Conclusions

Plants grown on soils that have been fumigated with methyl bromide usually show increased bromide concentrations. The highest concentrations occur during the first year following fumigation. While there is a potential health hazard involved, particularly where animals consume the forage grown, this can be minimized by choice of crop and by monitoring the accumulation of bromide by plants. It appears that fumigation before planting strawberries and grapevines is relatively safe, since the two crops do not absorb as much bromide from the soil as some other plant species and, furthermore, because bromide uptake in the fruit of both is extremely low.

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TABLE 1. Bromide Concentration of Several Plant Species in the Unfumigated and Methyl-Bromide-Fumigated Plots*

Plant species and part	Treatment	Range in bromide conc. (ppm)	Avg. bromide conc. (ppm)	S.E. of means
Barley (whole top)	Check	4 to 575	106 (19)**	38
	Fumigated	120 to 5,235	1,788 (23)	373
Bur clover (whole top)	Check	1 to 407	96 (11)	40
	Fumigated	196 to 2,371	1,334 (14)	155
Filaree (whole top)	Check	4 to 546	135 (14)	47
	Fumigated	718 to 7,380	2,600 (10)	683
Wild oats (whole top)	Check	9 to 876	196 (14)	66
	Fumigated	1,233 to 5,034	3,364 (11)	441
Spinach (leaves)	Fumigated	1,772 to 3,195	2,521 (04)	387
Ryegrass	Fumigated	1,481 to 2,790	2,378 (04)	302
Sweet potato (leaves)				
1st sampling	Fumigated	640 to 923	753 (04)	69
4th sampling	Fumigated	312 to 372	330 (04)	14
Sweet potato (root)	Fumigated	204 to 237	220 (02)	17
Strawberry (leaves)†	Check	14 to 129	63 (09)	16
	Fumigated	3 to 372	88 (36)	13
Grape (leaves)‡	Check	1 to 101	28 (90)	3
	Fumigated	1 to 402	48(278)	4

* These data represent samples collected the first year after fumigation with MeBr at rates of 300 to 600 lb/acre, except for grape leaves.
† Strawberry leaves were collected after one to six annual fumigations with MeBr.
‡ Grape leaves were collected two to four years after fumigation with MeBr.
** Numbers in parentheses refer to the number of samples in the average.

TABLE 2. Bromide Concentrations in Plant Material (ppm on Dry Weight Basis), 1, 2, 3, and 4 Years after Fumigation with Methyl Bromide

	Bromide concentrations (ppm)				
	Untreated	Years after Fumigation			
County	Controls	1	2	3	4
Sonoma	94 (19)*	3018 (16)	360 (15)	516 (8)	12 (3)
Napa	163 (21)	1476 (15)	742 (10)	430 (2)	

* Numbers in parentheses = number of samples included in the average.

Ozone-pesticide interactions

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Pesticides that interact to produce less damage may be of great value in minimizing air pollution losses and should be incorporated into pest management systems where there is significant air pollution.

Air pollutants and pesticides are two of the major environmental contaminants present in agricultural areas. Both categories of contaminants have been the subject of intensive research by scientists interested in pest management, phytotoxicity, and crop production. Most of the main effects of air pollutants and pesticides have, therefore, been documented rather extensively. However, the combined effects (interactions) of air pollutants and pesticides have not received equal attention.

A few fungicides, herbicides, anti-transpirants, and selected chemicals have been screened for interactions. Most were included in studies targeted at identifying anti-air pollutant qualities. Benomyl, methyl 1-(butylcarbamoyl)- 2-benzimidazole carbamate, has been one of the most tested compounds for its reported anti-oxidant property. Insecticides, however, have been largely ignored.

Two insecticides, Spectracide 25EC (diazinon) and Lannate 90SP (methomyl), were selected to be tested for potential interactions with ozone, the most prevalent phytotoxic air pollutant. Commercial formulations of both insecticides were applied at the recommended concentrations of 1 oz/3 gal of water and 0.5 lb/100 gal of water, respectively, on beans.

Forty 14-day-old Pinto bean seedlings (*Phaseolus vulgaris* L., var. UI III) were treated with the respective insecticides employing a dip method of application. The insecticide treatments and a control treatment were set up in a randomized complete block and replicated four times, with ten plants per replicate. Half of the plants in each treatment were fumigated with ozone at a level of 30 parts per hundred million (pphm) for two hours on the following day. All plants were harvested 3 days after the ozone exposure. The experiment was carried out in a 100 x 35 ft activated carbon-filtered greenhouse. Beans were grown in 4-inch plastic pots and selected for uniformity before being randomly selected for treatments.

Diazinon and methomyl both interacted with ozone to produce dramatic alterations in foliar injury. Methomyl and ozone interacted to produce a synergistic response, greater injury than that produced by the sum of methomyl and ozone applied separately (fig. 1). Diazinon and ozone interacted to produce an antagonistic response: less injury than that caused by the ozone alone (fig. 2). The methomyl-ozone interaction resulted in accentuated phytotoxicity with subsequently more leaf area injured. The diazinon-ozone interaction resulted in decreased phytotoxicity and the absence of foliar injury.

The analysis of variance using dry weights of unifoliate leaves showed highly significant ($P < .01$) interactions with ozone. Dry-weight differences separated well (see table). The diazinon-ozone treatment produced a significant (13.2 percent) increase in dry weight over the fumigated control while the methomyl-ozone produced a 21.4 percent loss. It should be noted that diazinon and methomyl were from formulated products and not pure material.

The diazinon-ozone and methomyl-ozone interactions were brought about with a single formulation concentration of insecticide and a single dose of ozone. The experiment did not provide sufficient data to define the ranges of pesticides or ozone concentration within which the interactions occur. Also, the magnitude and direction of the interactive responses on pinto bean were determined only at the labelled concentrations of pesticides and a single concentration of ozone. The interactive responses may be altered at different concentrations of either constituent—important areas of research which are needed to effectively characterize such interactions.

It is apparent from these data and those

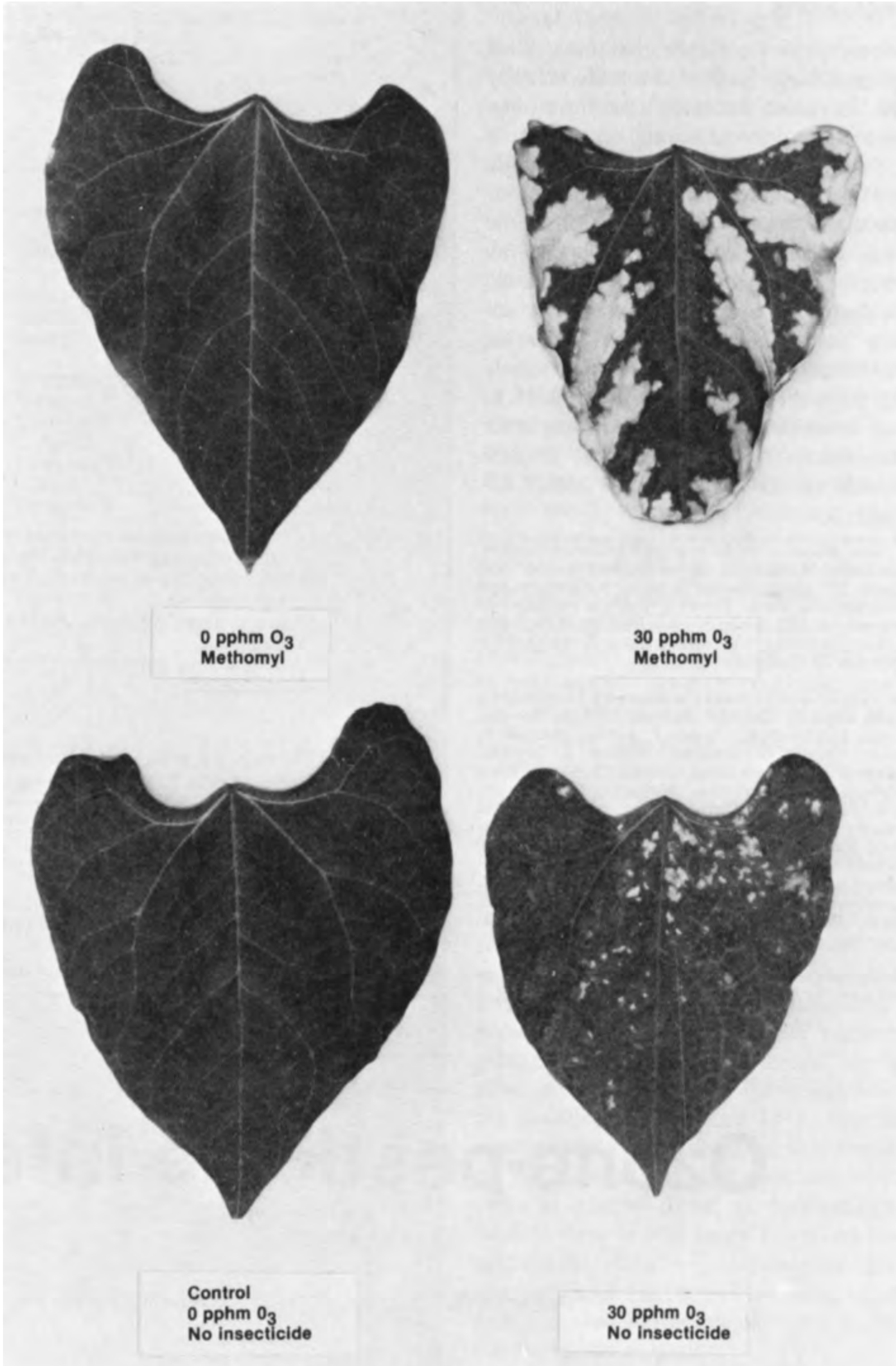

Fig. 1. Effect of methomyl and ozone alone and in combination on the unifoliate leaves of pinto bean.

Unifoliate Pinto-Bean Leaf Dry-Weights under Various Insecticide, Insecticide/Ozone Treatments

Treatment	Dry wt* (gms)
Diazinon-ozone	.2270 a†
Control-ozone	.2005 b
Lannate	.1970 b
Control	.1965 b
Diazinon	.1920 b
Lannate-ozone	.1575 c

* Treatment means.
† Means followed by the same letter are not significantly different at the 0.5 level by Duncan's Multiple Range Test.
LSD = .02392

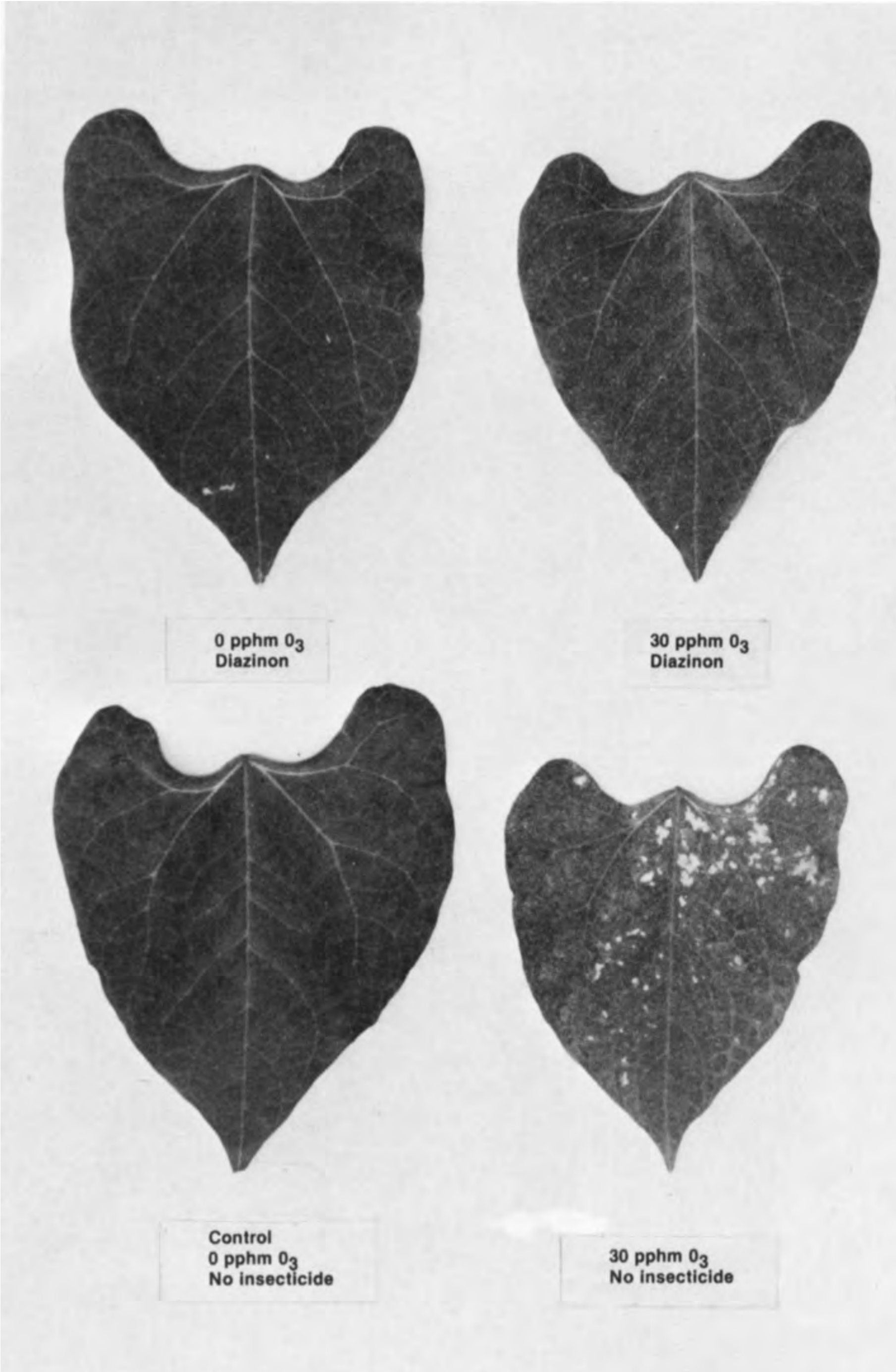

Fig. 2. Effect of diazinon and ozone alone and in combination on the unifoliate leaves of pinto bean.

already in the literature that interactions between pesticides and air pollutants may have an enormous impact on agriculture. There is ample documentation that both pesticide use and ambient ozone are widespread in California. The potential for interactions occurring in the environment is therefore extremely high. It is not unreasonable to believe that many of the reports of phytotoxicity in the agricultural industry, previously blamed on pesticides or air pollutants alone, are in fact the result of interactions. Pesticide effectiveness may also be influenced by air pollutants. Pinto beans have been reported to be sensitized to ozone injury by the presence of phenamiphos, fensulfothion, aldicarb, and oxamyl. The effectiveness of 2,4-D has been demonstrated to be reduced when applied in the presence of ozone. The current data for pesticide-air pollutant interactions are alarmingly scarce considering the numbers and quantities of pesticides in use.

Air pollution-pesticide interactions may profoundly affect the Integrated Pest Management approach to pest control. This type of information would be necessary in order to put together a viable pest management program for locations with significant air pollution. It would be of little value to recommend particular pesticides for pest suppression unless their interactive potential is known. Pesticides that interact to produce less damage may be of great value in minimizing air pollution losses and should be incorporated into IPM programs for areas with significant air pollution.

Future research must be directed toward identifying air pollution-pesticide interactions and quantifying interactive responses. Research should be carried out both in controlled experimentation and in the field if this information is to be utilized to improve the current situation.

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Publication on grapevine nutrition

A 40-page practical guide for diagnosing nutrient deficiencies or excesses, *Grapevine Nutrition and Fertilization in the San Joaquin Valley* (Publication No. 4087) discusses the role and utilization of minerals important in grapevine nutrition, describes symptoms of problems, and recommends corrective measures. Twenty-one color photographs show fruit, leaf, or shoot symptoms of deficiencies or excesses of nitrogen, potassium, magnesium, zinc, boron, iron, manganese, and salt.

Laboratory diagnostic procedures and tissue sampling methods are described, and values are given for interpreting laboratory analyses.

Of special interest to growers in the San Joaquin Valley, the manual also contains information applicable to other grape-growing areas in California.

Price—$5.00—includes postage and handling within the United States only. (California residents, add sales tax.) Orders of less than $10.00 must be prepaid. Please make check or money order payable to The Regents of the University of California. When ordering from outside the United States, request a Pro Forma Invoice and state postal charges desired—air or surface mail. **Address:** Agricultural Sciences Publications, University of California, 1422 Harbour Way South, Richmond, California 94804.