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Impact of Clopyralid on Strawberry (*Fragaria* x *ananassa,* 'Festival') Growth and Yield

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Clopyralid is the only post emergent broadleaf herbicide registered for use in strawberry (*Fragaria ananassa*) in Florida. An experiment was conducted in 2013 to evaluate the impact of clopyralid rate (0, 140, 280, and 560 g·ha^{-1}) and application timing (10 and 19 December and 2, 16, and 30 January) on strawberry vegetative and reproductive growth. Two and four weeks after spraying there was a significant rate by application timing interaction (*P* = 0.0004 and 0.0013) on leaf number. Clopyralid applications on 10 and 19 December had no impact on leaf number whereas there was a 40% and 52% reduction in leaf number, respectively, compared to the untreated control if sprayed at 280 or 560 g·ha^{-1} on 2 January. Similar trends were observed when clopyralid was sprayed on 16 January. There was a significant interaction (*P* = 0.0227) between herbicide rate and application timing on berry yield. Lower yields were obtained at the highest herbicide rate compared to the untreated control when applied on 10 December. Clopyralid applications later in the season did not impact yield. We conclude that clopyralid applied at label rates may reduce leaf number but is unlikely to impact yield of strawberry.

In Florida, the majority of strawberries are grown in Hillsborough County during the winter months. Soils are typically fumigated in August or September and strawberries are transplanted in September or October and harvested from December through March. Nearly all production occurs on plasticulture production systems and relies predominately on drip irrigation. Weeds are major pests with broadleaf and grass species emerging between the raised beds (row middles) and from planting holes. Nutsedge species are especially problematic due to their ability to penetrate the plastic mulch. Growers rely on fumigation and pre-emergence herbicides for weed control as there are very few registered post emergence products in Florida.

During the winter months in Florida, black medic (*Medicago lupulina*) and Carolina geranium (*Geranium carolinianum*) are broadleaf weeds that emerge from the planting holes and compete with strawberry. Pre-emergence herbicides provide poor control of both species probably due in part to the early winter emergence period which is three to four months after pre-emergence herbicides are applied and strawberry are transplanted. Stinger® (active ingredient clopyralid) is the only post emergence herbicide registered for use in strawberry that adequately controls both species. McMurray et al. (1996) reported 83% control of black medic at 0.28 kg·ha^{-1} a.i. In Florida, Stinger has a 24(c) supplemental label on strawberry with an application rate of 1/3 to 2/3 pints/acre and a preharvest interval of 7 d.

Reports on the impact of clopyralid on strawberry have varied. Clay (1984) reported leaf damage with early applications, but no difference in yield; whereas applications on non-vigorous crops during flower initiation reduced yields by 16% to 30%. McMurray et al. (1996) reported less than 6% injury at rates up to 280 g·ha^{-1} a.i. (0.25 lb/acre a.i.) over a range of plant stages varying from 6–14 leaves in North Carolina. They reported no impact on yield. In Ohio, Figueroa and Doohan (2006) reported that clopyralid applications of 200 g·ha^{-1} (0.18 lb/acre) had greater yields than higher or lower application rates. The canopy cover six weeks after treatment was lower in the plots that received 400 g·ha^{-1} (0.36 lb/acre) when compared to the control and clopyralid rates of 25 and 50 g·ha^{-1} (0.022 and 0.045 lb/acre). In a greenhouse study in Florida, Hunnicutt et al. (2013) found 12% leaf malformation when Stinger was applied at 79 g·ha^{-1} (0.0703 lb/acre) across a range of cultivars. The efficacy of clopyralid on black medic and Carolina geranium is well established, but additional research is needed to better define the impact of application timing and rate on strawberry growth and yield.

Materials and Methods

An experiment was conducted in 2012–13 at the Gulf Coast Research and Education Center in Wimauma, FL, to evaluate the impact of clopyralid rate (0, 140, 280, and 560 g·ha^{-1} at 20 gpa) and application timing (10 and 19 Dec., and 2, 16, and 30 Jan.) on strawberry vegetative and reproductive growth. All beds were shaped and fumigated with 336 kg·ha^{-1} (300 lbs acre^{-1}) of C35 on 31 Aug. 2012. Beds were on 1.2 m (4 ft) centers and each bed had a height of 30.5 cm (12 inches) and a bed top of 66 cm (26 inches) wide. Plots were irrigated and fertilized as per industry standards. Each plot was 4.5 m (15 ft) long with 1.5 m (5 ft) buffers) with two rows of strawberries with each plant spaced 38 cm (15 inches) apart. The experiment was set up as a randomized complete block with four blocks. Clopyralid was applied using a handheld CO_2 pressurized sprayer at 0.24 MPa (35 psi) equipped with a single nozzle boom with a Teejet 8002VS nozzle.

The number of undamaged leaves, damaged leaves, flower buds, open flowers, and fruit were counted on the same 10 plants in each plot 2, 4, and 8 weeks after spraying (WAS). Ripe berries

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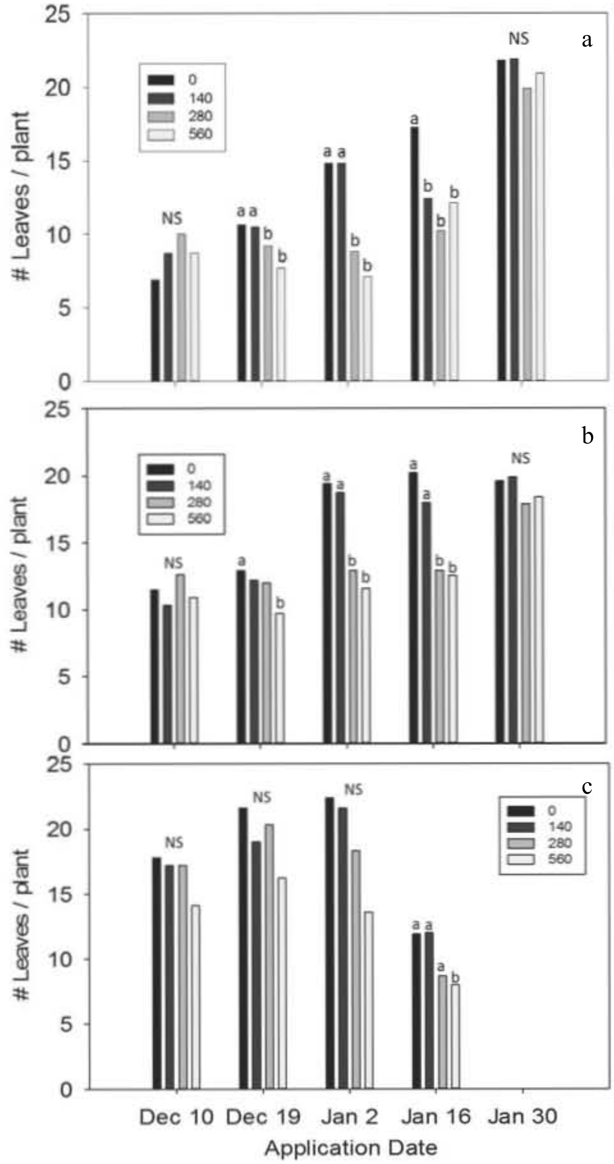

Fig. 1. Impact of clopyralid application rate (g·ha-1) and date on the number of undamaged leaves per plant two (a), four (b), and eight (c) weeks after spraying.

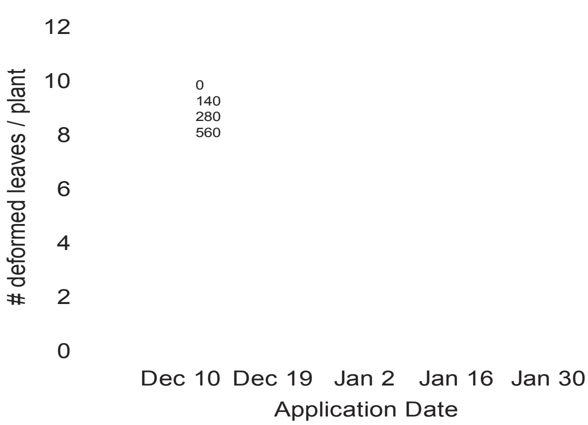

Fig. 2. Impact of clopyralid application rate (g·ha-1) and date on the number of damaged leaves per plant four weeks after spraying.

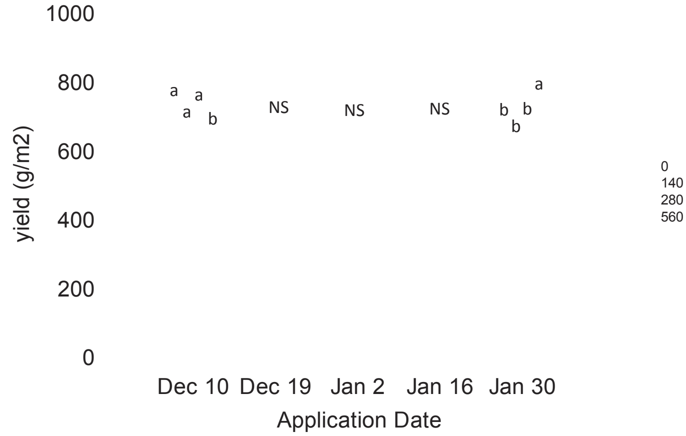

Fig. 3. Impact of clopyralid application rate (g·ha-1) and date on the total marketable yield.

were harvested twice per week and marketable and non-marketable berries weighed. The berry harvest ended when fruit quality began to decline as temperatures increased.

Data was analyzed in SAS using Proc Mixed with block as the random factor. Data were analyzed using the repeated statement in SAS with means compared using a Tukey adjustment. Data were transformed as necessary to meet model assumptions but arithmetic means are presented.

Results and Discussion

There was a significant herbicide rate by application timing interaction at 2 WAS ($P = 0.0004$), 4 WAS ($P = 0.0013$) but not 8 WAS ($P = 0.1268$) on the number of undamaged leaves (Fig. 1). Clopyralid rate had no impact on leaf number for plants sprayed on 10 Dec. and 30 Jan. On all other dates, 280 or 560 g·ha^{-1} of clopyralid significantly reduced leaf number by as much as 40% and 52%, respectively. Though not significant, similar trends were noted 8 WAS as well. The number of deformed leaves also tended to increase with rate on all application dates though the differences were much larger mid-season (Fig. 2).

There was a significant rate by application timing interaction ($P = 0.0227$) on total marketable yield. Clopyralid rate had no impact on yield on 19 Dec., 2 Jan., and 16 Jan. (Fig. 3). The highest application rate reduced yield by 14% on 10 Dec but increased overall yield when applied on 30 Jan. None of the label rates had an impact on yield. Overall, our results indicate that when clopyralid is applied at registered rates there may be a reduction in leaf number but this has no impact on yield unless applied very early in the season. Further research is needed to better understand the interaction between clopyralid and strawberry.

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