Use of Para Formaldehyde as a Potential Soil Sterilant: A Preliminary Investigation©

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INTRODUCTION

Para formaldehyde is the polymerized solid form of formaldehyde. Formaldehyde's role as a sterilant and a preservative is well known in scientific circles and is a common component for the sterilization and preservation of animal specimen and tissues in laboratories. In the mid 1920s the nursery industry used an aqueous solution of formaldehyde (Kains and McQuesten, 1950; Mahlsteade and Haber. 1957) for soil sterilization at a rate of 200 ppm formaldehyde. However, liquid formulations of formaldehyde due to the fumes and toxicity are difficult and hazardous to handle and the use of this material has fallen out of favor.

Fast forward to the last 10 years or so and things have changed. Much of the work of aqueous formaldehyde was replaced by methyl bromide, another hazardous and difficult chemical. Scientific studies showed that methyl bromide is a culprit with atmospheric contamination and it has subsequently been scheduled for removal from the market place by the year 2005.

There are other chemicals on the market that do fill the niche for soil sterilization. Vapam, (methamsodium), yields methyl isothiocyanate upon reaction with water and is an effective soil sterilizer, but has a long residual activity and can influence woody plant growth for up to 1 year from the time of application (Barnes, unpublished results). Basamid granules (chemical name, Dazomet) has been used with some success (Shugert, 1988) but it is costly and many nurseries do not use it when compared to methyl bromide. According to Ashworth (1989) Basamid is also converted in the soil to methyl isothiocyanate. Presumably some of the same problems with residual activity would be present. Ashworth (1989) also reports that using Basamid at ½ the rate appears to be effective for weed control. Perhaps this lower rate offsets some of the delayed activity as seen by Barnes (unpublished results). To date very little as been done using para formaldehyde as a soil sterilant.

Industrially para formaldehyde is a white powder. It is usually available commercially as a blue dyed material in the sanitary sewer business. Portable toilets and fixed tanks in boats, airplanes, and recreational vehicles are regularly disinfected by application of para formaldehyde. At present this chemical does have EPA registration for its use in these capacities; there is no agricultural or horticultural use labeling.

Since it is a powder, para formaldehyde is vastly easier and safer to use than aqueous solutions of formaldehyde especially since no mixing of caustic chemical concentrates is necessary and there is less chance of rapid volatilization from the solid.

This investigation was designed to test the efficacy of para formaldehyde and to set the stage for further evaluation of its potential as a soil sterilant.

METHODS

Nursery field soil was obtained from an area not treated with herbicides. The initial weeds were removed by hand; care was taken to preserve as much topsoil as possible

to keep the native weed seed population intact. Everything in the soil was collected including bugs, worms, and root pieces of perennial weeds, foreign matter such as old pieces of wood and of course the naturally occurring weed seeds. The soil was collected into plastic lined nursery pots that contained 1 ft^3 of soil. A sample of soil was removed and weighted and then air-dried in an oven at 110°F for several days. Soil was a clay loam field soil from central Bucks County, Pennsylvania, with a moisture content of 13.8%. After a total of eight tubs of soil were collected, they were removed to the test area and individually dumped into a wheelbarrow and a specific amount of commercial grade para formaldehyde was blended thoroughly in to the soil. Since the product is a bright blue it is easy to see how well it is blended in. Para formaldehyde powder was blended with 1 ft^3 of soil at the following levels: 2 oz, 4 oz, 6 oz, and 8 oz; a control with no additive was also included.

Once blended in thoroughly the soil was returned to the plastic bag in the original tub and sealed against the elements and to trap the para formaldehyde vapors. Caution was used during this phase by the wearing of rubber gloves and goggles to prevent possible interaction with the chemical.

Sealed tubs were left in a dry area in full sun for an initial time of 10 days. Physical and biological characteristics were noted and soil samples were removed and placed into large trays with a depth of 4 inches and a surface area of 2 ft^2. These trays were then placed in the nursery environment under daily irrigation. After another 6 weeks the trays were evaluated for weed development.

After removal of the initial soil samples, the bags were resealed and held for an additional 10 days. Samples were again removed and placed in 4-inch pots and treated in the same manner as the original sample trays. They were in turn evaluated after 6 weeks in the open (Tables 1 and 2).

RESULTS AND DISCUSSION

It is clear that after 10 days of fumigation with 8 oz of paraformaldehyde per ft^3 of soil a significant affect upon weed seed germination occurs. In an evaluation of both monocot species and dicots it is clear that at the 8-oz dosage rate nearly all of the weed seeds present were destroyed. Six ounces of para formaldehyde was almost as effective with respect to dicot species, however, it failed to control the monocot species with an equal effectiveness. It is interesting that 4 oz of paraformaldehyde was nearly as effective as 6 oz for both monocots and dicots. And in fact the data

Table 1. Weed data after 6 weeks of open-air trays with a 2 ft^2 surface area watered daily.

Application rate (oz)	Monocots		Dicots	
	Species (no.)	Plants (no.)	Species (no.)	Plants (no.)
Control	2	85	9	101
2	1	75	7	69
4	3	24	4	4
6	1	33	2	9
8	0	0	0	0

Table 2. Soil held 20 days then put into 4-inch pots, left to the open air, and watered daily (surface area 12.56 inches^2).

Application rate (oz)	Monocots Species (no.)	Plants (no.)	Dicots Species (no.)	Plants (no.)
Control	1	12	6	29
2	2	31	5	34
4	1	30	1	8
6	1	11	0	0
8	1	1	0	0

suggest that 6 oz of paraformaldehyde was not as effective as 4 oz. However, experience with methyl bromide suggests that there are some species of weed, (red clover being one) that are actually encouraged to germinate after treatment with that gas. It is plausible that 4oz was sufficient to kill most seeds and that it was not strong enough to promote the germination of particularly dormant seeds, but the 6-oz treatment was sufficient to actually promote the germination of the more difficult-to-germinate seeds, in a manner similar to that of methyl bromide.

A further 10 days of fumigation seems to correct most of these problems. Examination of the data suggests that again 8 oz of fumigant is sufficient to kill just about everything in the soil. Six ounces was equally effective when dicot species were examined, but 6 oz of paraformaldehyde was not sufficient to kill all of the monocot species. It was however, strong enough to overcome the possible acceleration of dormant seeds and had a significant affect as compared to 4 oz. It is possible that during the 20-day period the chemical did much the same thing as was demonstrated in the 10-day study and actually promoted the germination of the more dormant seeds but once germinated they were in turn killed by the extended presence of the para formaldehyde.

It is obvious from the data that 2 oz per ft^3 were inadequate even after 20 days of fumigation. Four ounces for both time periods looks like a plausible dose but does not compare to the overall effectiveness of 8 oz, whether it is for the 10-day period or the 20-day period. However, a further look at the 2-oz dosage seems to indicate that a 20-day period will actually increase the germination of some seeds compared to the control. Further work might indicate that para formaldehyde could be used to overcome hard seed coat dormancy of some seeds. It is known that methyl bromide does this and the data here suggests a similar trend.

It also interesting to note how strongly dicot seeds are affected as compared to monocots at the same dosage. It is clear that monocot seeds are far more able to resist the affects of para formaldehyde as compared to dicots.

CONCLUSIONS

The data suggests that further work needs to be done to further evaluate the nature of the para formaldehyde activity. Initial results indicate that at the 8 oz per ft^3 level, it is effective at soil sterilization and that this higher dosage seems to be the most comprehensive of the dosages evaluated. A curious development is what appears to

be seed germination enhancement by the low level of 2 oz of para formaldehyde per cu ft of soil. Further work should be done with this to determine how soil moisture might affect this and whether their were ramifications of soil temperature as well.

The objective of this study was to determine an effective dosage for the control of the germination of weed seed. It is clear the 8 oz at the very least is quite effective at achieving this goal, but other parameters have been opened up by this initial investigation and many new questions have presented themselves that will require further work.

LITERATURE CITED

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East Meets South in Baltimore!©

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The Eastern Region, North American of the International Plant Propagators Society is looking forward to the joint meeting with her sister Society from the Southern Region. The meeting dates are 29 Sept. 2002 to 2 Oct. 2002.

Its is anticipated that this meeting will be unprecedented with the combined attendance from both regions expected to be close to 700 people.

The local site committee, headed by Dick Marshall from the Southern Region and co-chairs of Steve Castorani and Bill Barnes from the Eastern Region, North American, has been actively pursuing a meeting to be remembered. Program chairs for next year's meeting are Jim Johnson for the Eastern Region, North American, and Randy Jacobs for the Southern Region and I am sure they will want to hear from YOU about giving a talk for the 2002 meeting. Alan Jones will be the poster chair for our contingent and Donna Fare will be bird dogging the Southern Region. The Southern Region is also looking for likely participants. So don't be bashful, introduce yourself to these fine people and get on board! Lou Marshall from the Southern Region is putting together a spouse's tour with cultural attractions.

Originally the site was planned to be in the Wilmington, Delaware area but a hotel suitable to accommodate the combined memberships could not be found. A rather lengthy search of Baltimore City also failed to turn up a hotel that was suitable. Nevertheless the local committee persevered and settled upon the Marriott at Hunt Valley, (Cockeysville, Maryland) just a short hop from downtown Baltimore. In addition there is a mall across the street from the hotel and there are numerous restaurants and activities in the area. Steve Castorani, man about town, will give us an update on the whole affair during this year's Eastern Region meeting here in Kentucky.