SODIUM AZIDE [SEP-100] FOR CONTROL OF NEMATODES AND WEED PROBLEMS IN GREEN PEPPER PRODUCTION

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ABSTRACT

The efficacy of SEP-100, a liquid formulation of Na azide, as an alternative for methyl bromide (MB) in soil fumigation was studied in field experiments with 'Aladdin' green pepper [*Capsicum annum*]. Pre-plant applications of SEP-100 by drip irrigation to plastic covered beds at rates of 50, 75, 100, 125, 150, 175, and 200 lbs.a.i./A, were effective in controlling root-knot nematode (*Meloidogyne incognita*), purple nutsedge (*Cyperus rotundus*), and *Panicum* spp. Na azide rates $\geq$ 100 lbs /A consistently equaled or outperformed MB (300 lbs/A) in controlling root-knot nematodes and weeds. Total marketable yields, and yields of Fancy, No. 1, and No. 2 peppers increased directly and linearly in relation to SEP 100 doses. MB fumigation resulted in increased marketable yield and increases in weights of all yield categories; however, these responses did not achieve the levels observed for SEP 100 rates > 125 lbs a.i./A. Results indicate that Na azide in the SEP-100 formulation is a practical and safe potential alternative to MB for soil fumigation in green pepper production.

Key Words: azides, inorganic azides, herbicide, horticultural crops, hydrazoic acid, methyl bromide alternatives, nematicide, pest management, root-knot nematodes, soil-borne pests, soil fumigation, weed control.

INTRODUCTION

Green or bell peppers constitute over two-thirds of the total pepper production in North America (Sundstrom, 1992). Total U.S. acreage of green peppers is about 60,000 acres with an estimated value of $414 million. California (25,000), Florida (20,000) and Texas (8,000) have the largest harvested acreage of green peppers in the U.S. Pepper yields average about 5 tons per acre (Sundstrom, 1992).

Methyl bromide [MB] is used in pepper production systems mainly for nematode and weed control. Reduction in the incidence of damping-off fungal diseases caused by *Pythium spp.* and *Phytophothora spp.* and southern blight (*Sclerotium rolfsii)* can be an added benefit. One estimate suggested that the loss of MB in Florida would result in a 63% decline in total pepper production (Van Sickle and Spreen,1994). Alternatives to MB such as various combinations of Telone and chloropicrin have been shown to adequately control nematodes and soil borne diseases, but do a poor job in controlling weeds, especially nutsedge (Gilreath et al., 1999). Thus, an herbicide is required in most instances. Pepper growers are less fortunate than tomato growers in that they have few herbicides to choose from, and all do poorly in controlling nutsedge (Gilreath et al., 1999). There is compelling need to find an adequate substitute for MB in pepper production.

Na and K azides are salts of hydrazoic acid [HN_3] that have been explored in a limited manner for their pest controlling properties in the past [MBTOC, 2002]. These compounds are solids, readily soluble in water, and are stable under ordinary conditions of temperature and pressure. Field research at Auburn University in the 1970's showed that granular formulations of Na azide applied to soil had broad spectrum activity against weeds, nematodes, and soil-borne phytopathogenic fungi (Kelley & Rodríguez-Kábana, 1979; Rodríguez-Kábana & Robertson, 2000a,b; Rodríguez-Kábana, *et al.*, 1975; Rodríguez-Kábana *et al.*, 1972). Similar results were obtained in other areas of the U.S. and in Belgium with high-value horticultural crops (van Wambeke *et al.*, 1984, 1985; van Wambeke & van den Abeele, 1983).

Sodium and K azides can be formulated as granules or in a variety of liquid formulations [Rodriguez-Kabana, 2001b]. Granular formulations were used to control weeds and soil-borne pests typically located in the top 7 - 10 cm of the soil profile. However, liquid formulations are more suitable for pests [e.g. nematodes, *Fusarium, Verticillium*] and situations requiring deeper penetration of the chemical in the soil profile. One way to achieve a more uniform and deeper distribution of the chemical in the soil is to apply it by drip irrigation.

The general broad-spectrum activities of Na azide, its solubility in water and other favourable properties as a potential substitute for MB led our research team at Auburn University to develop new formulations suitable for field use with drip irrigation or similar systems [Rodriguez-Kabana, 2000a, 2001; 2002a,b,c]. This paper presents results from a field experiment evaluating one of these formulations, SEP 100, as an alternative to MB for control of nematodes, weeds, and other soil-borne pests in green pepper production.

MATERIALS AND METHODS

A field experiment was conducted in the Spring 2003 to assess the value of Na azide in the SEP 100 formulation, for control of weeds, plant pathogenic nematodes and other soil-borne pest problems. The experiment was set up at the Brewton Agricultural Research Unit, near Brewton, Escambia county, in southern Alabama. The area chosen for the experiment was severely infested with root-knot nematode [*Meloidogyne incognita*] and had purple nutsedge [*Cyperus rotundus*] and *Panicum* spp. as the principal weeds. The soil was a silt loam [pH 6.2; org. matter <1.0%; C.E.C. <10 meq/100 gms soil] and had been in vegetable production for several years. SEP 100 was applied on April 22, at rates of: 0, 50, 75, 100, 125, 150, 175, and 200 lbs.a.i./A. The compound was delivered in 0.5" water [5 hrs] through 2 drip tapes set 10" apart on the surface of plant beds covered with standard white polyethylene. This was followed 5 days later by application of 0.75" water, followed by 1" water 5 days later, and by 0.5" water at transplanting of 'Aladdin' green pepper [*Capsicum annum*] seedlings 3 weeks [May 14] after application of the chemical. The seedlings were set 18" apart along the centre of the bed between the two drip tapes. A MB treatment [300 lbs/A] was included for comparative purposes. The beds were 3' wide, 100' long and approx. 6" high. The beds were divided in 17' long plots and there were 6 plots per treatment. Fertilization and control of insects and foliar diseases were according to standard recommendations for the area. Green peppers were harvested at weekly intervals beginning on July 7 with the final harvest on August 5. At each harvest the peppers were classified according to the standard categories of: Fancy, Number 1, Number 2, and Cull; weights for each category were recorded.

Soil samples for nematode analyses were taken from every plot on August 11, when the numbers and species of weeds in each plot was determined. Soil samples consisted of 1-inch diam. soil cores taken from the root zone of each plant to a depth of approx. 10" have 8-10 cores/plot. The cores were composited and a 100 cm^3 sub-sample was used to extract nematodes with the salad bowl incubation technique [Rodriguez-Kabana & Pope, 1981]. Roots from 2 plants/plot were dug out and after washing were rated for root-knot according to a 0-10 scale where 0 represents no galls and 10 maximal galling [Zeck, 1971].

All data were analysed following standard procedures for analyses of variance. Fisher's least significant differences [FLSD] were calculated when F values were significant. Unless otherwise stated all differences referred to in the text were significant at $p \leq 0.05$.

RESULTS

The MB and all SEP 100 treatments reduced weed densities as illustrated in Figure 1A. SEP-100 treatments were more effective for controlling nutsedge than for *Panicum* spp.; where nutsedge was practically eliminated by all treatments the same level of control for *Panicum* spp. required rates $\geq$ 100 lbs a.i./A. Fumigation with MB and applications of SEP 100 eliminated juveniles populations of *M. incognita* in soil [Fig. 1B]. This was reflected in sharp reductions in root gall index values proportional to SEP 100 doses; MB reduced root galling but did not achieve the low index values observed in roots corresponding to SEP 100 treatments $\geq$ 150 lbs a.i./A.

Root weights were increased by MB fumigation and by SEP 100 doses >50 lbs a.i./A [Figure 2]. General appearance, "root health", assessed by the root condition index was greatly improved by MB and all SEP 100 treatments [Fig. 2].

Yield data are presented in Figure 3. Total marketable yields, and yields of Fancy, No. 1, and No. 2 peppers [Fig. 3A] increased directly and linearly in relation to SEP 100 doses [Fig. 3B]. Response in total yields parallelled that observed for total marketable yield [Fig. 3C] but weights in the cull category was uninfluenced by SEP 100 doses. MB fumigation resulted in increased marketable yield and increases in weights of all yield categories; however, these responses did not achieve the levels observed for SEP 100 rates > 125 lbs a.i./A. The percent Cull weights for the MB treatment was generally higher than observed for the SEP 100 treatments.

CONCLUSIONS

Applications of Na azide using the SEP-100 formulation resulted in green pepper yield responses and control of weeds and root-knot nematodes equal or better than obtained with MB fumigation. SEP-100 treatments either did not affect, or increase populations of beneficial microbivorous nematodes. Sodium azide in the SEP-100 formulation represents a practical and safe composition to consider as a potential alternative to soil fumigation with MB in green pepper production.

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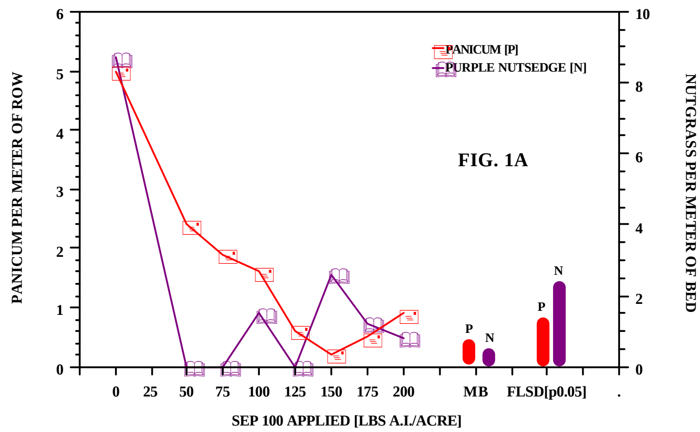
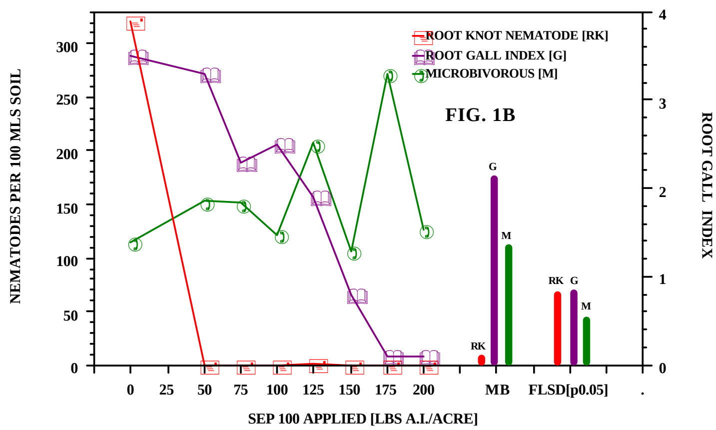
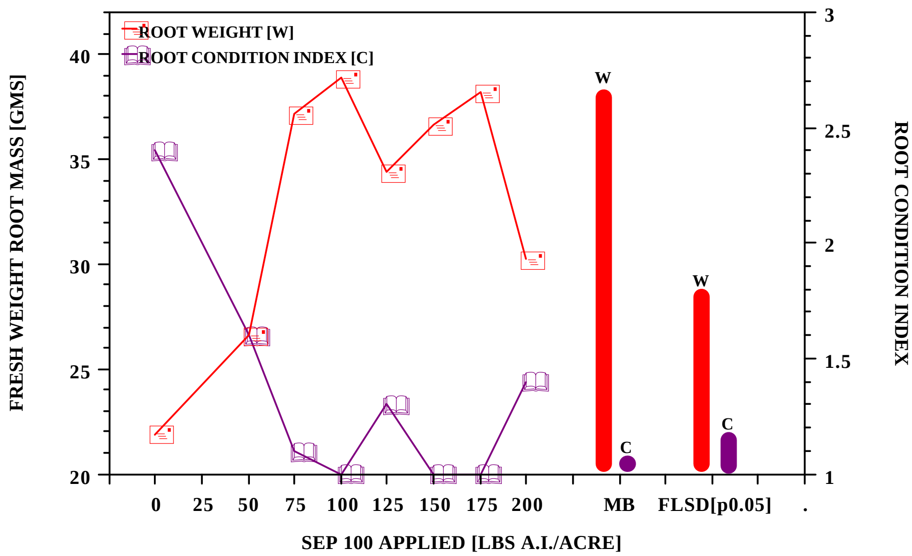




ROOT GALL INDEX ON A SCALE FROM 0= NO GALLS TO 10= MAXIMUM GALLING

Figure 1. Relation between Na azide doses applied as SEP-100 and weed density (A), root-knot incidence, and numbers of root-knot [*Meloidogyne incognita*] and microbivorous nematodes in soil from a 2003 field experiment with 'Aladdin' green pepper [*Capsicum annum*] at the Brewton Agricultural Research Unit in southern Alabama. Methyl bromide [MB] was applied at 300 lbs/A.



ROOT CONDITION INDEX ON A SCALE FROM 1= BEST APPEARANCE TO 5= ROOT SYSTEM VERY REDUCED AND HEAVILY DISEASED

Figure 2. Effect of MB and SEP 100 treatments on fresh weight of roots and general appearance of root systems [root condition index] in a field experiment with 'Aladdin' green peppers at the Brewton Agricultural Research Unit in southern Alabama.

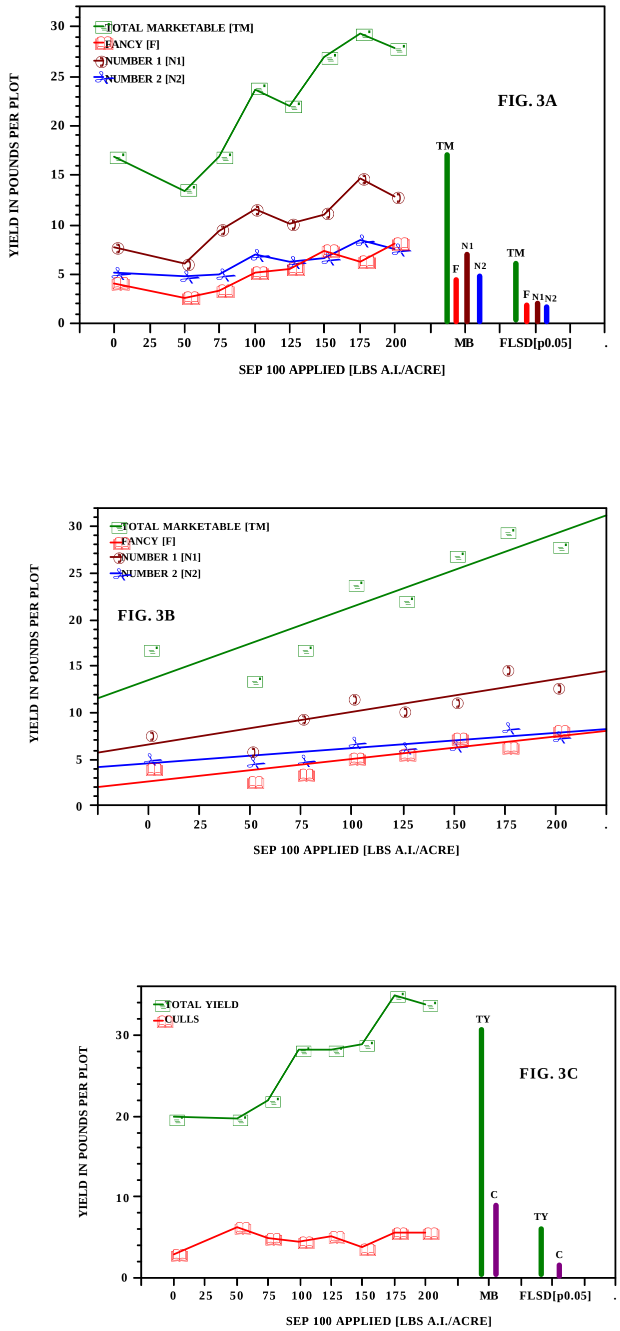


Figure 3. Yield response of ‘Aladdin’ green pepper to applications of SEP 100 [Na Azide] in 2003 experiment in a field severely infested with root-knot nematode [*M. incognita*], purple nutsedge [*C. rotundus*] and other weeds, at the Brewton Agricultural Research Unit in southern Alabama.