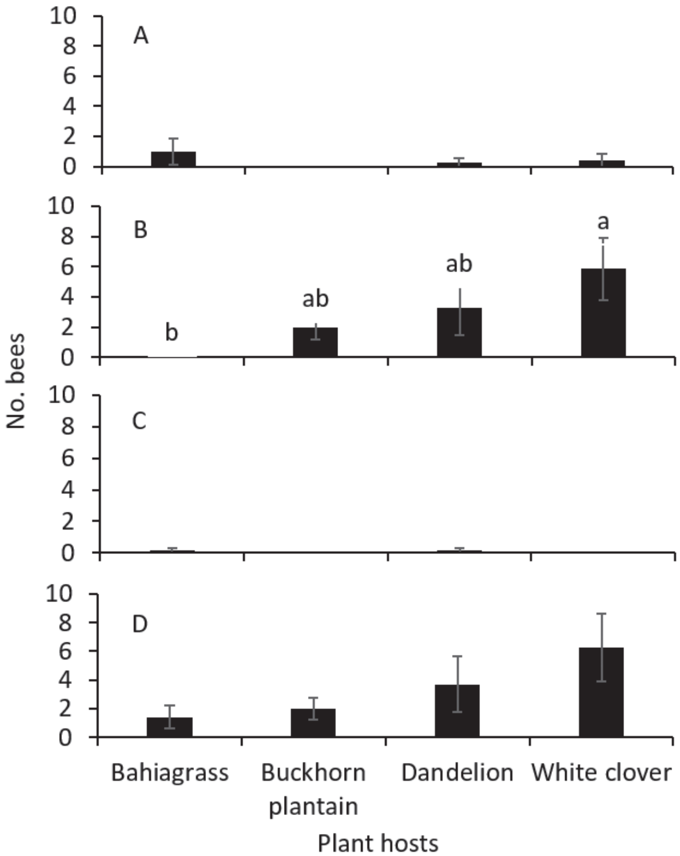

Fig. 2. Number of (A) honey bee (*Apis melifera*), (B) bumblebee (*Bombus* spp.), (C) sweat bee (*Lasioglossum* spp.), and (D) total foraging bees observed or captured in 20 mins from various hosts from natural bahiagrass patches in central Georgia, USA. Bars (means ± SE) with the same letters are not significantly different (LSD test, α > 0.05). Where no significant differences were observed, no letters are given.

Floral resources are important for supporting diverse bee communities in urban and suburban landscapes (McIntyre & Hostetler 2001; Lerman & Milam 2016; Bennett & Lovell 2019). This study is the first report that bahiagrass spikelets were visited by honey bees, bumblebees, and sweat bees, and may provide supplemental floral resources for some bees.

Summary

Bahiagrass (*Paspalum notatum* Flüggé; Poaceae) is primarily a pasture grass in the southern US. It is also lawn grass found in residential settings, public parks, and planted in golf courses. Bahiagrass is principally wind-pollinated, but the pollination contribution of insect pollinators is not documented. A survey was conducted on bahiagrass patches in central Georgia, USA, to determine the visitation of foraging pollinators. The results showed that European honey bees, bumblebees, and sweat bees forage on bahiagrass spikelets. Of the total bees observed, 10.6% (n = 94) were foraging on bahiagrass, compared to 46.8% on white clover, 27.7% on dandelion, and 14.8% on buckhorn plantain. This is the first report showing bee foraging on bahiagrass. The results suggest that bahiagrass spikelets may be a supplemental resource for bees and essential for bee conservation programs in rural and suburban areas. More research is warranted to determine how bahiagrass spikelets play a role in meeting the nutritional needs of bees to help sustain their colony and provide pollination service.

Key Words: pollinators; *Paspalum notatum*; turfgrass; European honey bee; bumblebees; sweat bees

Sumario

El pasto Bahía (*Paspalum notatum* Flüggé; Poaceae) es principalmente de zacate de pasturas en el sur de los Estados Unidos. También, es un césped que se encuentra en entornos residenciales, parques públicos y en campos de golf. El pasto Bahía se poliniza principalmente por el viento, pero no se ha documentado la contribución de los insectos polinizadores a la polinización. Se realizó un sondeo en parches de pasto Bahía en el centro de Georgia, EE. UU., para determinar las visitas de polinizadores forrajeros. Los resultados mostraron que las abejas melíferas, los abejorros y las abejas sudoríparas europeas se alimentan de espiguillas del pasto Bahía. Del total de abejas observadas, el 10,6% (n = 94) se alimentaba del pasto Bahía, en comparación con el 46,8% de trébol blanco, el 27,7% de diente de león y el 14,8% del llantén menor (o siete venas, *Plantago lanceolata*). Este es el primer informe que muestra la búsqueda de alimento por las abejas sobre el pasto Bahía. Los resultados sugieren que las espiguillas del pasto Bahía pueden ser un recurso complementario para las abejas y esencial para los programas de conservación de abejas en áreas rurales y suburbanas. Se necesitan más investigaciones para determinar el papel que juegan las espiguillas del pasto en las necesidades nutricionales de las abejas para ayudar a mantener su colonia y brindar el servicio de polinización.

Palabras Clave: polinizadores; *Paspalum notatum*; césped *Abeja europea*; abejorros abejas del sudor

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