North Florida Research and Education Center
Suwannee Valley

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Effect of 1,3-Dichloropropene and Chloropicrin on Purple Nutsedge (Cyperus Rotundus L.) Control Under Two Mulches & Two Application Methods during the Spring of 2002[1]

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Abstract. **Purple nutsedge (*Cyperus rotundus L.*) and yellow nutsedge (*Cyperus esculentus* L.) are serious problems in much of the vegetable production area of North Florida. Methyl bromide has traditionally provided excellent control of nutsedge in field plasticulture systems in Florida. This trial was conducted to evaluate alternative fumigants to methyl bromide due to the proposed phase out of methyl bromide in 2005. Plots were established in the spring of 2002 on Lakeland fine sand near Live Oak, Florida. The experimental design was a split plot with soil fumigants assigned to main plots and polyethylene mulch types to subplots. Fumigant and mulch treatments were applied on 6 March 2002. Three soil fumigant treatments were evaluated in the trial: (1) no fumigant, (2) 1,3-Dichloropropene plus chloropicrin soil injected, and (3) 1,3-Dichloropropene plus chloropicrin chemigated via drip tape. The two polyethylene mulch treatments included; (1) standard high density polyethylene, and (2) a virtually impermeable film (VIF). Purple nutsedge populations were totally controlled when 1,3-Dichloropropene plus chloropicrin via drip tape chemigation or via soil injection was used with VIF film. When high density polyethylene mulch was used, nutsedge populations were reduced by both 1,3-Dichloropropene plus chloropicrin treatments when compared to the untreated plots. Soil gas concentrations of 1,3-Dichloropropene were consistently higher in soil under VIF than high density polyethylene mulch plots from 5 to 15 days after application.**

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The use of polyethylene mulch, drip irrigation, and the soil fumigant methyl bromide have all been important components in the cultural practices used by successful vegetable growers in Florida (Maynard and Olson, 2001; Overman and Jones, 1984; Overman and Martin, 1978). The US Congress has legislated the phase-out of methyl bromide in the US by 2005. Researchers in the US have been searching for effective alternatives to methyl bromide in plasticulture systems.

One soil fumigant, 1,3-Dichloropropene (1,3-D) = chloropicrin (pic) has been widely tested in Florida as a possible alternative to methyl bromide (Gilreath et al., 1994; Gilreath et al., 1997; Gilreath et al., 1999; Jones et al., 1995; Locascio et al., 1997; Locascio et al., 1999; McSorley and McGovern, 1996; Stall, 1994; Stall and Gilreath, 1996). Nutsedge (*Cyperus esculentus, C. rotundus*) is common in vegetables crops in Florida and both species are very difficult to control. Methyl bromide has provided excellent control in past plasticulture systems. Recent research with 1,3-D + pic has shown promise when used in conjunction with virtually impermeable polyethylene films (Hochmuth et al., 2002; Nelson et al., 2000; Wang et al., 1997). This study was conducted to evaluate the effectiveness of controlling purple nutsedge (*C. rotundus*) when using 1,3-D and pic under two polyethylene mulches and two methods of application.

Materials and Methods

Plots were established in the spring of 2002 on a Lakeland fine sand at the North Florida Research and Education Center – Suwannee Valley near Live Oak, Florida. The soil was prepared by rototilling to a depth of eight inches. Beds were formed on 5-ft centers and were fertilized with 500 lbs/A of 13-1.7-10.8 (N-P-K) as they were formed. Plots were arranged in a randomized split plot design with four replications. Main plots were soil fumigants and split plots were plastic mulch types. All fumigant and mulch treatments were applied on 6 March 2002.

The soil fumigant treatments were: no fumigant (untreated), 61.1% 1,3-D and 34.7% pic (Telone C-35®, Dow AgroSciences LLC, Indianapolis, IN), and 60.8% 1,3-D and 33.3% pic (InLine®, Dow AgroSciences). 1.3-D + pic (Telone C-35) soil injected was applied at 35 gal/acre (gpa) to plots via pre-bedder application rig (Mirusso Fumigation, Boynton Beach, FL). 1,3-D + pic was applied via 3 chisels per bed, 12 inches apart and 14 inches deep. Mulch treatments were applied to 1,3-D + pic soil injected plots within 5 hours of application to soil. 1,3-D + pic (InLine) was applied via the drip irrigation system under the applied mulches at the rate of 35 gpa calculated based on the treated area under the mulch.

Mulch treatments were high density white-on-black (0.75 mil), black side up polyethylene (Sonoco, Charleston, SC) or virtually impermeable polyethylene film white-on-black (0.75 mil), black side up (Hytibarrier) (Kerk's, Richburg, SC). Each mulch plot was 200 ft long. Final pressed beds were 32 inches wide and 6 inches high. Each bed had one drip irrigation tape laid in a one-inch-deep groove in the bed center. The drip tape (Roberts RoDrip, San Marcos, CA) had emitters at 12-8inch spacing and a flow rate of 24 gal/hr/100 ft. The 1,3-D + pic via drip irrigation was applied using nitrogen gas as the propellant metering devices (Dow AgroSciences). Treatment was delivered over a total time of 240 minutes at 1324 ppm of 1,3-D + pic.

Beginning five days after application of all treatments (11 March 2002), soil temperatures and gas traces of 1,3-D were recorded. Concentrations of 1,3-D were determined by sampling the air in the soil four inches deep using a sampling tube (Gas Tech) sensitive to 1,3-D. The bed center sample was taken next to the drip tape in the bed center and bed edge samples were taken two inches from the bed shoulder. Soil temperature and gas concentration data were collected between 1 and 2 pm on 11, 12, 15, 18, and 21 March 2002 (corresponding to 5, 7, 9, 12, and 15 days after treatment (DAT), respectively).

Purple nutsedge (*Cyperus rotundus* L.) counts were taken in each plot on 21 March and 2 April 2002. Data are presented as number of purple nutsedge per 30 feet of mulched bed top (15 and 27 days after treatment, respectively). Data were analyzed by analysis of variance and mean separation was by Duncan's Multiple Range Test.

Results and Discussion

Purple nutsedge populations were controlled when 1,3-D + pic via drip tape or soil injected was used with VIF film (Table 1). When these combinations were used, nutsedge populations were totally controlled for 27 days after treatment.

When high density mulch was used, nutsedge populations were reduced by both 1,3-D + pic treatments when compared to the untreated plots. The soil injection of 1,3-D + pic (29 plants per 30 ft of bed) was significantly better for nutsedge control than 1,3-D + pic via the drip tape (112 plants per 30 ft of bed) after 15 days. The same trend was found in the high density mulch plots after 27 days.

Soil gas concentrations of 1,3-D were consistently higher with VIF than high density mulched plots (Table 2). Within VIF mulch plots, both in the bed center or edge, the 1,3-D gas concentrations were either similar between soil injected and drip application; or were higher when 1,3-D was applied via drip tape. This trend was also similar under high density mulch plots. By 5 DAT, the concentrations of 1,3-D had dropped to 100 ppm or lower with all treatments under high density mulch, whereas under VIF mulch, concentrations were still ranging between 271 and 500 ppm (Fig 1). Soil concentrations of 1,3-D did not drop below 100 ppm under any VIF mulch fumigated plot until 15 DAT.

Soil temperatures at 4-in depth were significantly higher under VIF mulch on 4 of the 5 dates (Table 3). Only the temperature measurements taken on 13 March were similar between high density and VIF. The temperatures on 13 March were the lowest of the 5 dates. The mean temperature over all dates was 94^{o} for VIF and 89^{o} for high density film.

Spring applications of 1,3-D + pic in this trial were successfully used to control purple nutsedge populations; however, several cultural practices were important. The rate of the 1,3-D + pic used in this study was 35 gallons per treated area. When 1,3-D + pic was soil injected or was chemigated via drip tape, excellent nutsedge control was achieved only when the mulch was VIF. Nutsedge control was poor with these same fumigation treatments under standard high density film. One drip tape was sufficient in this trial for excellent nutsedge control in the 32-inch wide beds covered with VIF mulch. Further studies are suggested to duplicate this work. Successful control of nutsedge with 1,3-D + pic via drip tape may be related to soil temperatures after application. Research on this technique is needed when soil temperatures are higher than in this trial.

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Table 1. Effect of soil fumigant, method of application, and mulch type on purple nutsedge (_Cyperus rotundus_) populations on two dates after treatment (DAT)[z].

Mulch Type	Fumigant	Method of Application	Purple Nutsedge (No/30 bed ft) 15 DAT	Purple Nutsedge (No/30 bed ft) 27 DAT
High Density	1,3-D + pic	Via Drip	112 b[z]	358 b
High Density	1,3-D + pic	Soil Injection	29 c	87 c
High Density	None	N/A	297 a	713 a
VIF	1,3-D + pic	Via Drip	0 b	0 b
VIF	1,3-D + pic	Soil Injection	0 b	0 b
VIF	None	N/A	380 a	931 a

[z] Interaction is significant and mean separation within mulch by Duncan's Multiple Range Test at the 5% level.

Table 2. Effect of soil fumigant, method of application, and mulch type on gas concentrations of 1,3-Dichloropropene on the center and the edge of the bed (beds were 32-inches wide) over time.

Days After Treatment [z]	Mulch Type [y]	Method of Application [x]	Level of 1,3-D Concentration (ppm) [w]			
			Bed Center		Bed Edge	
5	HD	Soil Injected	56	b	33	a
5	HD	Via Drip	104	a	40	a
5	VIF	Soil Injected	405	a	271	a
5	VIF	Via Drip	500	a	385	a
7	HD	Soil Injected	21	a	13	a
7	HD	Via Drip	10	a	5	a
7	VIF	Soil Injected	133	a	114	a
7	VIF	Via Drip	189	a	139	a
9	HD	Soil Injected	0	a	8	a
9	HD	Via Drip	8	a	4	a
9	VIF	Soil Injected	146	b	130	b
9	VIF	Via Drip	284	a	266	a
12	HD	Soil Injected	0	a	0	a
12	HD	Via Drip	1	a	0	a
12	VIF	Soil Injected	160	b	106	a
12	VIF	Via Drip	215	a	156	a
15	HD	Soil Injected	0	a	0	a
15	HD	Via Drip	0	a	0	a
15	VIF	Soil Injected	28	a	8	a
15	VIF	Via Drip	55	a	30	a

[z] Treatment date was 6 March 2002.

[y] Mulch type was either: HD=Sonoco high density polyethylene film white-on-black (0.75 mil) with the black side up, or VIF=Virtually impermeable film (1.4 mil) Hytibarrier Film.

[x] Method of application was soil injected using Telone C-35, or via drip using Inline. Both used mixtures of 1,3-D + pic.

[w] Levels of 1,3-D were determined by sampling the air in the soil bed four inches deep.

Within each date and within each mulch type, mean gas concentration readings followed by different letters are significantly different according to Duncan's Multiple Range Test at the 5% level.

The interaction date *mulch type* method of application was significant for center ($p<0.01$) and edge ($p>0.01$) measurements. Therefore, data were analyzed by date separately. The significance of the interaction mulch type * method of application was 0.23, 0.01, 0.01, and 0.05 for measurement at the center of the bed, and 0.01, 0.26, 0.01, 0.03, and 0.05 for measurement at the edge of the bed for dates 11, 13, 15, 18, and 21 March respectively. Therefore within each date, data were re-analyzed by mulch type separately.

Table 3. Effect of mulch type on soil temperature on several dates.

Date	Soil Temperature (°F)[z]			
	HD[y]		VIF[y]	
11 March	81	b[z]	91	a
13 March	68	a	69	a
15 March	98	b	101	a
18 March	106	b	112	a
21 March	91	b	95	a
Mean for all Dates	89		94	

[z] Soil temperatures were measured at 4 inches deep at the bed center at 1-2 pm each day.

[y] Mulch type was either HD=Sonoco high density polyethylene (0.75 mil) white-on-black with the black side up; or VIF=Hytibarrier virtually impermeable film (1.4 mil) white-on-black with black side up.

[x] Soil temperature between the two mulches for the same date were significantly different if the letter following the means are different ($p \leq 0.05$).