WEED CONTROL WITH METAM POTASSIUM AND CHLOROPICRIN + 1,3-DICHLOROPROPENE INJECTED WITH SINGLE AND DUAL PORT SHANKS

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Commercial vegetable production in Florida relies the use of soil fumigation to limit the impact of soil-borne pathogens, nematodes and weeds on vegetable production. Growers historically relied on methyl bromide for soil fumigation because it volatilizes and moves rapidly through the soil and effectively controls soil-borne pathogens, nematodes, and weeds. The use of methyl bromide is no longer permitted in the United States and as a result pest pressure has increased and growers are looking for alternative management tools. To address this need, extensive research has been conducted to identify alternative fumigants with several commercially registered products such as metam potassium, dimethyl disulfuide (DMDS) and various combinations of chloropicrin and 1,3-dichloropropene (1,3-D). All of the registered alternatives have significantly lower vapor pressures and higher boiling points than methyl bromide. As a result, they do not move through the soil as quickly or as extensively. The reduced efficacy that is frequently observed is due at least in part to the fumigant not coming in contact with the pest or pathogen at the right time.

Weed management is one of the most significant pest management issues faced by growers. Most of the alternative fumigants provide moderate to weak levels of weed control and as a result weed control is often identified as a pest management priority. This is especially true of purple nutsedge which tends to be more tolerant of fumigants (Culpepper and Langston 2004). Registered fumigants can reduce nutsedge density but control levels are erratic and vary with nutsedge growth stage, environmental conditions and fumigant distribution in the soil profile. For example, Boyd et al. (2015) found that metam potassium applied alone at 195 kg/ha did not reduce nutsedge density compared to a nontreated control whereas metam potassium + DMDS significantly reduced nutsedge density. In addition, bed placement of metam potassium impacted efficacy with the greatest nutsedge reduction when metam potassium was applied at a depth of 10 cm versus 30 cm. This research supports the theory that any application technology that enhances spatial fumigant distribution and applies fumigants to the correct management zone can improve weed control without increases in fumigant application rates. The objective of this research was to determine if improved fumigant distribution within the raised plant bed would improve nutsedge and broadleaf weed control in Florida plasticulture systems.

Experiments were conducted in two separate fields in the spring and fall of 2015 at the Gulf Coast Research Education Center in Balm, Florida, to determine if increasing the number of injection points without increasing the overall fumigant rate would improve nutsedge, broadleaf and grass weed control. All experiments were a split-plot design with five blocks. The main plot was injection technique. Metam potassium (374 L ha^{-1}) or 1,3-D (131 kg ha^{-1}) + chloropicrin (200 kg ha^{-1}) were injected with a standard fumigation rig equipped with (1) 3 shanks with single ports, (2) 4 shanks with single ports, (3) 3 shanks with double ports, or (4) 4 shanks with double ports. Shanks with single ports injected the fumigants at 20 cm depths whereas shanks with dual ports injected fumigants at 10 and 20 cm depths. All beds were covered with VIF plastic mulch (Berry Plastics) immediately after fumigation. The sub-plot was transplant date and tomatoes (cv. Charger) were transplanted in a single row with 61 cm between plants 7, 14, 21, and 28 days after fumigation and irrigated and fertilized as per industry standards. Data collection included tomato plant heights, damage ratings and fruit yield as well as the number of nutsedge emerging through the plastic mulch and the number of broadleaf and grass weeds emerging in the planting holes.

Chloropicrin + 1,3-D applications reduced purple nutsedge density in 3 of 4 trials by 50-100% (Table 1). The number of shanks or injection ports did not have a consistent effect on nutsedge density. Metam potassium applications reduced nutsedge density in 2 of 4 trials by 36-50%. Increasing the number of injection ports tended to improve nutsedge control with metam potassium in the spring. The same trend was not observed in the fall. Chloropicrin + 1,3-D applications had an inconsistent effect on broadleaf and grass weed control in the planting holes (Table 2). Metam potassium applications reduced broadleaf and grass weed emergence in the planting hole in 2 of 4 years by 33-50%. The number of injection ports did not have a consistent effect on broadleaf and grass weed control. Increased number of injection ports reduced fumigant damage in the tomatoes when applying Chloropicrin + 1,3-D in the fall but not in the spring. Crop damage due to fumigation was greater with increased injection ports in the spring following metam potassium applications but in the fall tomato plants were taller when fumigants were injected with a greater number of ports. None of the treatments had a statistically significant effect on tomato yield.

We conclude that increasing the number of injection ports without increasing fumigant rate does not improve nutsedge, broadleaf, or grass control. We also conclude that the use of split stream placement from a single shank had no consistent effect on crop growth and yield.

Literature Cited

Boyd, N. S., G. Vallad, and J. Noling. 2015. Weed control in Florida tomato with combinations of dimethyl disulfide, chloropicrin, 1,3-dichloropropene and metam potassium. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. San Diego, Ca.

Culpepper, A. S. and D. L. Langston. 2004. Methyl bromide alternatives for nutsedge in pepper. Proc. South. Weed Sci. Soc. 57:142.

Table 1. The effect of the number of shanks and fumigant injection ports on nutsedge density emerging through the plastic mulch following fumigation with chloropicrin + 1,3-dichloropropene (1,3-D) and metam potassium at the Gulf Coast Research and Education Center in Balm, FL.

Fumigant	Spring Site 1	Spring Site 2	Fall Site 1	Fall Site 2
	--------------------------	# m^{-2}	--------------------------	
chloropicrin+1,3-D				
Non-fumigated	18 a[1]	7 a	22 ab	12 a
3 shanks-3 ports	4 b	0 c	19 ab	5 c
4 shanks-4 ports	4 b	0 c	28 a	9 ab
3 shanks-6 ports	4 b	0 c	13 b	6 c
4 shanks-8 ports	3 b	1 b	22 ab	6 bc
P value	<0.0001	<0.0001	0.0683	<0.0001
metam potassium				
Non-fumigated	6 a	14 a	154	3 ab
3 shanks-3 ports	5 ab	13 a	113	3 ab
4 shanks-4 ports	3 cd	10 b	107	4 a
3 shanks-6 ports	4 bc	9 b	164	3 b
4 shanks-8 ports	3 d	9 b	130	3 ab
P value	<0.0001	<0.0001	0.1208	0.0266

[1]Means within columns and fumigants followed by the same letter are not significantly different at $p<0.05$ based on Tukey adjusted means comparisons.

Table 2. The effect of the number of shanks and fumigant injection ports on broadleaf and grass weeds in the planting holes (based on 4,356 holes ha^{-1}) following fumigation with chloropicrin + 1,3-dichloropropene (1,3-D) and metam potassium at the Gulf Coast Research and Education Center in Balm, FL.

Fumigant	Spring Site 1	Spring Site 2	Fall Site 1	Fall Site 2
	-------------------------# ha^{-1}	-------------------------		
chloropicrin+1,3-D				
non-fumigated	-	1,307 a[1]	3,485 a	873 a
3 shanks-3 ports	-	436 c	1,742 b	1,742 ab
4 shanks-4 ports	-	871 ab	3,485 a	871 a
3 shanks-6 ports	-	436 c	871 b	436 b
4 shanks-8 ports	-	871 bc	1,742 b	436 b
P value	-	<0.0001	<0.0001	0.0025
metam potassium				
non-fumigated	1,307 a	1,742 a	4,356	2,614
3 shanks-3 ports	871 b	1,307 ab	4,356	2,178
4 shanks-4 ports	871 b	871 bc	4,356	2,178
3 shanks-6 ports	871 b	871 c	3,049	1,307
4 shanks-8 ports	871 b	871 c	3,920	871
P value	<0.0001	<0.0001	0.4202	0.0980

[1]Means within columns and fumigants followed by the same letter are not significantly different at $p<0.05$ based on Tukey adjusted means comparisons.