FRESH FRUIT FUMIGATION WITH PHOSPHINE AS ALTERNATIVE FOR METYL BROMIDE

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This is an alternative for fresh fruit fumigation where pure phosphine, free of ammonia is used at low temperature for the control of pests in fresh fruit. The gas is applied in fumigation chambers, cooling chambers or controlled atmosphere chambers at low temperatures.

It was determined that this can be done successfully if the fumigation is carried out at a temperature between –1,5 and 15 ºC with a concentration of pure phosphine free from ammonia, between 700 and 3500 ppm (1-5 grams /m^3) in a sealed enclosure, with a exposure time between 36 and 72 hours. The gas used for the described fumigations was VAPORPH_3OS, manufactured by Cytec.

No damage to the fruit has been detected if the fumigation is carried out under the above conditions.

Some small off-taste of fumigated fruits was observed following fumigation, but this disappeared after 5 or 6 days of storage at low temperatures.

Until now the treatment with high dosages of methyl bromide (30-60 grams/m^3) was the most used and effective fumigation method for fresh fruit, which, although quick and efficient, has a series of disadvantages, such as the known ozone depletion, residues and phytotoxicity.

For several years, phosphine has been investigated as an alternative for the treatment of fresh fruit and vegetables with methyl bromide. The research have shown good results as for mortality of insects. However, acceptable results were not obtained in reference to the quality of treated fruit, which had always suffered damage. This damage has been caused by two reasons mainly: presence of ammonia and relatively high fumigation temperature, over 15°C, to which the tests have been carried out.

Until the Horn Diluphos System was developed, it was not possible to apply pure phosphine for fumigations, because of the pyrophobic characteristics of the product. Therefore, until that moment, the only possible way to apply phosphine was through a reaction of hydrolysis of metallic phosphides like aluminum phosphide or magnesium phosphide.

The problem was that the aluminum phosphide or magnesium phosphide based products have the great disadvantage that, if they are used at low temperature, they produce phosphine very slowly and that they always produce ammonia as a by-

product and ammonia is known to be very phytotoxic. For that reason damage to the fruit is expected when using metal phosphides.

As now in the last few years pure phosphine free of ammonia was available, it has been possible to carry out fresh fruit fumigation at low temperature and with high gas concentrations, with the surprising discovery that the quality of the fruits is not damaged and it is possible to eliminate the main pests of fruits.

This fumigations can be carried out diluting the pure phosphine with air, using the Horn Diluphos System, or using a non flamable mixture of nitrogen and phosphine.

It was discovered that when lowering the temperature, it is possible to carry out the fumigation with a very high concentration of phosphine with no damage to the fruit, since at that temperature, the metabolic activity of the fruit is slowed down.

This high concentration compensates the low activity of the insects at low temperatures controlling the pests.

The best way to do the treatment with phosphine is to fumigate the fruits directly in the cooling chambers where the fruit is stored after the selection process, leaving the cooling system working during the whole fumigation period.

The fruit is preferably treated at the cold storage temperature of each fruit. For example, for apples, grapes, kiwis and berries, pears, nectarines, peaches, etc. it is preferred the treatment with temperatures from –1,5 to 2°C. Other fruits like avocados, citric, mangos are preferably to be treated to their corresponding cold storage temperature.

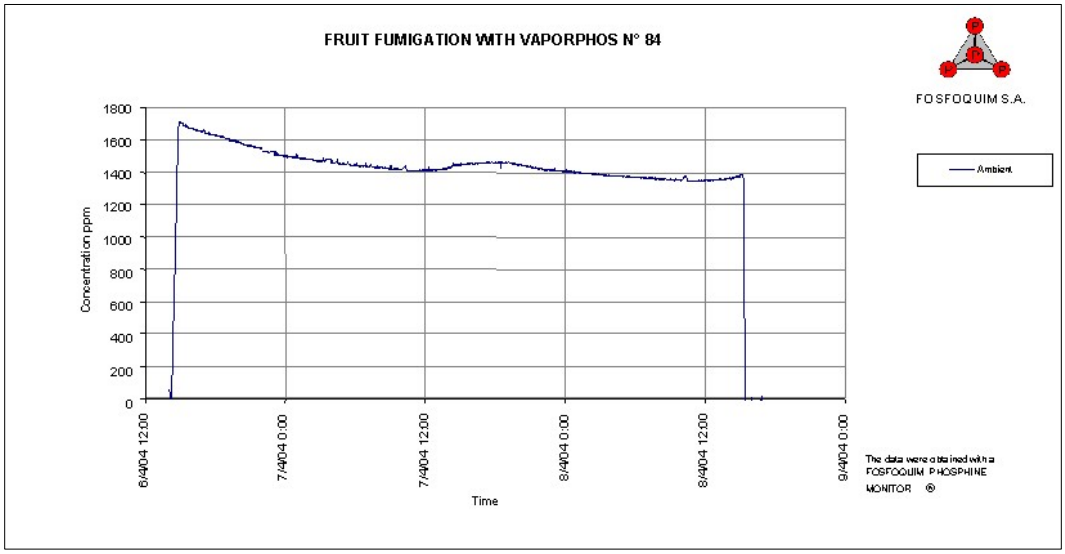
In this procedure, using the Horn Diluphos System, no increase of pressure is generated inside the enclosure to fumigate, since the air of the inside of the enclosure is recirculated through the HDS system.

The use of pure phosphine has as main advantage, compared to methyl bromide, which is the fact that it does not leave bromine residues in the fruits after treatment and that after liberated to the atmosphere, phosphine is oxidized into phosphoric acid by the action of sunlight.

It has been demonstrated that it is possible to control the main pests of the fruit, such as the mealybugs, *Pseudococcus spp*; apple moth, *Cydia pomonella*; eulia, *Proeulia spp*; fruit tree weevil, *Naupactus xanthographus*; mediterranean fruit fly, *Ceratitis capitata*; fruit flys, *Rhagoletis spp*, *Bractocera spp*, *Anastrepha spp*; chilean false spider, *Brevipalpus chilensis;* and *Thrips spp.*

TREATMENT	INSECT	STAGE	Description	Insects	Alive	Dead	Rate %
Exposure to 2.1 grs. of phosphine/m^3 at a temperature between -1 a –0.3º C during 62 hours and 44 minutes	*Pseudococcus viburni*	Adult	FUMIGATED	160	0	160	100.0
			NOT FUMIGATED	65	55	10	15.4
		Crawler	FUMIGATED	819	0	819	100.0
			NOT FUMIGATED	335	305	30	9.0
		Egg	FUMIGATED	360	1	359	99.7
			NOT FUMIGATED	120	108	12	10.0
	Cydia pomonella	1st state larva	FUMIGATED	16	0	16	100.0
			NOT FUMIGATED	5	5	0	0.0
		5t state larva	FUMIGATED	7	0	7	100.0
			NOT FUMIGATED	6	5	1	16.7

Table 1.: Phosphine fumigation results on infected apples compared with non fumigated apples.



Graph 1.: Phosphine concentration graph during whole fumigation period.