Fumigant Ratios and Combinations for Weed Control in Strawberry

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Summary

The fumigation combination selected by growers can have a significant impact on pest control and crop yield. In this study we found no effect of the ratio of chloropicrin and 1,3-dichloropropene on strawberry growth, berry yield or weed control. The lack of difference may be attributed to low pest pressure at the research sites. However, the use of supplemental K-Pam reduced purple nutsedge density and reduced yellow nutsedge tuber sprouting. The research further proves the benefits of adopting the Florida 3-way fumigation system which consists of the injection of a combination of chloropicrin and 1,3-dichloropropene followed by the injection of supplemental K-Pam.

Methods

Materials and Methods

An experiment was conducted in the fall of 2020 at the Gulf Coast Research and Education Center (27°N, 82°W) in Balm, Florida, to evaluate different fumigant ratios for weed control in Florida strawberry. A repeat of the experiment was conducted on a commercial strawberry field in Central Florida. Soil type at GCREC is a Myakka fine sand (Sandy, Siliceous Hyperthermic Oxyaquic Alorthod) with a pH of 6.45, 0.68% organic matter and 92, 5.2, and 2.8% sand, silt, and clay, respectively.

The experimental design at GCREC was a split-plot design set up in the field as a randomized complete block design with four blocks. The main-plot was the ratio of chloropicrin to 1,3-dichloropropene with all ratios applied at 250 lbs/acre (114 kg/acre). The ratios evaluated were; 1) a nontreated control, 2) Telone™ II (Corteva Agriscience Wilmington, DE), 3) Telone C-15, 4) Telone C-35, 5) Pic-Clor 60 (TriCal, Hollister, CA), 6) Pic-Clor 80, and 7) Tri-Pic 100. The sub-plot was the presence or absence of K-Pam® (AMVAC Chemical Corporation, Los Angeles, CA) injected through the drip tape at 60 gallons/acre (27 kg/acre). The exact same treatments were applied at the commercial site minus the K-Pam injections. Therefore, the experimental design at the commercial site was a randomized complete block design. At both sites, all beds were fumigated with a standard fumigation rig (Kennco Manufacturing, Ruskin, FL, USA) and covered with TIF plastic mulch (Berry Plastics) in late August, 2020. A single drip tape with emitters every 30 cm and a flow rate of 1.57 L min^{-1} was placed at the center of the bed just beneath the soil surface. At GCREC, the main plot was 2 beds (2.44 m) wide and 7.62 m long. The sub-plot was 7.62 m of a single raised bed. Beds were spaced 1.22 m apart and were 0.81 m at the base, 0.71 m wide at the top and 30.5 cm tall. Two rows of strawberry (cv Brilliance) were transplanted per bed with 38-cm spacing between plants on October 8, 2020. At the commercial site, the bed spacing and size were the same as GCREC but each plot was 91m of two strawberry beds. Strawberry plants (cv Odessa) were transplanted on October 15, 2020. At both sites, strawberries were irrigated, fertilized, and managed for foliar pests as per industry standards in the region.

Data Collection at GCREC

The number of purple nutsedge shoots that punctured the VIF plastic was counted within the planted area (22.9 meters of the bed) on October 7, 2020, January 4, and February 23, 2021. Soil moisture was measured on August 31, 2020. Twenty-five yellow nutsedge tubers were placed in 10 cm x 10 cm square organdy bags. One bag was buried 10 cm deep at the center of the bed in each plot on August 31, 2020. All bags were removed September 15, 2020. The number of yellow nutsedge tubers that germinated were recorded as a percentage of total tubers. Additional organdy bags of 25 seeds per bag of goose grass, cut leaf evening primrose and black medic were buried 10 cm deep in the center of each plot on August 31, 2020. All bags were removed September 15, 2020, seeds were rinsed with 1% sodium hypochlorite solution, air dried, placed in petri dishes and incubated at 25°C for 14 days. The number of seeds that germinated were recorded as a percentage of total seeds per bag. Broadleaf weeds and grasses growing in the planting holes were counted on January 4, and February 23, 2021. Strawberry plant injury where 0 is no injury and 100 represents complete desiccation was visually evaluated on October 15, October 22, November 5, 2020, January 4, and February 23, 2021. Strawberry plant mortality where 0 is no injury and 100 represents complete desiccation was visually evaluated on January 4, and February 23, 2021. Approximately 32 strawberry plants per plot were harvested bi-weekly from all plots from January 5 to late February 22, 2021. All fruit per plot were weighed for overall yield.

Data Collection at the Commercial Site

Crop Vigor was measured along the entire length of both beds using the greenseeker on November 13, January 8, 26, and February 4. The total number of weeds emerged in the planting holes were counted on January 8, January 26, and February 4. The number of dead plants in each plot were counted on January 8, January 26, and February 24.

Data Analysis

Data were analyzed using the Proc Mixed procedure in SAS (version 9.4; SAS Institute, Cary, NC). Block was considered a random variable.

Results

Strawberry Growth and Yield

Fumigant treatments had no effect on crop vigor or the number of dead plants at both sites. At GCREC, none of the chloropicrin (Pic) and 1,3-dichloropropene (1,3-D) ratios had an effect on the total strawberry yield (p=0.1695) nor did the presence or absence of K-Pam (0.4184). We conclude that in this trial, fumigant ratio or the presence or absence of K-Pam had no effect on crop growth or yield. This is likely due to the absence of intense pest pressure at the study location throughout the production year.

Weed Control

At GCREC, the application of Pic and 1,3-D reduced purple nutsedge densities in some plots but not others. The response to varying fumigant ratios was highly variable with no obvious trend whereas the use of supplemental K-Pam reduced nutsedge density by 50% (Tables 1 and 2). The effectiveness of supplemental K-Pam did not vary with Pic and 1,3-D ratio (p=0.2741). On the commercial, no differences in weed control were observed. These results are consistent with other trials that have frequently demonstrated inconsistent control of purple nutsedge with combinations of Pic and 1,3-D but increased control when the Florida 3-way was adopted. The Florida 3-way is defined as the injection of any Pic and 1,3-D ratio followed by the application of supplemental K-Pam typically applied near the surface of the bed. Broadleaf and grass densities were very low throughout the trial and no significant differences were observed with any treatments (Tables 1 and 2).

Black medic seed germination was not inhibited by fumigation (Table 3). In fact, germination increased by 73% when fumigated with Tri-Pic 100 compared to the nontreated control. Supplemental K-Pam also increased black medic germination by 49% (Table 4). Black medic seeds have a thick seed coat, and it is possible that scarification by Tri-Pic 100 and K-Pam caused the increased germination, but this cannot be proven with the data collected. Goosegrass seed germination following fumigation was not significantly different but tended to decrease at higher Pic rates (Table 3). Yellow nutsedge tuber sprouting was highly variable and as a result fumigation did not a significant effect (Table 3). However, combinations of Pic and 1,3-D tended to reduce tuber viability. Supplemental K-Pam consistently reduced yellow nutsedge tuber sprouting (Table 4).

We conclude that in this trial that none of the ratios of Pic and 1,3-D had a consistent effect on crop growth, berry yield, or weed control even when evaluated in large plots on commercial farms. This lack of difference can probably be attributed to low pest pressures. However, supplemental K-Pam reduced purple nutsedge density and inhibited yellow nutsedge tuber sprouting. This study is consistent with previous research in Florida which has demonstrated the benefits of adopting the Florida 3-way fumigation system.

Table 1. Effect of Chloropicrin and 1,3-dichloropropene ratio on purple nutsedge density penetrating the plastic mulch as well as broadleaf and grass weeds emerging in the planting holes in a strawberry field at GCREC in 2019-2020.

Fumigant	Nutsedge	Broadleaf	Grass
	---#/m^2---	----------#/plot----------	
Nontreated	4 a[1]	3	0
Telone II	3 c	3	1
Telone C-15	7 a	3	0
Telone C-35	2 c	4	1
Pic Clor-60	3 c	3	0
Pic Clor-80	4 a	2	0
Tri-Pic 100	2 c	3	0
P value	0.0115	0.8563	0.6879

[1]Numbers followed by different letters are significantly different at p<0.05.

Table 2. Effect of the presence or absence of K-Pam on purple nutsedge density penetrating the plastic mulch as well as broadleaf and grass weeds emerging in the planting holes in a strawberry field at GCREC in 2019-2020.

Fumigant	Nutsedge	Broadleaf	Grass
	---#/m^2---	----------#/plot----------	
No K-Pam	4 a[1]	3	0
K-Pam	2 b	3	1
P value	0.0013	0.7579	0.1201

[1]Numbers followed by different letters are significantly different at p<0.05.

Table 3. Effect of Chloropicrin and 1,3-dichloropropene ratio on the germination of black medic and goosegrass seeds and the sprouting of yellow nutsedge tubers buried in the raised beds prior to fumigation in a strawberry field at GCREC in 2019-2020.

Fumigant	Black medic	goosegrass	Yellow nutsedge
	---------------------------%---------------------------		
Nontreated	14 b[1]	4	27
Telone II	25 b	1	2
Telone C-15	23 b	1	7
Telone C-35	23 b	0	14
Pic Clor-60	24 b	0	2
Pic Clor-80	32 b	0	7
Tri-Pic 100	52 a	0	10
P value	0.0172	0.1686	0.3738

[1]Numbers followed by different letters are significantly different at $p<0.05$.

Table 4. Effect of the presence or absence of K-Pam on the germination of black medic and goosegrass seeds and the sprouting of yellow nutsedge tubers buried in the raised beds prior to fumigation in a strawberry field at GCREC in 2019-2020.

Fumigant	Black medic	Goosegrass	Yellow nutsedge
	--------------------------%---------------------------		
No K-Pam	19 b[1]	1	17 a[1]
K-Pam	37 a	1	3 b
P value	0.0013	0.7668	0.0223

[1]Numbers followed by different letters are significantly different at $p<0.05$.

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