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Original article

Bermuda grass (*Cynodon dactylon*) as a pollen resource for honey bee colonies in the Lower Colorado River agroecosystem[1]

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Summary — Beekeepers in southwestern Arizona and southeastern California frequently report the poisoning of numerous honey bee colonies following the application of insecticides to blooming bermuda grass grown for seed. This study was undertaken to characterize the relative frequency, intensity, and seasonality of honey bee foraging for bermuda grass pollen. The results show that bermuda grass pollen was gathered only intermittently at both of two study sites throughout the 54 week study period. Moreover, only a small fraction of all pollen gathered, 1.2% at site A and 1.5% at site B, was from bermuda grass. Bermuda grass does not appear to be a preferred pollen resource for honey bees, and it may be foraged only in response to the relative unavailability of other more acceptable sources. Honey bee losses due to insecticides applied to bermuda grass may be driven by these foraging dynamics and/or other factors.

***Cynodon dactylon* / pollen plant / *Apis mellifera* / pollen foraging / mortality**

INTRODUCTION

The southern extreme of the lower Colorado River agroecosystem includes the Yuma-Wellton area of Yuma County in the southwestern corner of Arizona and parts of Imperial County in the southeastern corner of California. The region has an abundance of arable land (> 121 500 ha) and a long growing season. Moderate winters are followed by hot summers with low annual precipitation (≈ 5 cm), hence, cropland must be irrigated. The region is intensively cultivated and agriculturally diverse. Major crops

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include cotton, hay (alfalfa), vegetables, citrus, small grains, and numerous seed crops (Barmore, 1980). As a result, there is a high demand for crop pollinators, principally honey bees, *Apis mellifera* L in the area.

Bermuda grass, *Cynodon dactylon* (L) Pers, is one of the major seed crops produced in the Yuma-Wellton area with approximately 5 260 ha grown annually. Pests of bermuda grass include armyworms, cutworms, mirids, spider mites, thrips, weevils and whiteflies (Rethwisch et al, 1995). Pest feeding reduces yields. In response, insecticides and miticides are often applied during bloom and seed set. Honey bee foraging for pollen in bermuda grass seed production fields has led to numerous beekeeper reports of poisoning of honey bee colonies following the application of insecticides.

There are documented instances of honey bees gathering pollen from bermuda grass (Oertel, 1980; Schmalzel, 1980; O'Neal and Waller, 1984). Unfortunately, most reports of bees gathering bermuda grass pollen are anecdotal and involve bermuda grass grown as turf or in patches of weeds. However, Bogdan (1962) reported that in Kenya, bermuda grass production fields attracted numerous pollen-collecting honey bees between 0800 and 1000 h, on some days, but not others. O'Neal and Waller (1984) found that bermuda grass pollen comprised only 0.5% of all pollen gathered by honey bees in five apiaries at Tucson, AZ, during the weeks of 3 June and 6 October 1976. They further reported that 0.4% of all pollen gathered by colonies in a single apiary at Tucson, AZ, over 3 years (1976, 1978, 1979) was from bermuda grass.

The purpose of this study was to characterize the relative frequency and intensity of honey bee foraging for bermuda grass pollen in seed production fields.

MATERIALS AND METHODS

Two sites in the Yuma Valley, separated by about 17.7 km, were selected for study. The entire area is under cultivation except for wet lands and banks along the Colorado River. Both sites were adjacent to and within honey bee flight range of several fields of bermuda grass grown for seed. Site A was located on the University of Arizona Experimental Farm approximately 3.2 km west of Yuma, site B was approximately 1.6 km east of Gadsden, AZ. Site A was characterized by mixed agriculture, in part the result of the diversity of experimental plots on the farm. In contrast, cropland in the vicinity of site B was devoted principally to citrus and cotton production. They were also within honey bee flight range of native plants in uncultivated areas along the Colorado River.

Seven full strength honey bee colonies in two 24.5 cm deep Langstroth hive bodies were placed at each site in late May 1987. Each colony was equipped with a combination dead bee/pollen trap (Pennwalt Corp, Philadelphia, PA). Pollen samples were removed weekly from each colony from 6/9/87 to 7/2/88, that is a period spanning two bermuda grass bloom seasons (54 weeks). The pollen samples were immediately frozen and stored for subsequent analyses. Dead bees trapped from each colony were removed and counted weekly.

Each of about 700 pollen samples, consisting of the individual pollen pellets stripped from the legs of foraging bees returning to the hive, was individually weighed. The pollen pellets in each sample were sorted by color and texture. Pollen pellet types occurring in minor amounts (less than 2% of the total) were placed in a category labelled miscellaneous. The data for each type were averaged over all colonies at each site for each sampling date and presented as percent of total sample weight.

Pollen identification

Each pollen pellet was assumed to be homogeneous with regard to plant species (O'Neal and Waller, 1984). One or two pellets were crushed on a microscope slide, stained with basic fuchsin and mounted in glycerine jelly. The specimens were covered with a cover slip and placed on a slide warmer for 24 h. Ten slides were made from each pollen type. Individual pollen grains on each slide were identified using an Olympus®

microscope at 600 magnification or 1 000 magnification (oil emersion).

Fresh flowers of bermuda grass, corn, Johnson grass and sorghum were collected from the study area for comparison. Reference slides were made from these flowers using the methods above. Pollen classes representing more than 2% of each sample were identified to plant family based on morphology and size of the individual pollen grains. Identification was confirmed using the reference slides and published references (Bassett et al, 1978; Huang, 1972; Kremp, 1965; Lewis et al, 1983; Martin and Drew, 1969, 1970; Punt and Clarke, 1980).

RESULTS AND DISCUSSION

The results of these studies suggest that honey bees are able to find pollen resources in the Yuma Valley throughout the year except for a 4 to 6 week period from late November through December (fig 1). Data gaps in February and May 1988, reflect samples damaged or lost due to rain.

The total amount of pollen by weight, gathered weekly by honey bees at each site during the study period, was first divided into three groups: non-Poaceae, Poaceae other than bermuda grass and bermuda grass, to analyze bee foraging preferences. These data, presented in figure 1, clearly show that pollen from grasses other than bermuda grass predominated over bermuda grass by a wide margin. As reported by Bogdan (1962) bermuda grass pollen was gathered only intermittently at both sites throughout the study period even though bermuda grass seed production fields bloom for 6 to 8 weeks. Converting weights to percentiles, figure 2 again shows that of the pollen gathered from grasses, only a very small fraction was from bermuda grass. The mean incidence of bermuda grass pollen in all samples for the entire study period was 1.2% at site A and 1.5% at site B. These data are similar to the findings of O'Neal and Waller (1984). Other Poaceae pollen comprised means of 13.5% and 17.9%, respectively, for the two sites, with the bal-

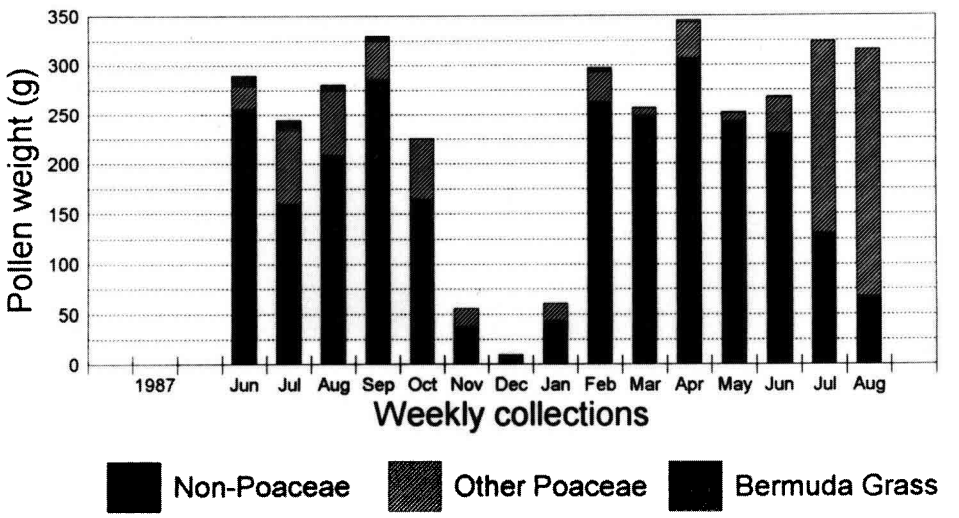

Fig 1. Weekly analyses of pollen types, by weight.

ance (85.3 and 80.1%, respectively) being non-Poaceae. Bermuda grass pollen occurred in only 11 samples at site A and 12 samples at site B during the study period. Weeks during which bermuda grass pollen was gathered coincide with, but do not encompass entirely, the flowering periods of the cultivated fields. Bermuda grass pollen gathered in February and March likely came from uncultivated plants.

Non-Poaceae pollens comprised the majority of pollens collected during the study (fig 2). Thirteen plant families were represented most frequently in this group. Not surprisingly, this group was dominated by the Asteraceae, Fabaceae, Polygonaceae and Tamaricaceae which, unlike Poaceae pollen (Stanley and Linskens, 1974), represent some of the most nutritive pollens for honey bees. Chenopodiaceae and Rutaceae pollens were also present in significant amounts in some samples. The pollen profiles at both sites were similar.

The number of dead bees trapped per colony remained low (less than 100 bees per colony per week) throughout the study period except for the second week in September at Gadsden and the third week in March at Yuma. Although slightly elevated (300-400 dead bees per colony), this level of mortality was not sufficient to threaten colony survival.

Honey bees can sometimes be found foraging extensively in blooming bermuda grass seed production fields in the Yuma-Wellton area (Erickson et al, personal observation). Even so, it is remarkable that so little pollen from bermuda grass, compared to that from other sources, was gathered by honey bees in this study. The intermittency of the intrafield foraging reported here was also observed by Bogdan (1962). The data

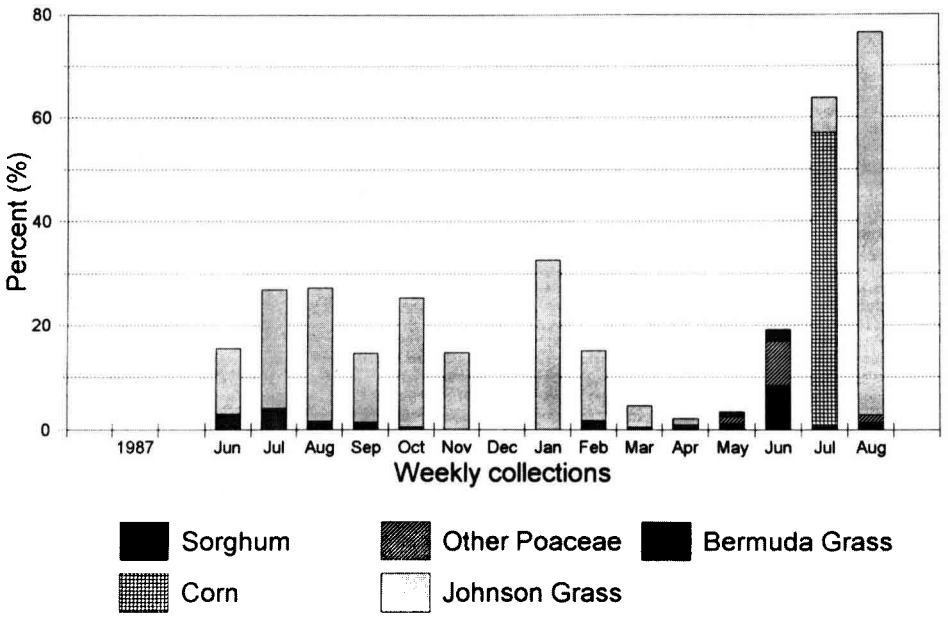

Fig 2. Weekly analyses of Poaceae pollen types, by percent.

suggest that bermuda grass pollen is not a preferred resource for honey bees, and may in fact be gathered only in the absence of sufficient quantities of other more acceptable pollens. Data from studies on sweet corn (Erickson et al, unpublished), also a marginal pollen resource for bees, leads us to suspect that, while honey bee losses occur as a result of exposure to insecticides applied to bermuda grass in bloom, these losses may be driven by mitigating factors such as the relative availability of other pollen resources.

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Résumé — Le chiendent (*Cynodon dactylon*) comme source de pollen pour les colonies d'abeilles dans l'agroécosystème du Bas Colorado. Les apiculteurs du sud-ouest de l'Arizona et du sud-est de la Californie font souvent état d'empoisonnement de nombreuses colonies d'abeilles suite aux traitements insecticides appliqués sur le chiendent en fleurs, cultivé dans ces régions pour la production de semences. Cette étude vise à caractériser la fréquence relative, l'intensité et la variation saisonnière de la récolte de pollen de chiendent par l'abeille domestique. Pour cela sept colonies ont été placées fin mai 1987 dans chacun des deux sites étudiés. Les ruches étaient équipées d'une trappe mixte à pollen et abeilles mortes. Les échantillons de pollen ont été prélevés chaque semaine du 6/9/87 au 7/2/88, période couvrant deux saisons de floraison du chiendent, puis congelés pour être analysés ultérieurement. Les pelotes de pollen ont été pesées et classées selon leur couleur et leur texture. Pour les types de pelotes présents à plus de 2 % dans les échantillons, les familles botaniques ont été déterminées d'après la morphologie et la taille des grains de pollen. Sur chaque lame, les grains de pollen ont été identifiés individuellement au microscope. Le nombre total d'abeilles mortes dans les trappes est resté faible durant toute la période d'étude. Toutes les colonies ont pu récolter du pollen excepté durant une courte période de 4 à 6 semaines, de fin novembre à fin décembre. La majorité du pollen ne provenait pas des Poaceae. Treize familles botaniques ont été les plus représentées, les Asteraceae, Fabaceae, Polygonaceae et Tamaricaceae arrivant en tête. Sur les deux sites d'étude, le pollen de chiendent n'a été récolté que sporadiquement au cours des 54 semaines étudiées. En outre, seule une très petite fraction du pollen récolté au total était du pollen de chiendent : 1,2 % sur le site A, 1,5 % sur le site B (fig 1). Il ne représente également qu'une faible portion du pollen de graminées récolté (fig 2). Le pollen de chiendent ne figure donc pas parmi les sources polliniques préférées des abeilles et semble n'être récolté qu'en l'absence de pollens plus intéressants en quantités suffisantes. Les pertes d'abeilles dues aux traitements insecticides sur le chiendent dépendent donc de la dynamique du butinage et/ou d'autres facteurs.

***Cynodon dactylon* / plante pollinifère / *Apis mellifera* / butinage / mortalité**

Zusammenfassung — Bermudagras (*Cynodon dactylon*) als Pollenquelle für Honigbienen im Agro-Ökosystem des unteren Coloradoflusses. Die Anwendung von Insektiziden während der Blüte von zur Samenerzeugung angebautem Bermudagras führt häufig zur Vergiftung zahlreicher Bienenvölker. Da über die Beziehung von Bermudagras und Honigbienen sehr wenig bekannt ist, wurde eine Untersuchung der relativen Häufigkeit und Intensität des Beflugs von Bermudagras durch pollen-

sammelnde Bienen durchgeführt. Hierzu wurden zwei Untersuchungsgebiete in einem landwirtschaftlich divers genutzten Gebiet nahe Yuma /AZ ausgesucht. Ende Mai 1987 wurden an beiden Standorten jeweils 7 Bienenvölker aufgestellt und mit kombinierten Fallen zur Erfassung toter Bienen sowie zum Pollensammeln versehen. Die Pollenproben und die toten Bienen wurden vom 6.9.87 bis zum 7.2.88 wöchentlich von jedem Volk entnommen, eingefroren und später analysiert. Die Pollenproben wurden gewogen und nach Farbe und Oberflächenbeschaffenheit sortiert. Jede der Pollensorten wurde mikroskopisch bestimmt. Für Pollensorten mit einem Anteil von mehr als 2% in den Proben wurde die Pflanzenfamilie auf Grund der Morphologie und Größe der einzelnen Pollenkörner bestimmt. Die Anzahl von toten Bienen in den Fallen war während des Untersuchungszeitraumes gering. Alle Bienenvölker konnten während des gesamten Jahres Pollen finden, außer während eines kurzen Zeitraums von 4 - 6 Wochen vom späten November bis Ende Dezember. Während der gesamten Zeit stammte der meiste Pollen nicht von Poaceen. Dreizehn Pflanzenfamilien waren dabei am stärksten repräsentiert: Asteraceae, Fabaceae, Polygonaceae und Tamaricaceae. Über den Untersuchungszeitraum von 54 Wochen wurde an beiden Standorten nur vereinzelt Pollen von Bermudagras gesammelt. Darüberhinaus entstammte in beiden Gebieten nur ein sehr geringer Anteil des gesammelten Pollens dem Bermudagras (Abb 1; A: 1,2%; B: 1,5%). Andere Graspollen dominierten stark über den Bermudagraspollen (Abb 2). Dieses stellt daher keine bevorzugte Pollenquelle dar und wird möglicherweise nur bei Abwesenheit von günstigeren Pollenquellen besammelt. Verluste an Honigbienen auf Grund von Insektizidanwendung auf Bermudagras sind daher von der Sammeldynamik der Bienen sowie möglicherweise auch anderen Faktoren abhängig.

***Cynodon dactylon* / Bermudagras /*Apis mellifera* / Pollenpflanze/ Pollensammeln / Vergiftungen**

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