Metam Sodium Combined with Chloropicrin as an Alternative to Methyl Bromide
Fumigation for Tomato

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Studies were conducted during two seasons with metam-Na combined with chloropicrin (Pic) + pebulate as an alternative to MBr-Pic fumigation for polyethylene mulched tomato (*Lycopersicon esculentum* Mill.). In past work, metam-sodium, applied as a single treatment, did not provide acceptable disease control, whereas 1,3- dichloropropene + 17% Pic (1,3-D + Pic) at 327 L×ha^{-1} plus pebulate (4.5 kg×ha^{-1}) provided good control of plant-parasitic nematodes, soil fungi, and nutsedge in polyethylene mulched tomato. This latter treatment is considered the best alternative for methyl bromide which is scheduled for phase-out in the United States by January 2001.

In fall 1997, on a Millhopper fine sand near Gainesville, FL, metam-Na (295 L×ha^{-1}) was applied alone, combined with Pic (168 kg×ha^{1}) + 4.5 kg×ha^{-1} pebulate, and 1,3-D + 35 % Pic at 168 and 225 L×ha^{-1} + pebulate were compared to MBr-Pic (98-2% at 345 kg×ha^{-1} and 67-33% at 500 kg×ha^{-1}) for polyethylene mulched tomato. Fumigants were injected 20 cm deep into 0.9 m wide beds except metam-Na and pebulate were sprayed over the bed surface and incorporated 15 cm deep into the bed and drip tubing and white on black polyethylene mulch were applied. Irrigation was applied before transplanting on some metam-Na plots through two drip tubes in an effort to enhance fumigant activity. Treatments were arranged in a randomized complete-block design with five replications in plots 1.8 m x 11.0 m. Treatments were applied on 30 July 1997 . On 15 August 1997, 'Solar-Set' tomato seedlings were transplanted 0.45 m apart on the bed. Counts of purple and yellow nutsedge (*Cyperus rotundus* L. and *Cyperus esculentus* L.) seedlings that grew through the mulch were counted on the side of the bed were the drip irrigation tubing was placed on14 Oct. 1997. After fruit were harvested, 10 tomato plants were dug, and roots were rated for the presence of root-knot nematodes *Meloidogyne incognita* (Kofoid &White) Chitwood.

In spring 1998, on an adjacent site, treatments included metam-Na at 295 L×ha^{-1} applied alone, combined with pebulate at 4.5 kg×ha^{-1} , and with Pic from 84 to 168 kg×ha^{-1}, C-35 from 168 to 336 L×ha^{-1} + 4.5 kg×ha^{-1} pebulate, 1,3-D + 17% Pic (C-17) at 327 L×ha^{-1} + pebulate, and MBr-Pic at rates listed above. Treatments were applied on 1 Mar. 1998 with drip irrigation tubing and black polyethylene mulch. 'AgriSet 761' tomato plants were transplanted 0.45 m apart on 25 Mar.

In the fall study (Table 1), marketable yields with MBr-Pic, 225 L×ha^{-1} 1,3-D + Pic, and metam-Na + Pic were significantly higher than with the check. Yield with metam-Na alone was similar to that with the check. The additional water applied before transplanting with some metam-Na treatments did not increase yield over those similar treatments that had no additional water. Nutsedge was controlled with MBr-Pic and all treatments with pebulate. Metam-Na treatments alone and with Pic resulted in nutsedge counts numerically higher but statistically similar to that with the check. Nematode root-gall ratings were high on tomato grown without fumigants (8.9

rating on a scale of 0 to 10 with 0 = no galling), low with MBr-Pic (0.33), and intermediate with all other treatments (2.2 to 5.5) except with the low 168 L×ha^{-1} rate of C-35 (8.2).

In the 1998 spring study (Table 1), fruit yields were highest with both MBr-Pic treatments, C-35 at 280 L×ha^{-1} + 4.5 kg×ha^{-1} pebulate, and C-17 at 327 L×ha^{-1} + pebulate and were significantly lower with no fumigant. Yields were statistically similar to that with the check with all metam-Na treatments with and without Pic and pebulate, and with C-35 at the lower (168 L×ha^{-1}) and higher rate(336 L×ha^{-1}) with pebulate. Nematode root-gall ratings were lowest with MBr-Pic 67-33%, and with all C-35 + pebulate, and with C-17 + pebulate treatments and significantly higher with the check. Root-gall ratings were significantly higher with all metam-Na than with the above, and were higher then the rating with no fumigant treatment. Nutsedge control was

excellent with the two MBr-Pic treatments, with metam-Na + pebulate, and with C-17 and C-35 + pebulate
treatments. The addition of Pic with the metam-Na + pebulate treatments resulted in nutsedge counts that were statistically similar to that with the check treatment.

During the fall study, the combination of Pic with metam-Na provided fruit yields similar to that with MBr-Pic. However, in the spring study this positive response was not recorded. In the fall study, tomato plants were growing from a warmer period at planting to a cooler period during fruit development and harvest. In the spring, the growing conditions were opposite with planting during a cooler period and maturing during a warmer period. Yields were lower with all treatments in the fall compared with the spring study. Disease pressure would be expected to be greater during the higher yielding spring study. Thus, with the poor control of nematodes observed with metam-Na treatments, fruit production suffered more during the spring than the fall study. As in past studies, C-17 + pebulate was the best alternative to MBr-Pic for tomato production. C-35 at 280 L×ha^{-1} pebulate, was an equally effective alternative for MB-Pic. Fruit yields with C-35 at the lower rates of 168 and 224 L×ha^{-1} + pebulate and at the higher rate of 336 L×ha^{-1} + pebulate were lower than with 280 L×ha^{-1}. Nematode root-gall ratings were higher with these lower C-35 rates. The reduced nematode control with these lower rates probably influenced yields. In contrast, the higher rate of 336 L×ha^{-1} C-35 may need more time between treatment and tomato transplanting to ensure no toxicity to transplants.

Table 1. Marketable tomato fruit yields, root-knot nematode root-gall ratings, and nutsedge populations as influenced by fumigant and herbicide treatments during a Fall 1997 and Spring 1998 study at Gainesville, FL.

		Mark. yield (t/ha)		Nematode gall index[x]		Nut
		Fall	Spring	Fall	Spring	
Treatment	Rate/ha	1997	1998	1997	1998	1
Untreated		18.7f	52.5d	8.9a	6.0bc	7a-d
MBR-Pic 67-33	500 kg	36.6a	68.7abc	0.3d	1.9dc	1d
MBr-Pic 98-2	345 kg	38.7a	79.3a	0.3d	4.6cd	1d
Metam-Na	300 L	27.1cdc	—	3.4b		15a
Metam-Na*[z]	295 L	24.1ef	—	4.4bc		10ab
Metam-Na+peculate	295L+4.5kg	31.1a-e	62.45bcd	5.3b	7.8ab	2cd
Metam-Na+pebulate*	295L+4.5kg	27.9b-e		4.6bc		1d
Metam-Na+Pic	295L+168kg	33.9a-d	57.1cd	3.5bc	8.8ab	11ab
Metam-Na+Pic+peb.	295L+84kg+4.5kg	—[y]	57.2cd	—	9.8a	
Metam-Na+Pic+peb.	295L+112kg+4.5kg	—	63.8bcd	—	7.9ab	
Metam-Na+Pic+peb.	295L+168kg+4.5kg	—	58.2cd	—	7.1abc	
Metam-Na+Pic*	295L+168kg	35.9ab	—	2.6bcd		5bcd
Metam-Na+Pic+peb.*	295L+168kg+4.5kg	35.3abc	—	2.2cd		3bcd

1,3-D+35%Pic(C-35)+peb.	168L+4.5kg	26.8de	—	8.2a		5bcd	
1,3-D+35% Pic+peb.	224L+4.5kg	35.6ab	61.5bcd	5.5b	2.1de	3bcd	1c
1,3D+35% Pic+peb.	280L+4.5kg	—	72.8ab	—	0.5e	—	0c
1,3D+35% Pic+peb.	336L+4.5kg	—	64.4bcd	—	0.6e	—	0c
1,3-D+17% Pic+peb.	327L+4.5kg	—	67.4abc	—	2.7de	—	1c

[z]Irrigation applied before transplanting by two drip lines placed under the mulch.
[y]Treatment not applied.
[x]Root knot gall indices 0-10 with 0=no galls and 10=100% of root system galled.
Mean separation within columns by Duncan’s multiple range test, P=0.05.