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EFFECT OF INCORPORATION METHOD ON PEBULATE EFFICACY UNDER POLYETHYLENE MULCH IN TOMATO[1]

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Abstract. **Pebulate incorporation methods were compared for purple nutsedge (*Cyperus rotundus* L.) control and tomato (*Lycopersicon esculentum* Mill.) response when applied with and without soil fumigation with a mixture of 1,3-dichloropropene and chloropicrin in the spring of 1996. Pebulate was incorporated into the soil with a rototiller, disk, or field cultivator (S-tine harrow with rolling crust breakers) prior to bed preparation and fumigation to determine if one method of incorporation was superior to the others in terms of nutsedge control. Initially, nutsedge control was improved by the addition of soil fumigant; however, by late season there was no difference in the nutsedge population in fumigated versus nonfumigated plots. Combination of pebulate with fumigant improved nutsedge control. There was no difference in nutsedge control with the three incorporation methods evaluated. Tomato plant vigor and fruit production were greater in plots receiving fumigant with no differences observed among incorporation methods in this study.**

Weed control, especially purple nutsedge control, has been demonstrated to be one of the most important limitations for any of the currently available fumigant alternatives to methyl bromide in polyethylene mulched tomato production (Gilreath et al., 1994). Therefore, for a fumigant alternative to be successful, it will require the addition of a herbicide for nutsedge control, which may, in turn, require additional equipment and time during the field and bed preparation stage. Pebulate provides good nutsedge control in both mulched and nonmulched tomatoes (Burgis, 1973; Brown, 1983; Gilreath et al., 1994). Early work with pebulate indicated that thorough soil incorporation improved efficacy and reduced phytotoxicity (Colbert, 1974) and the Tillam (pebulate) product label specifies this (Chemical & Pharmaceutical Press, 1995), due to the volatile nature of the compound (Weed Sci. Soc. of Amer., 1983). General recommendations for pebulate incorporation specify thorough incorporation immediately after application. Directions for preplant applications specify the use of power-driven cultivation equipment or a tandem disk, followed by a spike tooth harrow, with disking performed twice at right angles (cross disking). Rototiller incorporation of pebulate followed by soil injection of 1,3-dichloropropene + 17% chloropicrin (Telone C-17) has provided good nutsedge control in mulched tomato, usually as good as methyl bromide applied alone (Gilreath et al., 1994). Most tomato growers do not have rototillers with which they could incorporate pebulate. Although bed preparation equipment is available which includes a rototiller in the mouth of the bedder, the addition of the rototiller requires more horsepower, thus a larger tractor, than would be required for a typical bedder. Cultivation equipment which is readily available on farms typically consists of a disk and a field cultivator, also referred to as an S-tine harrow with small sweeps on it and crust and trash breaker rolling cages on the rear. Disking at right angles is virtually impossible due to the presence of field ditches for irrigation and drainage. Time constraints in land preparation, especially between the fall and spring seasons in west central Florida, dictate that operations proceed quickly and that a minimum amount of equipment be involved. Addition of an extra step or more equipment in the land and bed preparation phases

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would require more time and might require additional tractors at a time when all existing tractors are already in use. Adoption of any fumigant alternative program would be best facilitated by easy or minimal change of equipment and operations. Therefore, research was conducted in the spring of 1996 to determine if uni-directional incorporation of pebulate with one pass of a disk or field cultivator, followed by bed preparation with a typical bedder, would provide purple nutsedge control equivalent to incorporation with a tractor-powered rototiller prior to bed formation and if the addition of 1,3-dichloropropene + chloropicrin improved nutsedge control.

Materials and Methods

An area heavily infested with purple nutsedge was chosen for the test site at the Gulf Coast Research and Education Center in Bradenton, FL. The soil in the test area was an EauGallie fine sand with 0.78% organic matter and a pH of 7.1. The crop was irrigated by subsurface delivery of water through a semi-enclosed system with irrigation being supplied all the time, except during and immediately after rainfall events. Fertility was supplied by in-bed (30% of total) and banded application of fertilizer (18-0-21, N-P-K) provide a total of 220 lb of N per acre. Treatments (Table 1) consisted of pebulate (4 lb.a.i./acre) incorporated 6 inches deep with a 5 ft disk, a 6 ft field cultivator, or a tractor-powered rototiller immediately after application to the soil surface, with and without C-17 (35 gal/acre), C-17 applied alone, and no C-17 or pebulate. Treatments were assigned to 40 ft single row plots arranged in a randomized complete block design and were replicated six times. The experiment was conducted as a 2 by 4 factorial experiment with two levels of C-17 (none and 35 gal/acre) and four incorporation methods of pebulate (none, disk, rototill, cultivator). All pebulate was applied prior to preparation of beds using a tractor mounted sprayer with a three nozzle boom (8004 flat fan nozzle) and a delivery rate of 56.1 gal/acre. A separate tractor followed immediately behind the sprayer and incorporated the pebulate with the appropriate implement. Once all pebulate treatments were applied, beds (7 inches tall, 30 inches wide, spaced 5 ft apart on center) were formed with a typical commercial bedder (Superbedder, Kennco Mfg., Ruskin, FL) and C-17 was injected 8 inches below the soil surface through three back swept knives using nitrogen gas as the propellant. The delivery rate was controlled by a 0.85 gal/minute (C-17 rate at 100% of flow) flow meter and a ground speed of 3 mph. Pebulate and C-17 were applied on 15 Feb 1996 and beds were covered with 1.5 mil thick, black polythylene mulch film immediately after injection of the fumigant. Soil moisture averaged approximately 16% by weight at the time of application. Twelve 'Sunbeam' tomato plants were planted 1.5 ft apart in each plot on 15 March 1996, four weeks after treatment application.

Tomato plant vigor was evaluated three and six weeks after planting using a percentage scale wherein all plants in all plots were compared to the best plot within the test for overall vigor, including plant height and width and other growth characteristics. The tomato harvesting season was brief as a result of accelerated maturity due to the high temperatures experienced during harvest time; therefore, mature green or more mature tomatoes were harvested once, graded, counted, and weighed. Purple nutsedge populations were monitored by counting the number of live plants per square ft in four 1 square ft samples per plot four, eight and twelve weeks after treatment application. Data were subjected to analysis of variance. Single degree of freedom orthogonal contrasts were made for the effect of the variables for which the experiment was designed.

Results and Discussion

Application of either C-17 or pebulate reduced the population of purple nutsede initially, but only pebulate had a season-long effect (Table 1). In fact, by eight weeks after application C-17 had no effect on nutsedge population and by twelve weeks significantly more nutsedge was present where C-17 was applied alone than where the soil was not treated with either fumigant or herbicide. Thus, combination

Table 1. Effect of C-17, pebulate and pebulate application method on nutsedge control in 'Sunbeam' tomatoes four, eight, and twelve weeks after application. Bradenton, FL, Spring 1996.

C-17	Pebulate	Tillage method	Number of nutsedge plants/sq. ft. 4 weeks	8 weeks	12 weeks
-	-	none	7.4	10.0	9.8
-	+	rototill	3.0	8.2	7.3
-	+	disk	4.0	8.0	9.6
-	+	cultivator	3.0	7.6	6.9
+	-	none	2.4	12.5	17.3
+	+	rototill	0.5	5.1	7.0
+	+	disk	0.4	4.2	5.8
+	+	cultivator	0.9	6.4	9.4
Single degree of freedom contrasts'					
C-17 vs. no C-17			**	ns	**
Pebulate vs. no pebulate			**	*	*
Disk vs. cultivator			ns	ns	ns
Rototiller vs. disk and cultivator			ns	ns	ns
C-17 + pebulate vs. C-17			ns	*	*

' *,**Denotes contrasts significant at the 0.05, 0.01 probability levels, respectively.
ns denotes not significant.

Table 2. Effect of C-17, pebulate and pebulate application method on vigor of 'Sunbeam' tomato plants three and six weeks after planting. Bradenton, FL, Spring 1996.

C-17	Pebulate	Tillage method	Vigor (%) 3 weeks	6 weeks
-	-	none	85	78
-	+	rototill	83	78
-	+	disk	86	81
-	+	cultivator	88	81
+	-	none	96	87
+	+	rototill	94	88
+	+	disk	92	87
+	+	cultivator	96	85
Single degree of freedom contrasts'				
C-17 vs. no C-17			**	**
Pebulate vs. no pebulate			ns	ns
Disk vs. cultivator			ns	ns
Rototiller vs. disk and cultivator			ns	ns
C-17 + pebulate vs. C-17			ns	ns

' *,**Denotes contrasts significant at the 0.05, 0.01 probability levels, respectively.
ns denotes not significant.

Table 3. Effect of C-17, pebulate and pebulate application method on total marketable yield of 'Sunbeam' tomatoes. Bradenton, FL, Spring 1996.

			25-lb boxes per acre			
C-17	Pebulate	Tillage method	Extra large	Large	Medium	Total
-	-	none	1084	590	561	2236
-	+	rototill	972	523	538	2035
-	+	disk	1191	538	498	2224
-	+	cultivator	1142	558	567	2267
+	-	none	1146	635	577	2358
+	+	rototill	1262	863	554	2679
+	+	disk	1067	631	577	2275
+	+	cultivator	1171	709	608	2488
Single degree of freedom contrasts'						
C-17 vs. no C-17			ns	**	ns	**
Pebulate vs. no pebulate			ns	ns	ns	ns
Disk vs. cultivator			ns	ns	ns	ns
Rototiller vs. disk and cultivator			ns	ns	ns	ns
C-17 + pebulate vs. C-17			ns	ns	ns	ns

' *,** Denotes contrasts significant at the 0.05, 0.01 probability levels, respectively.
ns denotes not significant.

of pebulate with C-17 was not important initially, but from eight weeks after application until the end of the season, the addition of pebulate was necessary to provide some reduction in nutsedge population density. The method of incorporation of pebulate was not important in this study as the use of a disk or a field cultivator performed as well as a rototiller.

Application of C-17 improved the vigor of tomato plants in this study at both time intervals; whereas, pebulate had no effect on plant vigor, whether applied alone or in combination with C-17 (Table 2). Vigor was not influenced by pebulate incorporation method. Fruit production followed a similar trend. Application of C-17 had no effect on production of extra large or medium-sized fruit, but production of large fruit was increased by C-17 with a subsequent increase in the total number of boxes of marketable fruit produced (Table 3). Neither pebulate nor its method of application affected fruit production in this study and combining pebulate with C-17 did not improve yield over that obtained with C-17 alone.

Results of this study indicate that pebulate has no deleterious effects on tomato when applied as described and that incorporation with a disk or a field cultivator is just as effective as with a rototiller. Nutsedge densities were high in the area of this experiment. Late season nutsedge densities generally were higher than what have been experienced in previous research where C-17 and pebulate have been combined (Gilreath et al., 1994). This may account for the lack of a yield effect due to pebulate as yield typically has been reduced where nutsedge has not been controlled. The high temperatures encountered during late spring in 1996 may have reduced the effective residual life of pebulate in the bed, allowing nutsedge populations to rebound. Although no soilborne diseases were observed in this experiment nor were nematodes present in sufficient numbers to influence results, the positive response of tomato plant vigor and yield to C-17 suggest that some soil-borne pest in addition to nutsedge may have been important in this study.

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