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Implications of planting date on Benghal dayflower (*Commelina benghalensis* L.) and sicklepod (*Senna obtusifolia* L.) management in peanut

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Research Article

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Abstract

Benghal dayflower and sicklepod are weeds of economic importance in peanut in the southeastern United States due to their extended emergence pattern and limited effective herbicides for control. Field studies were conducted near Jay, Florida, in 2022 and 2023, to evaluate the effect of planting date and herbicide combinations on Benghal dayflower and sicklepod control in peanut crops. Peanut planted in June was exposed to a higher Benghal dayflower density than peanut planted in May. Sicklepod density was similar between May and June planting dates at 28 d after preemergence and early postemergence herbicide applications, but density was greater in peanut that was planted in June, 28 d after the mid-postemergence application. A preemeergence herbicide application followed by (fb) an early postemergence application of *S*-metolachlor or diclosulam + *S*-metolachlor controlled Benghal dayflower 84% to 93% 28 d after early postemergence in peanut that was planted in May, but control was reduced to 58% to 78% in the crop that had been planted in June. Regardless of planting date, a preemeergence application fb *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence provided <80% sicklepod control 28 d after early postemergence. Imazapic + dimethenamid-*P* + 2,4-DB applied postemergence improved Benghal dayflower control to at least 94% 28 d after mid-postemergence, but sicklepod control was not >85%. Regardless of the planting date, paraquat + bentazon + *S*-metolachlor applied early postemergence was required to achieve ≥95% sicklepod control. However, herbicide combinations that included paraquat + bentazon + *S*-metolachlor reduced peanut yield when planting was delayed to June. In fields that are infested with Benghal dayflower and sicklepod, it is recommended that peanut be planted in early May to minimize the potential impact of these weeds and to increase peanut yield. Late-planted peanut required more intensive herbicide applications to obtain the same peanut yield as the May-planted peanut.

Introduction

In the southeastern United States, peanut crops are planted from mid-April to early June. The planting date can influence crop growth, alter the competition between the crop and weeds, and subsequently affect weed suppression, depending on soil moisture content and soil temperature (Kharel et al. 2022). Planting dates can be adjusted to allow the crop to compete with weeds when their density is lower, giving the crop a competitive advantage (Barnes and Oliver 2003). Combining cultural practices such as altering planting dates and herbicide combinations may improve weed control as components of an integrated weed management system. In previous research, sicklepod was less competitive with soybean (*Glycine max* L. Merr.) planted in May compared with soybean planted in June because of the temperature effect on sicklepod growth (Klingaman and Oliver 1994). Other results from studies evaluating the effect of peanut planting date on weed interference and control varied across years and weed species. In a 2-yr study, Kharel et al. (2022) found that sicklepod biomass was greater in peanut planted in May in one year but in June in another year, with differences between years attributed to variations in rainfall and soil temperature. Texas panicum (*Panicum texanum* Buckl.) control was greater when peanut was planted late (mid-June) compared with an earlier planting (i.e., early May) due to a decreased emergence of Texas panicum late in the season (Wehtje et al. 1986). In another study, Abouziena et al. (2013) reported a 44% reduction in the biomass of common lambsquarters (*Chenopodium album* L.) and large crabgrass (*Digitaria sanguinalis* L.) when peanut planting was delayed from mid-April to mid-May; however, yield from the mid-May planting was 20% lower than it was from the mid-April planting. Weed management decisions may change based on the dominant weed species as growers adjust planting dates to achieve higher yields.

Benghal dayflower and sicklepod are among the most troublesome dicotyledonous weeds in agronomic crop production throughout the southeastern United States (Webster et al. 2009; Webster and Sosnoskie 2010). These weeds interfere with crop growth, thereby reducing yield and harvest efficiency (Daramola et al. 2023a; Kharel et al. 2022; Stephenson and Brecke 2011). Both Benghal dayflower and sicklepod are difficult to control in peanut crops due to high seed production (>1,600 seeds plant^{-1}), extended emergence patterns (Senseman and Oliver 1993; Walker and Evenson 1985), and limited effective herbicide options (Daramola et al. 2023a; Webster and Sosnoskie 2010). In addition, sicklepod and peanut are members of the same plant family (Fabaceae), thus only a few selective herbicides are available for controlling this weed. The risk of yield loss due to competition from Benghal dayflower and sicklepod is high because peanut has a relatively shallow canopy and prostrate growth habit, which reduces its competitive ability (Webster et al. 2007). Additionally, peanut has a long growing season (4 to 5 mo) and is sown in a wide row spacing (91 cm), resulting in ample opportunities for weeds to occupy space and reduce productivity (Chaudhari et al. 2018). Sicklepod has been shown to reduce peanut yield by 22.3 kg ha^{-1} at a density of 1 plant 10 m^{-2} (Hauser et al. 1982), whereas Benghal dayflower reduced peanut yield by 10% when it was allowed to interfere for the first 4 wk, and by 51% with season-long interference (Webster et al. 2007). In the absence of adequate control measures, both species can form a canopy that shades peanut, thereby preventing fungicide deposition and causing greater yield loss (Hauser et al. 1975; Webster et al. 2007).

Weed management in peanut is overwhelmingly achieved with herbicides due to the high cost of hand-weeding and mechanical weeding, and the damaging effect they have on the peanut plant (Johnson et al. 2012). Because preemergence herbicides do not provide season-long weed control, successful weed management in peanut crops often requires a mixture of multiple modes of action and combinations of preemergence, early postemergence, mid-postemergence, and/or late postemergence herbicides with residual control (Chaudhari et al. 2018; Leon et al. 2019). Several postemergence herbicides including acifluorfen, bentazon, paraquat, imazapic, lactofen, and 2,4-DB are available for annual broadleaf weed control in peanut (Daramola et al. 2023b). However, no single herbicide provides the required level of Benghal dayflower and sicklepod control due to the weeds' extended emergence patterns. Acifluorfen and lactofen (protoporphyrinogen oxidase inhibitors), bentazon (a photosynthetic inhibitor), and 2,4-DB (a synthetic auxin) have low activity on Benghal dayflower and sicklepod, and thus do not provide effective control when applied alone (Ferrell et al. 2020). Imazapic, a herbicide that inhibits acetolactate synthase, provides 60% to 90% control of both species, depending on weed size at the time of application (Ferrell et al. 2020; Stephenson and Brecke 2011). However, crop rotational restrictions must be considered before choosing imazapic (Anonymous 2007). Paraquat, a nonselective photosynthetic inhibitor, provides 90% to 100% control of Benghal dayflower and sicklepod (Stephenson and Brecke 2011); however, it can cause peanut stunting and foliar injury, and this injury can interact with biotic or abiotic stress, resulting in yield reduction (Brecke et al. 1996). Additionally, paraquat lacks residual activity and can be applied only from peanut hypocotyl emergence until 28 d after emergence (Jordan et al. 2003). Hence, the objective of this study was to evaluate the effect of planting date and herbicide programs on Benghal dayflower and sicklepod control in peanut. We hypothesized that early planting with an application of residual and postemergence herbicides would improve Benghal dayflower and sicklepod control and increase peanut yield.

Materials and Methods

Experimental Site and Design

Field studies were conducted in 2022 and 2023 at the West Florida Research and Education Center in Jay, Florida (30.776542°N, 87.147662°W, 62 m a.s.l.). The soil at the experimental site was a Red Bay fine sandy loam (fine-loamy, kaolinitic, thermic Rhodic Kandiudults) with 2.1% organic matter, pH 5.6. The previous crop in both years was cotton (*Gossypium hirsutum* L.). In both years, the experimental area was tilled using a tractor-mounted moldboard plow to a depth of 8 cm, disked, and leveled before planting. The site was naturally infested with Benghal dayflower and sicklepod; however, sicklepod seeds obtained from Azlin Seed Service (Leland, MS) were spread at the rate of 300 m^{-2} (96% germination) in November of 2021 and 2022 to ensure uniform distribution for observation during the experiments in 2022 and 2023. Benghal dayflower and sicklepod were the predominant weeds throughout the study sites, but other weeds included barnyardgrass [*Echinochloa crus-galli* (L.) P. Beauv], Florida beggarweed (*Desmodium tortuosum* L.), ivyleaf morningglory [*Ipomoea hederacea* (L.) Jacq], and redroot pigweed (*Amaranthus retroflexus* L.). These species were not consistent enough throughout the study sites or years to be included in analysis. Weather data, including the monthly cumulative rainfall and average soil and air temperatures during the period of crop growth, are shown in Table 1.

The experimental design was a randomized complete block split plot with planting dates early (early May) or delayed (early June) as main plots and herbicide programs as subplots. Plots were 7.6 m long and 3.6 m wide with four rows 91 cm apart. Peanut ('Georgia-06G'; Branch 2007) was planted according to the planting date treatments (Table 2) at 20 seeds m^{-1} of crop row. Fertilizer, fungicide, insecticide, and gypsum were applied based on peanut production recommendations from the University of Florida Cooperative Extension Services (Wright et al. 2016). In addition to a nontreated control, nine herbicide programs were evaluated: three preemergence herbicides followed by (fb) an early postemergence + a residual herbicide; three preemergence herbicides fb two residual herbicides fb a mid-postemergence + one residual herbicide; and three preemergence herbicides fb a residual herbicide (Table 3). In both years, clethodim (Select Max; Valent USA Corporation, Walnut Creek, CA) was applied at 136 g ai ha^{-1} at 6 wk after planting to provide grass weed control. Herbicides were applied using a CO_2-pressurized backpack sprayer equipped with TeeJet TTI11002 nozzles (Spraying Systems Co., Glendale Heights, IL) and calibrated to deliver 140 L ha^{-1} spray volume at 4.8 km hr^{-1}.

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Table 1. Weather conditions at West Florida Research and Education Center during the experiment period in 2022 and 2023.[a]

	Precipitation			Average air temperature			Average soil temperature[b]		
	2022	2023	16-yr avg.	2022	2023	16-yr avg.	2022	2023	16-yr avg.
	mm			C			C		
May	253	108	135	24	23	23	23	23	23
June	106	343	202	27	25	26	27	26	27
July	262	84	212	27	27	27	26	27	28
August	197	42	149	27	28	27	26	29	29
September	10	149	125	26	24	24	24	25	25
October	20	30	122	21	19	21	18	19	18

[a]The 16-yr averages, for 2007 to 2023, were obtained from weather data maintained by the West Florida Research and Education Center.
[b]Average soil temperature a depth of 5 cm.

Table 2. Dates of field activities and treatments in field studies evaluating the effects of planting date and herbicide program on Benghal dayflower and sicklepod control in peanut near Jay, FL, in 2022 and 2023.

Field activities	2022	2023
May planting	May 3	May 1
June planting	June 2	June 2
Preemergence herbicide application for early planting	May 3	May 1
Preemergence herbicide application for delayed planting	June 2	June 2
Peanut emergence	May 12	May 9
Early postemergence herbicide application to early planting	June 3	June 2
Early postemergence herbicide application to delayed planting	July 1	June 30
Mid postemergence herbicide application to early planting	July 8	July 6
Mid postemergence herbicide in delayed planting	August 4	August 6
Peanut harvest, early planting	October 9	October 13
Peanut harvest, delayed planting	October 30	September 3

Table 3. Herbicide products, rates, and application timing for field experiment conducted near Jay, FL, in 2022 and 2023.

Herbicide	Trade name	Application timing	Rates	Manufacturer
			kg ai ha^{-1}	
Diclosulam	Strongarm®	Early postemergence	0.02	Dow AgroScience, Indianapolis, IN
Dimethenamid-*P*	Outlook®	Mid-postemergence	0.63	BASF Corporation, Research Triangle Park, NC
Flumioxazin	Valor® SX	Preemergence	0.06	Valent U.S.A. Corporation, Walnut Creek, CA
Fluridone	Brake®	Preemergence	0.16	SePRO, Carmel, IN
S-metolachlor	Dual Magnum®	Early postemergence	1.33	Syngenta Crop Protection, LLC, Greensboro, NC
Bentazon	Basagran	Early postemergence	0.33	Winfield Solutions, Research Triangle Park, NC
Imazapic	Cadre	Mid postemergence	0.07	BASF Corporation, Durham, NC
Paraquat	Gramozone® SL 3.0	Early postemergence	0.25	Syngenta Crop Protection, LLC, Greensboro, NC
2,4-DB	Butyric 200®	Mid-postemergence	0.25	Winfield United, Arden Hills, MN

Data Collection

Control ratings for Benghal dayflower and sicklepod following preemeergence, early postemergence, and mid-postemergence herbicide applications were accessed visually at 28 d after treatment on a scale of 0% to 100% (where 0% represents no injury and 100% represents complete death of the plant). Additionally, Benghal dayflower and sicklepod density were recorded 28 d after treatment by counting Benghal dayflower and sicklepod plants in two 0.5-m^2 quadrats placed randomly within the two middle rows of each plot. Benghal dayflower and sicklepod plants within each quadrat were harvested by clipping the plants at soil level. Peanut harvest timing was determined using the hull-scrape method (Williams and Drexler 1981), and yield was determined by harvesting the middle two rows of each plot. Peanut plants were dug using a conventional digger-shaker-inverter and allowed to air-dry in the field for 3 to 5 d. Yield was recorded at 10.5% moisture content using a grain moisture meter calibrated for peanut as recommended by Mulvaney and Devkota (2020).

Statistical Analysis

Data were analyzed using the GLIMMIX procedure with SAS software (version 9.4; SAS Institute Inc., Cary, NC). Initial analyses were performed on all dependent variables to determine the effect of year as a fixed effect. In these analyses, independent variables were year, planting date, and herbicide program. Year-by-planting pattern and year-by-herbicide program interactions were also evaluated, and if they were significant, data were presented separately for 2022 and 2023. Where year-by-planting date and year-by-herbicide program interactions were not significant, subsequent analyses were performed for the two years combined. For analyses by year, planting pattern, herbicide program, and

Table 4. Effects of planting date and herbicide programs on control and density of sicklepod at 28 d after herbicides were applied preemergence, early postemergence, and mid-postemergence, averaged over 2 yr from field experiments conducted near Jay, FL, in 2022 and 2023.[a–d]

	Evaluation timing											
Planting date	28 DAPRE		28 DAEPOST		28 MPOST		28 DAPRE		28 DAEPOST		28 DAMPOST	
	% Control						Density m^{-2}					
May	75	a	80	a	96	a	14	a	16	a	3	b
June	72	a	81	a	89	b	14	a	16	a	8	a
P-value	0.4		0.8		<.001		0.8		0.5		0.03	
Herbicide program												
Nontreated control	–		–		–		38	a	64	a	18	a
Fluridone fb paraquat + bentazon + *S*-metolachlor	69	b	96	a	98	a	16	b		C	1	c
Fluridone fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	67	b	69	b	87	b	15	b	12	b	8	b
Fluridone fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	69	b	63	b	85	b	16	b	17	b	6	b
Flumioxazin fb paraquat + bentazon + *S*-metolachlor	87	b	97	a	99	a	8	c	2	c	1	c
Flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	89	a	79	b	86	b	9	c	10	b	5	b
Flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	88	a	71	b	87	b	10	c	16	b	4	b
Fluridone + flumioxazin fb paraquat + bentazon + *S*-metolachlor	89	a	99	a	99	a	9	c	2	c	1	c
Fluridone + flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	89	a	77	b	87	b	8	c	12	b	5	b
Fluridone + flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	88	a	75	b	89	b	10	c	14	b	7	b
P-value	<.001		<.001		<.001		<.001		<.001		<.001	

[a]Abbreviations: DAPRE, days after preemergence; DAEPOST, days after early postemergence; DAMPOST, days after mid-postemergence; fb, followed by; MPOST, mid-postemergence; PRE, preemergence.
[b]Herbicides were applied PRE fb an EPOST application at 30 d after planting, or PRE fb EPOST at 30 d after planting fb MPOST at 60 d after planting.
[c]Visual efficacy/injury was determined based on a scale of 0% to 100%, where 0% = no control/no injury and 100% = complete control/plant death.
[d]Means (n = 2, 9) within a column followed by a different letter are significantly different at $\alpha \leq 0.05$.

their interactions were considered fixed effects, while replication and their interactions with fixed effects were considered random effects. For combined analyses, planting date, herbicide programs, and their interaction were considered fixed effects, while year, replication nested within year, and their interaction with fixed effects were considered random effects. Before ANOVA, all data were tested for homogeneity of error variances. Benghal dayflower and sicklepod densities needed square root transformation, and ANOVA was performed on the transformed data. Significant means were separated using Tukey's honest significant difference test at $P < 0.05$. Following treatment means separation, data were back-transformed for the presentation of results.

Results and Discussion

Effect of Planting Date and Herbicide Programs on Early Season Weed Control and Density Following Preemergence Herbicide Treatments

Year-by-planting date and year-by-herbicide program interaction were not significant for Benghal dayflower and sicklepod control; therefore, data were combined across both years. When assessed 28 d after preemergence, planting date did not affect sicklepod control (Table 4), but Benghal dayflower control was greatly reduced with delayed planting, when control from the May planting (98%) was approximately double that of the June planting (52%). Benghal dayflower density 28 d after preemergence was 6 plants m^{-2} after the May planting compared with 19 plants m^{-2} after the June planting (Table 5). This indicates that the number of Benghal dayflower plants emerging with peanut plants following preemergence herbicide applications increased as the planting date was delayed. The lower density of Benghal dayflower at the time of early season (May) measurement compared with that of later (June) planting is attributed to the late emergence pattern of Benghal dayflower (Ferreira et al. 1999). Webster et al. (2006) observed that most Benghal dayflower emergence occurred after June in cotton fields. Peanut is a poor early season competitor with weeds due to its relatively short canopy (Chaudhari et al. 2018); however, a May planting allowed the period of initial poor crop competition to occur before the peak of Benghal dayflower emergence, resulting in greater control.

Herbicide program had the most consistent effect on the control and density of Benghal dayflower and sicklepod. Control of sicklepod was less than 70% when fluridone was applied alone preemergence, whereas sicklepod control was 87% to 89% 28 d after flumioxazin alone was applied preemergence. Control was not improved when flumioxazin was mixed with fluridone (Table 4). These results are similar to those reported by Grey et al. (2002), who found that mixtures of flumioxazin with other residual herbicides such as dimethenamid-*P* and metolachlor, did not improve sicklepod control compared with flumioxazin alone. The density of sicklepod was at least 38% less following applications of flumioxazin or flumioxazin + fluridone relative to fluridone alone 28 d after preemergence (Table 4).

Benghal dayflower control ranged from 70% to 83% with flumioxazin + fluridone and flumioxazin alone providing greater control (81% to 83%) than fluridone alone (70% to 72%) 28 d after preemergence (Table 5). Flumioxazin applied alone and flumioxazin + fluridone reduced Benghal dayflower density by at least 60% relative to the nontreated control, whereas reduction in density with fluridone alone was not greater than 44% 28 d after preemergence (Table 5). To achieve adequate residual weed control, fluridone requires at least 1.3 cm of rain for activation (Anonymous, 2023). However, the total rain during the first week after the preemergence herbicide was applied did not exceed 1.0 cm. Hence, the reduced effectiveness of fluridone in 2022 may be attributed to the reduced amount of rain that was needed for

Table 5. Effects of planting date and herbicide programs on control and density of Benghal dayflower at 28 d after preemergence and mid-postemergence, averaged over 2 yr from field experiments conducted near Jay, FL, in 2022 and 2023.[a–d]

	Evaluation timing							
Planting date	28 DAPRE		28 DAMPOST		28 DAPRE		28 DAMPOST	
	% Control				Density m^{-2}			
May	98	a	99	a	14	a	16	a
June	52	b	96	a	14	a	16	a
P-value	<.001		0.2		0.8		0.5	
Herbicide program								
Nontreated control	–		–		27	a	23	a
Fluridone fb paraquat + bentazon + *S*-metolachlor	71	b	99	a	17	b	0 –	–
Fluridone fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	70	b	98	a	15	b	3	b
Fluridone fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	72	b	99	a	16	b	2	b
Flumioxazin fb paraquat + bentazon + *S*-metolachlor	81	a	98	a	9	c	0 –	–
Flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	83	a	94	a	10	c	4	b
Flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	82	a	96	a	8	c	4	b
Fluridone + flumioxazin fb paraquat + bentazon + *S*-metolachlor	82	a	99	a	11	c	0 –	–
Fluridone + flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	82	a	97	a	8	c	3	b
Fluridone + flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	83	a	99	a	7	c	2	b
P-value	<.001		<.001		<.001		<.001	

[a]Abbreviations: DAPRE, days after preemergence; DAMPOST, days after mid-postemergence; fb, followed by; MPOST, mid-postemergence; PRE, preemergence.
[b]Herbicides were applied PRE fb EPOST at 30 d after planting or PRE fb EPOST at 30 d after planting fb MPOST at 60 d after planting.
[c]Visual efficacy/injury was determined based on a scale of 0% to 100%, where 0% = no control/no injury and 100% = complete control/plant death.
[d]Means (n = 2, 9) within a column followed by a different letter are significantly different at $\alpha \le 0.05$.

activation. Hill et al. (2016) also reported reduced effectiveness of fluridone on Palmer amaranth (*Amaranthus palmeri* S. Wats.) in cotton due to inadequate moisture for activation.

Effect of Planting Date and Herbicide Programs on Mid-Season Weed Control and Density Following Early Postemergence Herbicide Treatments

Benghal dayflower control and density were affected by planting date, herbicide program, and the interaction of the two treatment factors 28 d after early postemergence. Regardless of the herbicide applied preemergence (flumioxazin, fluridone, or fluridone + flumioxazin), the planting date by herbicide program interaction showed a reduction in Benghal dayflower control in the absence of paraquat + bentazon + *S*-metolachlor applied early postemergence in the delayed planting (Table 6). A program of preemergence herbicide fb paraquat + bentazon + *S*-metolachlor applied early postemergence provided 95% to 99% control of Benghal dayflower in May and June plantings, respectively, 28 d after early postemergence. However, Benghal dayflower control in the absence of paraquat + bentazon + *S*-metolachlor applied early postemergence ranged from 81% to 93% in the May planting, but it was not greater than 78% in the June planting (Table 6). A preemergence herbicide fb *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence and a preemergence herbicide fb paraquat + bentazon + *S*-metolachlor applied early postemergence resulted in similar Benghal dayflower control in the May planting, but control with a preemergence herbicide fb an application of *S*-metolachlor or diclosulam + *S*-metolachlor was at least 22% lower relative to a preemergence herbicide fb an application of paraquat + bentazon + *S*-metolachlor in the June planting (Table 6).

Benghal dayflower density generally reflected the observed control. Regardless of the planting date, Benghal dayflower density in plots treated with a preemergence herbicide fb paraquat + bentazon + *S*-metolachlor applied early postemergence was ≤2 plants m^{-2} 28 d after early postemergence. However, Benghal dayflower density in plots treated with a preemergence herbicide fb residual herbicides *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence was 3 to 6 plants m^{-2} from the May planting, but that increased to 11 to 32 plants m^{-2} from the June planting (Table 6). The greater density of Benghal dayflower with the regimen of a preemergence herbicide fb *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence in the June relative to May plantings is related to the late emergence pattern of Benghal dayflower. The peak period of Benghal dayflower emergence possibly coincided with the period when the residual herbicides were still active in the soil for the May planting, which resulted in greater control relative to the June planting. In previous research *S*-metolachlor applied in late May at 1.6 kg ha^{-1} reduced the rate of Benghal dayflower emergence by 69% compared with an untreated control, providing at least 90% control 42 d after treatment in cotton (Webster et al. 2006), which is congruent with the results of the current study.

Sicklepod control and density at the time of mid-season measurements were affected only by herbicide programs. The program of a preemergence herbicide fb paraquat + bentazon + *S*-metolachlor applied early postemergence controlled sicklepod by 96% to 99% 28 d after early postemergence (Table 4). This agrees with previous research in which the combinations of diclosulam or flumioxazin applied preemergence fb paraquat + bentazon applied early postemergence provided >90% control of sicklepod (Brecke and Stephenson 2006; Grey and Wehtje 2005). The program of applying a preemergence herbicide fb *S*-metolachlor or diclosulam + *S*-metolachlor early postemergence provided 63% to 79% control of sicklepod 28 d after early postemergence (Table 4). Sicklepod density generally reflected the observed control. The density of sicklepod was ≤3 plants m^{-2} following an early postemergence application of paraquat + bentazon + *S*-metolachlor, whereas sicklepod density ranged from 10 to 17 plants m^{-2} following early postemergence applications of *S*-metolachlor or diclosulam + *S*-metolachlor

Table 6. Effects of planting date and herbicide program interaction on Benghal dayflower control and density at 28 d after an early postemergence herbicide application, averaged over 2 yr, and peanut yield from field experiments conducted near Jay, FL, in 2022 and 2023.[a–c]

Planting date	Herbicides program	Control		Density		Peanut yield 2022		Peanut yield 2023	
		%		Plants m^{-2}		kg ha^{-1}			
May	Nontreated control	–	–	22	c	2185	f	2075	i
	Fluridone fb paraquat + bentazon + *S*-metolachlor	95	a	1	g	5975	abcd	3567	cde
	Fluridone fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	87	abc	5	efg	5485	cde	2772	fgh
	Fluridone fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	89	abc	6	efg	5570	bcde	2656	h
	Flumioxazin fb paraquat + bentazon + *S*-metolachlor	98	a	1	g	6095	abc	3669	bcd
	Flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	93	ab	3	g	6275	abc	3703	abc
	Flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	81	bcd	9	def	6018	abc	2771	fgh
	Fluridone + flumioxazin fb paraquat + bentazon + *S*-metolachlor	98	a	1	g	6042	abcd	3884	abc
	Fluridone + flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	91	ab	5	efg	6168	abc	2684	gh
	Fluridone + flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	89	abc	5	efg	6420	a	3187	efg
June	Nontreated control	–		59	a	1965	f	1927	i
	Fluridone fb paraquat + bentazon + *S*-metolachlor	99	a	4	fg	4992	e	3091	efgh
	Fluridone fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	66	ef	15	cd	6335	ab	3604	cd
	Fluridone fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	67	ef	32	b	6048	abc	3652	bcd
	Flumioxazin fb paraquat + bentazon + *S*-metolachlor	100	a	1	g	5110	e	3080	efgh
	Flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	69	d	14	cd	6380	a	3829	abc
	Flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	58	f	19	c	6130	abc	3873	abc
	Fluridone + flumioxazin fb paraquat + bentazon + *S*-metolachlor	98	a	2	g	5325	de	3003	efgh
	Fluridone + flumioxazin fb diclosulam + *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	78	cde	11	de	6548	a	4203	a
	Fluridone + flumioxazin fb *S*-metolachlor fb imazapic + dimethenamid-*p* + 2,4-DB	58	f	20	c	6129	abc	4124	ab
	P-value	<.001		<.001		<.001		<.001	

[a]Abbreviations: EPOST, early postemergence; fb, followed by; MPOST, mid-postemergence; PRE, preemergence.
[b]Herbicides were applied PRE fb EPOST at 30 d after planting or PRE fb EPOST at 30 d after planting fb MPOST at 60 d after planting.
[c]Means (n = 2, 10) within a column followed by a different letter are significantly different at $\alpha \leq 0.05$.

(Table 4). Similar to Benghal dayflower control, the results indicate that regardless of planting date, the residual herbicides evaluated here would not be enough to provide adequate sicklepod control in peanut without timely application of a postemergence herbicide, such as paraquat. Previous researchers have emphasized the lack of effective residual herbicides for sicklepod control due primarily to its extended emergence pattern (Grey et al. 2002, 2003; Willingham et al. 2008).

Effect of Planting Date and Herbicide Programs on Late-Season Weed Control and Density Following Mid-Postemergence Herbicide Treatments

Planting date did not affect Benghal dayflower control or density at the time of late-season measurements, 28 d after mid-postemergence. The lack of significant planting date effect on Benghal dayflower late in the growing season was possibly due to the shading effect of peanut canopy on Benghal dayflower emergence and growth. Peanut achieved at least 86% canopy cover 28 d after mid-postemergence (data not shown) from both May and June plantings, which enhanced the suppression of the Benghal dayflower understory. Previous studies have shown that the emergence and growth of newly germinated Benghal dayflower seedlings is suppressed by closed crop canopy (Webster et al. 2005).

The effect of planting date on sicklepod control and density was significant only at the time of late-season measurements (Table 4). Averaged across herbicides, sicklepod control in the May planting was greater than control in the June planting 28 d after mid-postemergence (Table 4). The result on sicklepod density was generally consistent with sicklepod control observation. At 28 d mid-postemergence, sicklepod density increased from 3 to 8 plants m^{-2} when the May planting is compared with the June planting (Table 4). Although sicklepod exhibits a season-long emergence pattern (Teem et al. 1980), the greater late-season density of sicklepod in the June relative to the May planting may be because of higher temperatures, which affected sicklepod emergence and growth. Previous research showed that the intensity of sicklepod emergence increases as the growing season progresses and the soil warms up, with peak emergence between July and early August (Bararpour and Oliver 1998; Teem et al. 1980). Additionally, peanut planted in May had full canopy closure during the peak emergence period of sicklepod (July and early August), whereas peanut planted in June had only 86% canopy cover during the same time interval (data not shown), which may have contributed to increased sicklepod emergence and growth through light transmission to weeds in the understory (Nice et al. 2001). In previous research, Kharel et al. (2022) reported that the response of late-season sicklepod density to peanut planting dates was inconsistent, with environmental conditions favoring increased population and growth of sicklepod in the May planting in one year and the June planting in another year. However, results from the current study are similar to those reported by Barnes and Oliver (2003) who noted higher populations of sicklepod in soybean planted in June compared with a May planting date.

Imazapic + dimethenamid-P + 2,4-DB applied mid-postemergence improved sicklepod control to at least 85% following applications of preemeergence and early postemergence herbicides. However, a preemeergence herbicide fb an early postemergence application of paraquat + bentazon + *S*-metolachlor continued to provide greater sicklepod control (98% to 99%) 28 d after mid-postemergence (Table 4). At 28 d after mid-postemergence, sicklepod density in plots that received paraquat + bentazon + *S*-metolachlor early postemergence was just 1 plant m^{-2} compared with 4 to 8 plants m^{-2} in plots that received a preemeergence herbicide fb *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence fb imazapic + dimethenamid-P + 2,4-DB applied mid-postemergence (Table 4). The reduced control of sicklepod after an application of *S*-metolachlor fb imazapic + dimethenamid-P + 2,4-DB applied mid-postemergence may be due to the larger size of sicklepod at the time of mid-postemergence herbicide application. Sicklepod height at the time of mid-postemergence application ranged from 10 cm to 15 cm. De Moraes et al. (2020) reported a reduction in sicklepod control with imazapic applied alone or in a mixture with 2,4-DB when the plants were 15 cm tall compared with 8 cm.

Regardless of the residual herbicide applied preemeergence or early postemergence, Benghal dayflower control improved to at least 94% following a mid-postemergence application of imazapic + dimethenamid-P + 2,4-DB (Table 5). Regardless of planting dates, the density of Benghal dayflower was very low 28 d after mid-postemergence and did not differ among herbicide programs (Table 5). Herbicide programs that included paraquat + bentazon + *S*-metolachlor applied early postemergence completely eliminated Benghal dayflower 28 d after mid-postemergence (Table 5). Therefore, those treatments were excluded from the analysis to improve residual distributions due to lack of variance within the treatments. Herbicide programs that included fluridone, flumioxazin, or fluridone + flumioxazin applied preemeergence fb residual herbicides *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence fb imazapic + dimethenamid-P + 2,4-DB applied mid-postemergence reduced Benghal dayflower density to 2 to 4 plants m^{-2} compared with 23 plants m^{-2} in the nontreated control (Table 5).

Effect of Planting Date and Herbicide Programs on Peanut Yield

There was a significant effect of year-by-herbicide program interaction on peanut yield; therefore, the data are presented by year. There was no effect of planting date on peanut yield in either year; however, the effects of herbicide program and planting date-by-herbicide program interaction were significant in both years (Table 6). In both years, peanut yield from the May planting was generally greater when a preemeergence herbicide fb *S*-metolachlor or diclosulam + *S*-metolachlor was applied early postemergence fb imazapic + dimethenamid-P + 2,4-DB applied mid-postemergence, but yield was not always different from the regimen of a preemeergence herbicide fb paraquat + bentazon + *S*-metolachlor applied early postemergence. However, peanut yield from the June planting was consistently greater with the regimen of a preemeergence herbicide fb *S*-metolachlor or diclosulam + *S*-metolachlor applied early postemergence fb imazapic + dimethenamid-P + 2,4-DB applied mid-postemergence compared with preemeergence fb paraquat + bentazon + *S*-metolachlor early postemergence in both years (Table 6). Herbicide programs that included paraquat + bentazon + *S*-metolachlor produced lower peanut yields compared with herbicide programs that did not include paraquat + bentazon + *S*-metolachlor when planting was delayed to June in both years. Paraquat may have caused a yield reduction from peanut that was planted in June by causing delayed maturity because the vegetative growth and canopy of peanut were reduced following the application of paraquat + bentazon + *S*-metolachlor (data not shown). In the June planting, much of peanut pegging and fruit development likely occurred in the drier months of September and October, when the crop was less able to outgrow paraquat damage. Consequently, the potential for yield reduction from paraquat injury was greater in the June planting compared with the May planting because peanut pegging and pod development may have occurred in the relatively high rainfall months of July and August. Previous research has shown that paraquat can reduce peanut yield by reducing peanut growth and delaying maturity (Knauft et al. 1990). Additionally, reduced yield in June-planted peanut may be due to the shorter growing period coupled with a reduction in day length and growing degree days. Canavar and Kaynak (2010) attributed reduced yield in late-planted peanut to a shortened growing period and fewer growing degree days.

Practical Implications

Overall, this study showed that it is possible to suppress Benghal dayflower and sicklepod using residual herbicides at 28 d after planting, but not as a stand-alone weed management option. Due to the rapid growth and extended emergence pattern of these weed species, early postemergence herbicide application is important to ensure that the herbicides are applied to small weeds in a timely manner. Regardless of the planting date or residual herbicides used, an early postemergence application of paraquat + bentazon + *S*-metolachlor was required to provide ≥95% Benghal dayflower and sicklepod control at mid-season. Although a mid-postemergence application of imazapic + dimethenamid-P + 2,4-DB improved Benghal dayflower control to at least 94% late in the growing season, sicklepod control was less than 90% due to larger sicklepod plants being present at the time of mid-postemergence treatment, resulting in difficulty in peanut digging. The emergence pattern and growth of Benghal dayflower and sicklepod are not uniform and may change according to the environmental conditions in growing seasons. A practical implication is that weed management decisions, particularly the timing of herbicide application, may change based on the dominant weed species as growers adjust planting dates to achieve higher yields. Early planting (May) provided greater late-season control of Benghal dayflower and sicklepod than delayed planting (June) due to rapid peanut canopy closure before the late flush of emergence and establishment of Benghal dayflower and sicklepod. Therefore, It is recommended that peanut should be planted in early May in fields heavily infested with Benghal dayflower and sicklepod to minimize the potential impact of these weeds and to increase peanut yield. Growers might be able to reduce herbicide inputs and preclude mid-postemergence or late postemergence herbicide applications to peanut planted early compared with a late planting by using a preemeergence herbicide fb an early postemergence application of paraquat + bentazon + *S*-metolachlor. An early postemergence application of paraquat + bentazon + *S*-metolachlor to peanut planted in June provided effective Benghal dayflower and sicklepod control, but this combination of herbicides has the potential to reduce peanut yield. Peanut planted in June required multiple residual herbicides and postemergence herbicides to obtain a greater peanut yield than peanut planted in May due to the extended emergence of Benghal dayflower and sicklepod. Moreover, because less intensive weed management is necessary for early-planted peanut, the cost of weed management should be less than it would be for late-planted peanut. This is an example of the application of weed ecology knowledge to improve weed management.

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References

Abouziena HF, Abd El Wahed MSA, Eldabaa MAT, El-Desoki ER (2013) Effect of sowing date and reduced herbicides rate with additives on peanut (*Arachis hypogaea* L.) productivity and associated weeds. J Applied Sci Res 9: 2176–2187

Anonymous (2007) Cadre herbicide label. No. 241-364. Research Triangle Park, NC: BASF Corporation. 9 p

Anonymous (2023) Brake® product label. SePro Publication No. 67690-78. Carmel, IN: SePro Corporation. 6 p

Bararpour MT, Oliver LR (1998) Effect of tillage and interference on common cocklebur (*Xanthium strumarium*) and sicklepod (*Senna obtusifolia*) population, seed production, and seedbank. Weed Sci 46:424–431

Barnes JW, Oliver LR (2003) Cultural practices and glyphosate applications for sicklepod (*Senna obtusifolia*) control in soybean (*Glycine max*). Weed Technol 17:429–440

Branch WD (2007) Registration of 'Georgia-06G' peanut. J Plant Regist 1:120

Brecke BJ, Funderburk JE, Teare ID, Gorbet DW (1996) Interaction of early-season herbicide injury, tobacco thrips injury, and cultivar on peanut. Agron J 88:14–18

Brecke BJ, Stephenson DO IV (2006) Weed management in single- vs. twin-row peanut (Arachis hypogaea). Weed Technol 20:368–376

Canavar O, Kaynak MA (2010). Growing degree day and sunshine radiation effects on peanut pod yield and growth. Afr J Biotechnol 9:2234–2241

Chaudhari S, Jordan DL, Grey TL, Prostko EP, Jennings KM (2018) Weed control and peanut (*Arachis hypogaea*) response to acetochlor alone and in combination with various herbicides. Peanut Sci 45:45–55

Daramola OS, Iboyi JE, MacDonald GE, Kanissery RG, Singh H, Tillman BL, Devkota P (2023a) Competing with the competitors in an endless competition: a systematic review of non-chemical weed management research in peanut (*Arachis hypogea*) in the United States. Weed Sci. 71: 284–300

Daramola OS, Iboyi J, MacDonald G, Kanissery R, Tillman B, Singh H, Devkota P (2023b). A systematic review of chemical weed management in peanut (*Arachis hypogea*) in the United States: challenges and opportunities. Weed Sci 1–74

De Moraes JG, Prostko EP, Kruger GR, Rodrigues CC (2020) The influence of nozzle type and application speed on sicklepod control with cadre and butyrac. Crops Soils 53:3–7

Ferreira MI, Reinhardt CF (1999) The role of temperature in the germination of subterranean and aerial seeds of *Commelina benghalensis* L. S Afr J Plant Soil 16:165–168

Ferrell JA, MacDonald GE, Devkota P (2020) Weed management in peanuts: SS-AGR-03/WG008, rev. 05/2020. EDIS, 2020(3). Gainesville: University of Florida Institute of Food and Agricultural Sciences, Agronomy Department

Grey TL, Bridges DC, Eastin EF, MacDonald GE (2002) Influence of flumioxazin rate and herbicide combinations on weed control in peanut (*Arachis hypogaea*). Peanut Sci 29:24–29

Grey TL, Bridges DC, Prostko EP, Eastin EF, Johnson WC III, Vencill WK, Brecke BJ, MacDonald GE, Ducar JT, Everest JW, Wehtje GR (2003) Residual weed control with imazapic, diclosulam, and flumioxazin in southeastern peanut (*Arachis hypogaea*). Peanut Sci 30:22–27

Grey TL, Wehtje GR (2005) Residual herbicide weed control systems in peanut. Weed Technol 19:560–567

Hauser EW, Buchanan GA, Ethredge WJ (1975) Competition of Florida beggarweed and sicklepod with peanuts I. Effects of periods of weed-free maintenance or weed competition. Weed Sci 23:368–372

Hauser EW, Buchanan GA, Nichols RL, Patterson RM (1982) Effects of Florida beggarweed (*Desmodium tortuosum*) and sicklepod (*Cassia obtusifolia*) on peanut (*Arachis hypogaea*) yield. Weed Sci 33:602–604

Hill ZT, Norsworthy JK, Barber LT, Gbur E (2016) Residual weed control in cotton with Fluridone. J Cotton Sci 20:76–85

Johnson WC, Boudreau MA, Davis JW (2012) Cultural practices to improve in-row weed control with cultivation in organic peanut production. Weed Technol 26:718–723

Jordan DL, Spears JF, Wilcut JW (2003) Tolerance of peanut (*Arachis hypogaea*) to herbicides applied postemergence. Peanut Sci 30:8–13

Kharel P, Devkota P, Macdonald GE, Tillman BL, Mulvaney MJ (2022) Influence of planting date, row spacing, and reduced herbicide inputs on peanut canopy and sicklepod growth. Agron J 114:717–726

Klingaman TE, Oliver LR (1994) Influence of cotton (*Gossypium hirsutum*) and soybean (*Glycine max*) planting date on weed interference. Weed Sci 42:61–65

Knauft DA, Colvin DL, Gorbet DW (1990) Effect of paraquat on yield and market grade of peanut (*Arachis hypogaea*) genotypes. Weed Technol 4:866–870

Leon RG, Jordan DL, Bolfrey-Arku G, Dzomeku I, Korres NE, Burgos NR, Duke SO (2019) Sustainable weed management in peanut. Pages 345–366 *in* Korres NE, Burgos NR, Duke SO, eds. Weed Control: Sustainability, Hazards, and Risks in Cropping Systems Worldwide. Boca Raton, FL: CRC Press

Mulvaney MJ, Devkota P (2020) Adjusting crop yield to a standard moisture content: SS-AGR-443/AG442, 05/2020. EDIS, 2020(3). Gainesville: University of Florida Institute of Food and Agricultural Sciences, Agronomy Department. https://doi.org/10.32473/edis-ag442-2020

Nice GR, Buehring NW, Shaw DR (2001) Sicklepod (*Senna obtusifolia*) response to shading, soybean (*Glycine max*) row spacing, and population in three management systems. Weed Technol 15:155–162

Senseman SA, Oliver LR (1993) Flowering patterns, seed production, and somatic polymorphism of three weed species. Weed Sci 41:418–425

Stephenson DO IV, Brecke BJ (2011) Weed management in evenly-spaced 38- vs. 76-cm row peanut (*Arachis hypogaea*). Peanut Sci 38:66–72

Teem DH, Hoveland CS, Buchanan GA (1980) Sicklepod (*Cassia obtusifolia*) and coffee senna (*Cassia occidentalis*): geographic distribution, germination, and emergence. Weed Sci 28:68–71

Walker SR, Evenson JP (1985) Biology of *Commelina benghalensis* L. in south-eastern Queensland. 1. Growth, development and seed production. Weed Res 25:239–244

Webster TM, Burton MG, Culpepper AS, Flanders JT, Grey TL, York AC (2006) Tropical spiderwort (*Commelina benghalensis*) control and emergence patterns in preemergence herbicide systems. J Cotton Sci 10:68–75

Webster TM, Burton MG, Culpepper AS, York AC, Prostko EP (2005) Tropical spiderwort (*Commelina benghalensis*): a tropical invader threatens agroecosystems of the southern United States. Weed Technol 19:501–508

Webster TM, Faircloth WH, Flanders JT, Prostko EP, Grey TL (2007) The critical period of Bengal dayflower (*Commelina bengalensis*) control in peanut. Weed Sci 55:359–364

Webster TM, Grey TL, Flanders JT, Culpepper AS (2009) Cotton planting date affects the critical period of Benghal dayflower (*Commelina benghalensis*) control. Weed Sci 57:81–86

Webster TM, Sosnoskie LM (2010) Loss of glyphosate efficacy: a changing weed spectrum in Georgia cotton. Weed Sci 58:73–79

Wehtje G, McGuire JA, Walker RH, Patterson MG (1986) Texas panicum (*Panicum texanum*) control in peanuts (*Arachis hypogaea*) with paraquat. Weed Sci 34:308–311

Williams EJ, Drexler JS (1981) A non-destructive method for determining peanut pod maturity. Peanut Sci 8:134–141

Willingham SD, Brecke BJ, Treadaway-Ducar J, MacDonald GE (2008) Utility of reduced rates of diclosulam, flumioxazin, and imazapic for weed management in peanut. Weed Technol 22:74–80

Wright DL, Tillman B, Jowers E, Marois J, Ferrell JA, Katsvairo T, Whitty EB (2016) Management and cultural practices for peanuts. UF/IFAS Extension publication SS-AGR-74. Gainesville: University of Florida Institute of Food and Agricultural Sciences, Agronomy Department