EMF FOR PEST CONTROL IN SOIL AS A METHYL BROMIDE ALTERNATIVE

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Nonchemical methods of controlling pests are an ongoing need in crop production. Buildup of resistant strains and species, chemical residues, toxicity to workers, and unexpected interactions are chronic problems in the use of chemical pesticides. Presently , an acceptable substitute for methyl bromide(MeBr) is urgently needed for crops that require soil fumigation. Radiofrequency(RF) and ultrahigh(UHF) frequency electromagnetic fields(EMF), applied to the soil, have the requisite broad-spectrum effectiveness. There is substantial evidence that EMF exposure is effective against most soil borne pests and pathogens. Susceptibility to EMF in order of sensitivity appears to be insects>weed seeds=nematodes>fungi.

Nevertheless, until recently EMF used for soil disinfestation has been considered impractical for most uses because of inefficient delivery systems-- crude applicators wasted energy, the problems of attenuation/absorbtion and soil heterogeneity had not been addressed, and generators, magnetrons, and power supplies available were bulky, costly, and inefficient.

However, recent rapid improvements in the state of the art have completely changed the outlook for EMF soil pest control. Joining mass-produced, low cost industrial tubes to produce high power densities, combined with improved applicators, the development of light weight high powered generators, and an increase in magnetron efficiencies have decreased the energy requirement, weight, and cost of EMF pest control in soil remarkably, and increased operating efficiency by more than an order of magnitude. An additional half-order magnitude reduction in energy requirement may be possible from frequency sequencing[*].

This report will deal with economics. For EMF to be useful as an alternative, its cost should not greatly exceed the present contract cost of MeBr, which is in the range of $1500-2200/acre. Cost of EMF application is proportional to the cost of energy required, which has two components:

- amount of energy required per unit volume of soil in Watt-seconds/cm3 (Biological effectiveness index or BE)
- volume of soil per acre to be treated.

- [*]ata on effectiveness and energy requirements and additional information on the technology of EMF pest control may be obtained from Bioterm LLC at bioterm@startel.net /870-367-7888(fax)/888-760-3349.

BE is tentatively established at 45-60. Volume of soil/acre is determined by the width and depth of the *pest target zone* (or yield protection zone), the space around and beneath the root system which must be disinfested to protect yield. This zone varies with the crop and cropping system.

We believe that this new technology should be employed in high capacity machines providing a contract service. The fact that labor is the second most important cost of operation (after energy) calls for high capacity machines to maximize labor productivity Machine capacity (acres/day) is determined by the power incorporated into design and by energy requirement, and can be calculated by a simple equation:

$$A/hr = (s')(B/R)(D)(c)(BE)(1/P)(1/N)(1/s'')$$

in which s' = sq.ft./A(43560); B = band width in feet; R = row width in feet; D = depth of treatment in feet; c = cm3/cu.ft.(2.8 X 10000); BE in J/cm3; P = power in watts available for each row; N = number of rows treated in each pass; s" = seconds/hr(3600). Acres/day = (A/hr)(Hours of operation/day). The reader is invited to use this equation to calculate machine capacity in acres/day for the following crop/pest example: treating to control annual weeds in a row crop – 12” band on 48” center, BE = 45, 1” depth, 250 KW/row, 4 rows treated in a single pass, 20 treating hours/day. (63 A/day)

Cost/acre projections can be calculated using standard methods when machine capacity is known or estimated. Bioterm's cost projection program for EMF field machines requires reasonable assumptions about 13 variables. In the example for annualized day neutral fresh strawberries grown in the central region of California (Table 1), the operating cost divided by the number of acres treated gives an estimated breakeven of $347.44/acre for 24 fully utilized machines at the end of the second year of operation. The effect of *changing assumptions* can be roughly evaluated by simple ratio and proportion calculations, bearing in mind that significant changes in assumptions require recalculations to verify new approximations:

ASSUMPTION	CHANGED FROM	CHANGED TO	NEW BREAKEVEN ($/A)
Energy requirement			
(BE)	45	90	694.88
(BE)	45	10	77.20
depth of treatment	15 cm	45 cm	1042.32
Treated band (% coverage)	50	100	694.88
utilization rate (days/month)	25	15	578.51

Similar rough approximations may be made for varying two or more assumptions simultaneously. Since the breakeven cost based on the assumptions given in the preceding paragraph is less than one-fourth the current MeBr cost, a margin for EMF appears to exist, even for radically changed assumptions. The margin is any combination of changed assumptions that do not increase the total energy requirement more than 4X (400%) in this specific case of annualized strawberries grown in central California.

These calculations can be made for any cropping system for which volume of soil/A in the yield protection zone can be estimated or established by experimentation.

We conclude that, because of recent technology advances, fungi, nematodes and weeds can be controlled at a cost considerably less than the current contract cost of MeBr. This is now a promising approach and should be actively studied.