Metam Sodium and Dasomet as Herbicides for Use by Vegetable Growers

D.E. Carling, Professor of Horticulture and Plant Pathology
J.L. Walworth, Associate Professor of Soil Science
J.S. Conn, Research Agronomist, USDA, Agricultural Research Service

SCHOOL OF AGRICULTURE & LAND RESOURCES MANAGEMENT
AGRICULTURAL & FORESTRY EXPERIMENT STATION

INTRODUCTION

This report examines two studies of soil fumigants that may be used for weed control in commercial vegetable fields. The first, a study of metam sodium applied by injection, was initiated in 1992 and reported in AFES Research Progress Report No. 33 (Carling et al 1994). The initial report contained data on the effects of treatment with different rates of metam sodium on: 1) weed seed populations in the soil, 2) populations of various weeds growing in plots one month and 11 months after treatment, and 3) yield of head lettuce grown on treated plots. Also included in that initial report were actual and extrapolated costs of removing weeds with various combinations of hand labor and metam sodium.

The plots from which the above mentioned information was collected were preserved so additional head lettuce yield and weed removal measurements could be made in 1994 and in following years. Collecting data for many years is necessary to make accurate assessments of multi-year control with a single application of metam sodium.

The second experiment was established in 1994 and includes a field evaluation of two soil fumigants. In this experiment, six rates each of metam sodium and dasomet were applied to the soil surface and carried into the soil profile with water applied through overhead sprinklers. Metam sodium currently is labeled in the United States for use as an herbicide on food crops but dasomet is not. BASF, the manufacturer of dasomet, has indicated a label permitting use on food crops may be available within two to three years. This study was designed to determine: 1) the effectiveness of surface application followed by "watering in" as a method of applying these two chemicals, 2) the depths to which each chemical is carried into the soil profile by one inch of irrigation water, 3) optimal rates of metam sodium and dasomet required with this method of application to eliminate weed seeds from the plow layer, and 4) phytotoxic effects of metam sodium and dasomet on potatoes and vegetables.

MATERIALS AND METHODS

Specific details regarding plot management and application of metam sodium during the first production year of the initial study are summarized in Carling et al (1994). In brief, metam sodium was injected into the soil at 0, 25, 50 or 100 gallons/acre in late July 1992. Four replicates each of tarped and non-tarped treatments were included at each rate of application. In 1993, a crop of head lettuce was planted and harvested and data was collected on head lettuce yield, weed populations and weed removal costs. These plots were preserved following harvest of the lettuce crop in July 1993. On May 23, 1994 granular fertilizer (20-10-10) was applied to the plots' surface 800 pounds per acre followed by rototilling to a depth of 6-8 inches, and packing. Care was taken during the tilling process to insure that soil and weed seeds were not moved from plot to plot. Following fertilization and tilling, one inch of water was applied through overhead sprinklers. On May 26, 30 day old greenhouse produced head lettuce (*Lactuca sativa* L.) (cv. Alpha) seedlings were transplanted 12 inches apart in rows 18 inches apart. Soil moisture was monitored with tensiometers and irrigation water was applied as needed. On June 27, all weeds were removed by hand from the plots and the time required for this operation was recorded for each plot. Lettuce heads were harvested and weighed on July 27.

Plots for the second experiment were chisel plowed to a depth of 10-12 inches on July 28, 1994 and on July 29 three inches of water were applied through overhead sprinklers. Maximum effectiveness of the soil fumigants being tested in this experiment are only realized when soil moisture is within an acceptable range, and the rather large quantity of water applied was required because the initial soil moisture level was low. On August 2 plots were tilled with a roterra and packed. Chemical treatments were applied on August 4. The short delay between tilling and chemical treatment allowed irrigation water to equilibrate and dormant weed seeds to begin germinating. Metam sodium, a liquid, was applied as a spray at six rates (0.0, 12.5, 25, 50,

Table 1. Number of weeds per square foot on field plots treated with metam sodium. [a]

Metam sodium gallons/acre	Chick weed	Lambs-quarter	Pineapple-weed	Shepherds-purse	Other[b]	Total weeds	Percent cover
0	2.6	28.8	15.5	0.5	2.3	49.6	36.3
25	1.0	10.4	9.1	0.3	1.5	22.3	10.3
50	0.0	10.4	3.0	0.1	1.4	14.9	6.5
100	0.0	8.7	1.5	0.1	1.1	11.5	5.1
LSD 5%[c]	1.4	11.2	8.0	NS[d]	NS	14.9	11.5

[a]Data was collected on June 22, 1994, 23 months after treatment with metam sodium.
[b]Other included prostrate knotweed (*Polygonum aviculare* L.), wild geranium (*Geranium erianthum* DC) and unidentified species.
[c]Least significant difference.
[d]NS = not significant at the 5% level.

75, and 100 gallons per acre), and dasomet, a granular material, was sprinkled by hand at six rates (0, 40, 80, 160, 240, and 320 pounds per acre) onto the soil surface. The active ingredient in the two chemicals is methylisothiocyanate (MITC) and dasomet is nearly 100 percent active ingredient. The metam sodium used was a 32.7 percent solution of methyl dithiocarbamate that contained 3.18 pounds of active ingredient per gallon. For both materials MITC was applied at the approximate rates of 0, 40, 80, 160, 240 and 320 pounds per acre. Each of the 12 treatments was replicated four times on plots that measured 12 feet wide and 20 feet long. One inch of irrigation water was applied to all plots immediately after treatments to distribute the chemicals in the soil profile.

On September 8, weed seedling counts were taken, and on September 12, 10-12 soil core samples were collected from each plot. Soil core samples were taken to a depth of 12 inches and each core was subdivided into three inch increments. Increments from each level were combined for each plot and stored in a freezer. Soil core samples are to be used as a bioassay of efficacy and of movement of chemical through the plow layer. To eliminate the deposition of new weed seeds onto plots, all plots except those treated with the zero rate of metam sodium were treated with glyphosate on September 24. Plots treated with the zero rate of metam sodium were not treated with glyphosate because they will serve as non-weeded controls.

RESULTS AND DISCUSSIONS

In late June 1994, weed populations were measured on the plots treated with different rates of metam sodium in 1992. These data are summarized in Table 1. Since there was no statistical difference in populations between tarped and nontarped treatments at the various rates of metam sodium application, data from tarped and nontarped treatments were combined. As in 1993, the dominant weeds were pineappleweed [*Matricaria matricarioides* (Less) Porter] and lambsquarter (*Chenopodium album* L.), with lesser amounts of chickweed (*Stellaria media* L.), shepherds purse (*Capsella bursa-pastoris* L.), and several other species. There were significantly more weeds of most individual species, and significantly more total weeds, in the treatment receiving no metam sodium as compared to all treatments receiving metam sodium. However, there were no significant differences in the number of weeds (individual species or total) among the three metam sodium treatment rates. Values for percent cover (Table 1) followed a pattern similar to that of weed counts, with significantly more soil surface area covered by weeds in the nontreated plots than in any of the plots treated with metam sodium.

Weeds were removed by hand from the plots on June 27 and the time required for this procedure was measured for each treatment. Minutes per plot was converted to hours per acre and from this figure cost of removing weeds by hand per acre was estimated for each treatment using a labor cost of $7 per hour (Table 2). The cost of metam sodium ($7 per gallon) was included in the estimated overall cost of weed removal in these calculations to give a total cost per acre of weed removal with the four combinations of hand weeding and metam sodium. Costs ranged from 32-41 percent less when metam sodium was used compared with the untreated control. Note that there was little difference in total cost per acre among the three metam sodium

Table 2. Estimated cost of eliminating weeds with metam sodium and hand labor in 1994.[a]

Gal/acre metam sodium	Minutes/ plot	Hours/ acre	Hand labor @ $7/hr	Metam sodium[b]	Total cost/acre	Percent difference
0	16.5	153.6	$1,075	$0	$1,075	0
25	9.8	91.2	638	88	726	32
50	7.0	65.1	456	175	631	41
100	5.5	51.2	358	350	708	34

[a]Data collected on June 27, 1994, 23 months after applying metam sodium.
[b]The $7/gallon cost of metam sodium is halved as the cost is averaged over a two year period.

Table 3. Actual and estimated annual costs of weed removal with combinations of metam sodium and hand labor

Gal\acre metam sodium	Cost of metam sodium	Cost of hand labor 1993	Cost of hand labor 1994	Average weed control costs '93 &'94[a]	Four-year extrapolation 1993[b]	Four-year extrapolation '93 & '94[c]
0	$0	$2,801	$1,075	$1,938	$2,801	$1,507
25	195	1,677	638	1,246	1,721	942
50	350	1,010	456	908	1,097	682
100	700	293	358	676	468	517

[a](Cost of metam sodium + cost of hand labor for 1993 and 1994)/2.
[b](Cost of metam sodium + four times the 1993 hand labor costs)/4.
[c](Cost of metam sodium + 1993 hand labor costs + three times the 1994 hand labor costs)/4.

treatments, an observation which suggests that the lesser rates of application may be as economical as the highest rate. However, it must be remembered that all weeds were eliminated from each plot during hand weeding. As a result no new weed seeds were introduced into the plots. If weeds had been allowed to produce seeds, weed populations in plots with incomplete weed control would increase rapidly, thereby increasing long-term weed control costs in these plots. If growers decide to use a low or medium rate of metam sodium they must recognize the need to remove, by some other means, weeds that metam sodium survive treatment.

Additional comparisons of estimated costs, based on the data introduced in Table 2, are summarized in Table 3. Costs for metam sodium and hand labor for 1993 are taken from Carling et al (1994). The average weed control figures for 93-94 include the hand weeding costs for each of the two years plus the cost of metam sodium with the total divided by two (because metam sodium was applied only once, at the beginning of the experiment). The average of the two years is a more realistic figure for growers to consider at this point than either the figures for 1993 or 1994 alone. Additionally, a four year extrapolation based on 1993 and 1994 data is included to project costs over a four year period of time (Table 3). We will be collecting data on these plots for the next two years to confirm the accuracy of this projection.

Harvest data from the 1993 and 1994 growing seasons are summarized in Figure 1. The 1993 data suggest a trend toward an increased yield as the rate of application of metam sodium increases although there were no significant differences in yield among the four treatment rates. Again in 1994 there were no significant differences among the treatments although the trend observed in 1993 was not apparent. These data clearly illustrate there are no negative residual effects of treatment with metam sodium on head lettuce growth and yield.

From the experiment initiated in July 1994, we have one set of preliminary data (Table 4). These data indicate the relative effectiveness of metam sodium and dasomet applied to the soil surface and watered into the soil profile. The predominant weed in these plots was chickweed, although pineappleweed, lambsquarter and several other weeds commonly found in local vegetable fields also were present in most plots. The total number of weeds declined as the rate of application of either chemical was increased. The numbers of weeds at comparable rates of application were lower on plots treated with dasomet than in those where metam sodium was applied, suggesting that dasomet was more effective than metam sodium. These data, however, are only an indication of viable weed seeds present in the uppermost layer of soil and may not accurately reflect the effect of various rates and treatments on other parts of the soil profile. We speculate that dasomet remained close to the soil surface because of its granular formulation. Metam sodium, a liquid, may have been carried further into the soil by the irrigation water and as a result could provide better weed control throughout the plow layer than dasomet. Data that can be used to answer this question will be provided by bioassay of soil cores collected from the plots, and from future weed population measurements.

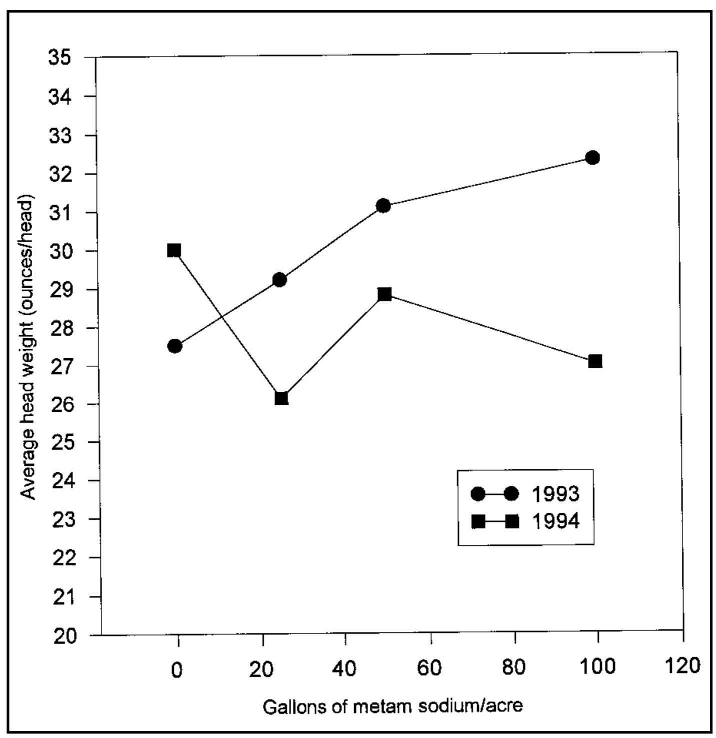

Figure 1.Weight of lettuce heads harvested from field plots treated with metam sodium.

1995 Plans

1. Metam sodium experiment (1992)
    a) Grow and harvest a crop of head lettuce
    b) Determine weed populations
    c) Determine cost of weed removal
2. Metam sodium-dasomet experiment (1994)
    a) Complete bioassay on soil core samples
    b) Grow and harvest a crop of potatoes
    c) Grow and harvest a crop of radish
    d) Determine weed populations
    e) Determine cost of weed removal

Table 4. Effect of treatment with metam sodium and dasomet on the number of weeds per square foot.[a]

Rate in pounds a.i./acre rate[b]	Weeds per square foot Metam sodium	Dasomet
0	12.8a[b]	8.6 ab[b]
40	9.0 ab	7.0 bc
80	12.7 a	1.4 d
160	6.9 bc	0.4 d
240	3.7 cd	0.2 d
320	2.7 cd	0.0 d

[a]Data collected approximately five weeks after application of chemicals.
[b]Numbers in rows and columns followed by the same letter are not significantly different P=0.05.

Literature Cited

Carling, D.E., J.S. Conn, and J.W. Walworth. 1994. *Potential of metam sodium as an herbicide for use by vegetable growers in Alaska*. Agricultural and Forestry Experiment Station, Research Progress Report No. 33, University of Alaska Fairbanks. Fairbanks, Alaska. 4pp.