EVALUATION OF XRC-245 AS A SOIL FUMIGANT FOR FLORIDA TOMATO

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Florida vegetable growers rely predominately on combinations or successive application of 1,3-dichloropropene (1,3-D), chloropicrin (Pic), dimethyl disulfide (DMDS) or metam potassium for pest control. The majority of fumigant treatments do not control as broad of a spectrum of pests as was achieved with methyl bromide nor do the registered fumigants move as readily through the soil. Growers continue to report that the loss of methyl bromide has led to increased production costs and increased pest pressure. There is a need to identify alternative fumigants that move more readily through the soil, control a broad spectrum of pests, and are economically viable.

XRC-245 is a new fumigant product under evaluation by Douglas Products. An experiment was conducted in the fall of 2017 at the Gulf Coast Research and Education Center (27°N, 82°W) in Balm, Florida, to evaluate this active alone or in conjunction with chloropicrin for pest control in Florida tomato. The soil type at the site is a Myakka fine sand (Sandy, Siliceous Hyperthermic Oxyaquic Alorthod) with a pH of 6.0, 1.5% organic matter and 98, 1, and 1 % sand, silt, and clay, respectively. The field used for the experiment had a history of purple nutsedge (*Cyperus rotundus* L.) infestation.

The experiment was conducted as a randomized complete block design with four blocks and ten treatments (Table 1). Plot size was 75 feet of a single raised bed. Beds were spaced 5 feet apart and were 32 inches wide at the base. Beds were shaped and fumigated on July 19, 2017. A single drip tape with emitters every foot was buried in the center of the bed at 1 inch beneath the soil surface. All fumigants except XRC-245 were applied with a standard fumigant rig (Kennco Manufacturing, Ruskin, FL) equipped with three shanks set to evenly distribute fumigant at the base of the 8 inch tall bed. Kpam applied with a standard fumigant rig (Kennco) equipped with six shanks set to evenly distribute fumigant at 4 inches deep within the raised bed. XRC-245 was injected as a gas in the drip tape after the beds were covered with TIF plastic mulch. Tomatoes (cv. HM1823) were transplanted in the center of the bed with 2 foot spacing between plants on August 31, 2017. Tomatoes were irrigated, fertilized, and managed for foliar pests as per industry standards in the region.

The number of purple nutsedge shoots that punctured the TIF mulch was counted within the planted area three times per season (transplanting, mid-season, at harvest). The number of weeds that emerged in the planting holes of each plot were also counted at tomato harvest. Ten tomato plants per plot were harvested from each plot and all fruit was graded prior to weighing as small (<5.5 cm diameter), medium (5.5 cm < diameter <6.5 cm), large (6.5 cm < diameter <7 cm) or extra large (>7 cm).

Buried bags with a known concentration of *Fusarium oxysporum* f. sp. *lycopersici* race 3 (FOL) were buried immediately prior to fumigation with XRC-245. Bags were made with 10 ×10 cm double mesh fabric and 3 g of sand inoculated corn meal. Bags remained in the field for two weeks. Levels of viable FOL were monitored by plating serial dilutions onto semi selective media (Komada's or Malachite Green).

Very few broadleaf weeds and grasses emerged in the planting holes (Table 2). All fumigants tended to reduce the number of broadleaf weeds and grasses but the results were not always significant. On September 1, all fumigants except 200 and 300 lbs acre^{-1} of XRC-245 alone significantly reduced purple nutsedge densities. A similar trend was observed on October 23 and November 21, but 400 lbs acre^{-1} of XRC-245 was no longer significantly different than the nontreated control by October. We conclude that XRC-245 at all rates evaluated combined with chloropicrin are as effective in terms of weed control as Pic-Clor 60 or Pic-Clor 60 + K-Pam.

All fumigant treatments significantly reduced fusarium compared to the nonfumigated control (Table 3). It is worth noting that when the lowest rate of XRC-245 was applied alone it provided equivalent control of fusarium as compared to all other fumigant combinations that included chloropicrin. Although not significant, the data suggests that XRC-245 at 200 lbs acre^{-1} may be more effective than the industry standard treatments. Further research is needed to evaluate efficacy on pathogens.

None of the fumigant treatments damaged the tomatoes, stunted the plants, or affected fruit yield (data not shown). All fumigation treatments were safe for tomato. We conclude that XRC-245 is safe for use on tomato. We also conclude that this product has good efficacy on nutsedge and fusarium. Further research is warranted.

Table 1. Treatments for the field experiment at the Gulf Coast Research and Education Center in Balm, Florida.

Treatment	Rate	Application method
	--lb acre^{-1}--	
Nontreated	-	--
Pic-Clor 60	250	shank
Pic-Clor 60 + K-Pam	250 + 636	shank fb shank
XRC-245	200	gas injected in drip tape
XRC-245	300	gas injected in drip tape
XRC-245	400	gas injected in drip tape
Tri-Pic 100 + XRC-245	150 + 200	shank fb gas injected in drip tape
Tri-Pic 100 + XRC-245	150 + 300	shank fb gas injected in drip tape
Tri-Pic 100 + XRC-245	150 + 400	shank fb gas injected in drip tape
Tri-Pic 100 + XRC-245	150 + 400	shank fb gas injected in drip tape

Abbreviations: Pic-Clor 60 (57% Pic + 37% 1,3-dichloropropene); K-Pam (metam potassium); Tri-Pic 100 (99% chloropicrin); fb (followed by).

Table 2. Weed control following the fumigation with various fumigant programs at the Gulf Coast Research and Education Center in Balm, Florida.

Fumigant	Rate	Broadleaf Weeds		Grass Weeds		Nutsedge		
		Nov 1	Nov 21	Nov 1	Nov 21	Sept 1	Oct 23	Nov 21
		------------------------------------# m^{-2}------------------------------------						
Nontreated	-	0.36a	0.64a	0.41	0.05	32.6a	96.6a	49.6ab
Pic-Clor 60	250	0.00c	0.10ab	0.00	0.03	0.0b	0.0c	0.1e
Pic-Clor 60 + K-Pam	250 + 636	0.00c	0.00b	0.00	0.00	0.4b	0.8c	1.4de
XRC-245	200	0.03bc	0.13ab	0.20	0.08	34.3a	96.0a	66.3a
XRC-245	300	0.03bc	0.28ab	0.46	0.15	12.9ab	70.9ab	50.9ab
XRC-245	400	0.13a-c	0.10ab	0.33	0.10	4.1b	52.1ab	49.1a-c
Tri-Pic 100 + XRC-245	150 + 200	0.08a-c	0.15ab	0.05	0.05	1.4b	7.1c	6.8c-d
Tri-Pic 100 + XRC-245	150 + 300	0.10a-c	0.05b	0.10	0.13	0.3b	14.0bc	13.5b-d
Tri-Pic 100 + XRC-245	150 + 400	0.31ab	0.03b	0.03	0.10	0.4b	0.1c	0.5de
Tri-Pic 100 + XRC-245	150 + 400	0.05bc	0.03b	0.03	0.15	0.0b	0.8c	0.3e
p-value		0.0011	0.0172	0.0526	0.4635	<0.0001	<0.0001	<0.0001

[1]Values followed by the same letter in the same column do not differ according to the least squares means statement with the Tukey adjustment at P = 0.05.
Abbreviations: Pic-Clor 60 (57% Pic + 37% 1,3-dichloropropene); Kpam (metam potassium); Pic (chloropicrin).

Table 3. Fusarium control following fumigation with various fumigant programs at the Gulf Coast Research and Education Center in Balm, Florida.[1]

Fumigant	Rate	Fusarium	
		Mean	SE[2]
	--lb acre^{-1}--	----- CFU g^{-1} soil----	
Nontreated	-	4256a	1605
Pic-Clor 60	250	1022b	636
Pic-Clor 60 + K-Pam	250 + 636	344b	329
XRC-245	200	97b	9343
XRC-245	300	122b	119
XRC-245	400	78b	42
Tri-Pic 100 + XRC-245	150 + 200	78b	47
Tri-Pic 100 + XRC-245	150 + 300	56b	28
Tri-Pic 100 + XRC-245	150 + 400	67b	39
Tri-Pic 100 + XRC-245	150 + 400	56b	32
p-value		<0.0001	

[1]Values followed by the same letter in the same column do not differ according to the least squares means statement with the Tukey adjustment at P = 0.05.
[2]SE, standard error (n =4)
Abbreviations: Pic-Clor 60 (57% Pic + 37% 1,3-dichloropropene); Kpam (metam potassium); Pic (chloropicrin).