CURRENT RESEARCH OF ALTERNATIVES TO METHYLE BROMIDE IN JAPANEASE QUARANTINE

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A total amount of methyl bromide (MB) consumption in Japanese quarantine in 1997 was 2,070 tons with 1,255 tons for timbers (60.6%), 579 tons for food grains (27.9%), 221 tons for fresh fruit and vegetables (10.7%) and 16 tons for cut flowers and live plants (0.8%). Japan has focused on development alternatives to MB for its reduction. Disinfestation technologies introduced into quarantine treatments and current research are as follows;

1. Stored grains

Carbon dioxide (CO_2): CO_2 fumigation in warehouse and silo had been introduced with four schedules based on the susceptibility of pests to CO_2 (*Sitophilus granarius; Sitophilus zeamais* and *Sitophilus oryzae; Tribolium confusum, Lasioderma serricorne* and *Rhizopertha dominica; Ephestia kuehniella, Plodia interpunctella* and *Cadra cautella).* **PH_3:** Small scale test against *S. granarius* pupae, which is the most resistant stage were killed at 0.5 g/m^3 of PH_3 from cylinder or gas generator for 10 days at 20 C. Complete mortalities at same dose and temperature were obtained for 14 days and 2 days, for *S. zeamais and S. oryzae* pupae and all stages of *T. confusum, L. serricorne and P. interpunctella*, respectively. **PH_3+CO_2:** Mortality effect on pupal stages of *S. granarius, S. zeamais and S. oryzae* was compared by gas mixtures of PH_3 (0.3 and 0.6g/m^3) and CO_2 (30, 40 and 50%) with PH_3 (0.3 and 0.6g/m^3) alone to study reduction of exposure period. PH_3+CO_2 fumigation showed an adverse effect on mortality than PH_3 alone. **Cold treatment (CT):** All stages of *S. granarius, Callosobruchus rodesianus, C. cautella*, and *E. kuehniella* were killed completely at –18 C for 4 hours and no damage was confirmed on wheat, maize, soy bean, small red bean. This technology could be applied for small amounts of commodities by postal packages and carry on baggage.

2. Fresh fruit and vegetables

Vapor heat (VH): Mangoes, papayas, bell pepper, etc. infested with *Bactrocera dorsalis species complex* and *B. cucurbitae* from Okinawa had been shipped to mainland of Japan after VH treatment at 43-46 C. Recently, sweet potato infested with *Cylas formicarius, Eusceps postfasciatus* and *Omphisa anastomosalis* from Okinawa was also shipped to mainland after treatment at 47-48 C for 3 hours and 10 minutes. Mortality tests against scales and mites on the surface of fruit are studying on. PH_3 Fumigation at 2g/m^3 for 16-24 hours at 15 C provided effective control of *Tetranychus urticae* without chemical injuries on apples (Ohrin, Kinsei, Jonagold, Mutsu and Fuji varieties) and grapefruit (Kyoho **v**ariety) at 3g/m^3 for 18-24 hours at 15 C while severe damage was observed on Satsuma mandarins. Mortality test against *Lepidopterous* species is studying on. **Methyl isothiocyanate (MITC):** MITC showed severe damage with brown colored skin and pulp of Ohrin, Kinsei, and Fuji apples and Satsuma mandarins at 4-8g/m^3 for 24 hours at 15 C.

3. Cut flowers

MB+ PH_3+ CO_2 or MB+PH_3: Each stage of eight species of pests (*T. kanzawai, Thrips palmi, Trialeurodes vaporarium, Aphis gossypii, etc.)* on cut flowers of chrysanthemum and orchid was fumigated by mixture gas with MB (10g/m^3), PH_3 (3g/m^3) and CO_2 (5%) for 3 hours at 15 C or for

4 hours at 15 C. *T. kanzawai* egg, which was most resistant stage to the fumigation was killed completely at above schedules. No injury was observed on six cultivars of chrysanthemum and four cultivars of orchid, which were more sensitive to the fumigation than others. The schedules had been introduced into quarantine treatment. MB dose in the schedule is reduced to 2/3 compared to that of conventional schedule (48g/m^3). Current research showed mixed gas of MB and PH_3 without CO_2 had almost the same efficacy against *T. kanzawai* egg. **Electron beam irradiation (EBI):** Seven species of insects (*T. urticae, T. palmi, A. gossypii, etc*.) on cut flowers are sterilized at 400Gy and no injury was observed on 17 species of cut flowers such as chrysanthemum, lily, carnations, orchid, etc. There are, however, a few quarantine problems of which sterile aphids still have ability to plant virus transmission and insufficient penetration to high- density packages.

4. Timbers

Sulfuryl fluoride (SF): Fourteen species of forest pests (*Semanotus japonicus, Monochamus alternatus, Cryphalus fulvus, Ips cembrae, Sirahoshizo sp., Xyleborus pfeili, etc.*) were fumigated with SF. *X. pfeili* egg, which was most resistant to SF was not killed at dose of as much as 100g/m^3 for 48 hours at 15 C. All stages of the pest including *X. pfeili* were killed at 50g/m^3 for 24 hours at 25 C. SF fumigation could be applied for imported timbers at limited seasons of late spring, summer and early autumn in Japan. **PH_3:** Eight species of pests (*S. japonica, C. rufipenne, M. alternatus, P. perlatus, C. fulvus, X. pfeili, etc)* were tested at 1.0 and 2.0g/m^3 for 24 and 48 hours at 15 and 25 C. *S. japonicas and P. perlatus* eggs were killed completely at 2.0g/m^3 for 24 hours at 15 C, but larvae and pupae of all species were not killed at 2.0g/m^3 for 48 hours at 15 C. All stages of *C. fulvus* and *X. pfeili* except *C. fulvus* larvae were killed at 2.0g/m^3 for 48 hours at 25 C. **SF+PH_3 or SF+MB:** Fumigant mixtures are under investigation to obtain higher mortality and to reduce MB consumption.