Bull. Environ. Contam. Toxicol. (1997) 59:564-569

Bulletin of Environmental Contamination and Toxicology

Degradation of Dimethoate in Chrysanthemums and Soil

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Received: 9 January 1996/Accepted: 25 June 1997

Chrysanthemum (*Chrysanthemum Morifolium* Tzvel) is an important medical herb that is widely planted in China. It can not only cure some diseases as a traditional medicine but may be a useful health protective ingredient. It is usually processed into dry flower or health beverage to go on the market. Aphids (*Aphids gossypii* Glover and *Pyrethrmyzus sanborni* Gilletti) and stem borers (*Phytoecia rufiventris* Gautier) are two important pests that damage Chrysanthemum plants and affect the yield of Chrysanthemum flowers. Dimethoate, O,O-dimethyl-S-(N-methylcarbamoyl-methyl)phosphorodithioate, is a broad-spectrum systemic insecticide used on many crops world-wide. It is also widely used to protect chrysanthemums from Aphids (*Aphis gossypii* Glover and *Pyrethrmyzus sanborni* Gilletti) and stem borer (*Phytoecia rufiventris* Gautier) in China currently. Because high residues of dimethoate will affect human health, degradation and residues of dimethoate in crops, fruits and vegetables have been brought to people's attention. Lee and Westcott (1981) described the rapid degradation of dimethoate in wheat leaves. MacNeil et al.(1975) studied the persistence of dimethoate and dimethoxan on cherries and found the half life in sweet and sour cherries was 6.6 and 4.69 days. Zwick et al.(1977) also determined the residues of dimethoate and dimethoxon on sweet cherries and found the half life degraded residues was 3.5 to 4 days. Woodham et al. (1974a, 1974b) designed several experiments for searching the effect of different application on persistence of dimethoate and its oxygen in citrus and showed higher residues by the aid of ultra low volume spray than conventional high volume spray. Yutaka Iwata et al. (1981) reported half life of dimethoate in citrus leaves was 3.6 days. Steller and Brand (1974) reported half life of dimethoate in grapes was 6.8-7.0 days. Ferreira et al. (1987) studied residues of dimethoate and omethoate in peaches and apples and described only in the case of apples with seven applications, mean residues of dimethoate exceeded 1 ppm at the end of the preharvest interval (14 days). Szeto et al. (1985) reported that after application of dimethoate, the residues in asparagus decreased by about 90% in 7 days. There is, however, no report on dimethoate residues in chrysanthemum flowers to be published. To determine dimethoate residues in chrysanthemum products and keep

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them below the maximum residue limit, it is necessary to design some tests to monitor the degrading behavior of dimethoate in the flowers of chrysanthemum and soil and establish a preharvest interval for safe application of the dimethoate.

MATERIALS AND METHODS

The trials on chrysanthemums and soil were set up at Chrysanthemum Test Station of Tongxiang Medical Company of Zhejiang Province. The trial soil was a loam. The physical and chemical property of soil is shown in Table 1. Every trial plot is 20 square meters. Trials and control plots were randomly selected and the protective lines were set up between trial plots. Every treatment was replicated three times. According to the time of insect pests happen, the trial plots were total treated twice. The first dimethoate treating of soil and chrysanthemum leaves was on Sept. 3, 1989 and Aug. 28, 1990 separately. This time, the total trial plots, except control plots, were treated at 600 ppm dimethoate water solution (0.45 kg AI/ha). A Solo manual backpack sprayer (made in China) was used to spray dimethoate water solution. Samples of soil were randomly collected from trial field on 0, 6, 9, 18, 29 (1989) and 0, 7, 11, 16, 20, 31 (1990) days after the first application.

Table 1. Physical and chemical property of soil

graduals composition (weight %)				O.C(%)	pH
>0.2mm	0.2-0.02mm	0.02-0.002mm	<0.002mm		
3.0	40.0	43.5	13.5	2.34	5.44

The second treatment was carried out on different preharvest intervals. The tests were separated into two groups. One group was treated at 600 ppm dimethoate water solution (0.45 kg AI/ha). Another was treated at 400 ppm dimethoate water solution (0.30 kg AI/ha). A micro manual sprayer of volume 1.5L was used to spray dimethoate water solution. Details of application times are shown in Tables 4, 5.

Samples of soil and chrysanthemum flowers were randomly collected from each field replicate at the harvest of chrysanthemum flowers.

Both soil and chrysanthemum flower samples were analyzed for determination of dimethoate. Soil samples were collected, dried by air in dark and sieved through 40 mesh screen. The preparation of dry flowers was as follows: first, the fresh flowers were put in a food steamer and steamed for 4 minutes above boiling water, then air-dried under the Sun. The detailed analytical procedure of soil and chrysanthemum flower samples was described by Jialun Wu and Defang Fan (1992).

RESULTS AND DISCUSSION

In the 1989 and 1990 field trials, the results of dimethoate degradation in soil are shown in Tables 2 and 3. According to the analytical results of dimethoate residues, the half lives of dimethoate in soil were 5.1(1989) and 7.1 (1990) days separately. The difference of two years in the half life of dimethoate in soil was the result of an immediate shower after applying dimethoate in the field in 1989. This shows that rainfall can affect the persistence of dimethoate in field soil.

Table 2. Degradation of dimethoate in soil (1989)

days after first appl.	residues ppm($\bar{x} \pm sd$)
0	–
6	0.117 ± 0.029
9	0.068 ± 0.006
18	0.014 ± 0.003
29	0.006 ± 0.001

Table 3. Degradation of dimethoate in soil (1990)

days after first appl.	residues ppm($\bar{x} \pm sd$)
0	0.334 ± 0.028
7	0.165 ± 0.011
11	0.078 ± 0.056
16	0.061 ± 0.0004
20	0.040 ± 0.005
31	0.016 ± 0.001

After the second application of dimethoate on different preharvest intervals, the residues of dimethoate in chrysanthemum flowers, leaves and soil were described in Tables 4 and 5. The results show that dimethoate residues can remain more than one month in the chrysanthemum flowers. The half life of dimethoate residues in fresh flowers was 5.2 (0.45 kg (ai)/ha,1989), 7.07 (0.30 kg(ai)/ha, 1989) 7.53 (0.45 kg(ai)/ha, 1990) and 7.07 (0.30 kg(ai)/ha, 1990) days. Chrysanthemum flower is usually soaked in hot water for drinking in summer. Because the fresh flower is difficult to store, it is usually made into dry flower by drying treatment. Owing to the weight ratio of fresh to dry flowers (about 5:1), the drying treatment of chrysanthemum flowers can concentrate the residues of dimethoate in the chrysanthemum flowers. The drying treatment, however, can cause dimethoate degrading. The concentrated ratio of dimethoate residues is different from the dimethoate residues in fresh flowers and drying process methods (such as the time of steaming fresh flower, exposed under sun and wind dry of the flowers etc.).

Dimethoate is a broad spectrum, systemic insecticide used on many crops world-wide. There has been a lot of research work on degradation and residues of dimethoate in crops, fruits and vegetables to be done. Lee and Westcott (1981) described that dimethoate can quickly degrade in wheat leaves. MacNeil et al.(1975) studied the persistence of dimethoate and dimethoxan on cherries and

Table 4. Residues of dimethoate in leaves and flowers of chrysanthemum and soil (1989)

days between last appl and harvest	rate, kg ai/ha	dimethoate residues ppm ($\bar{x} \pm sd$)			
		dry flower	fresh flower	fresh leaves	soil
10	0.450	2.36 ± 0.850	1.39 ±0.042	18.5 ± 4.31	0.157 ± 0.023
15		0.83 ± 0.035	0.56 ±0.035	14.2 ± 2.96	0.057 ± 0.014
19		0.46 ± 0.050	0.43 ±0.049	10.2 ± 0.34	0.017 ± 0.002
10	0.300	1.60 ± 0.460	0.80 ±0.134	14.0 ± 0.34	0.131 ± 0.015
15		0.81 ± 0.042	0.51 ±0.025	10.6 ± 2.92	0.062 ± 0.001
19		0.42 ± 0.085	0.33 ±0.021	6.69 ± 1.14	0.015 ± 0.001

Table 5. Residues of dimethoate in leaves and flowers of chrysanthemum and soil (1990)

days between last appl and harvest	rate, kg AI/ha	dimethoate residues ppm ($\bar{x} \pm sd$)		
		fresh flower	dry flower	soil
7	0.450	6.20 ± 0.223	1.22 ± 0.043	0.165± 0.011
11		1.28 ± 0.134	0.51 ± 0.108	0.086± 0.007
16		0.88 ± 0.028	0.31 ± 0.005	0.061± 0.001
21		0.60 ± 0.001	0.24 ± 0.020	0.047± 0.004
26		0.51 ± 0.049	0.16 ± 0.002	0.035± 0.053
31		0.17 ± 0.020	0.11 ± 0.009	0.016± 0.002
7	0.300	5.11 ± 0.064	1.13 ± 0.085	0.126± 0.004
11		1.15 ± 0.056	0.35 ± 0.008	0.078± 0.006
16		0.79 ± 0.106	0.28 ± 0.009	0.057± 0.008
21		0.51 ± 0.018	0.19 ± 0.010	0.040± 0.005
26		0.40 ± 0.006	0.14 ± 0.004	0.028± 0.001

found the half life in sweet and sour cherries was 6.6 and 4.69 days separately. Zwick et al.(1977) also determined the residues of dimethoate and dimethoxon on sweet cherries and found the half life degraded residues was 3.5 to 4 days. Woodham et al. (1974a, 1974b) carried on the research of effect of different applying methods on persistence of dimethoate and its oxygen in citrus and showed there were higher residues by the aid of ultra low volume spray than conventional high volume spray. Yutaka Iwata et al. (1981) reported half life of dimethoate in

citrus leaves was 3.6 days. Steller and Brand (1974) reported the half life of dimethoate in grape was 6.8-7.0 days. Ferreira et al.(1987) studied residues of dimethoate and omethoate in peaches and apples and described only in the case of apples with seven applications, mean residues of dimethoate exceeded 1 ppm at the end of the preharvest interval (14 days). Szeto et a1.(1985) reported that after application of dimethoate, the residues in asparagus decreased by about 90% in 7 days. Comparing these results to chrysanthemum flowers, it can be found that the degradation of dimethoate in chrysanthemum flowers is slower than in above plants. This is related to the low temperature and soft sunlight during florescence of chrysanthemum. Chrysanthemum flowers are used as a traditional medicine as well as a material that makes beverage. Considering the toxicity and water solubility of dimethoate, it is necessary to establish a safety application interval between last application and harvest to control its residues in chrysanthemum flowers. In view of the fact that no MRLs of dimethoate on chrysanthemum flowers have been established and previous MRLs of dimethoate on many fruits and vegetables were more than 1 ppm (FAO/WHO, 1994), 15 days the pre-harvest interval will be recommended as the minimum for application of dimethoate twice on the fresh chrysanthemum flowers per year if 1 ppm was considered as the MRLs of dimethoate on the fresh chrysanthemum flowers.

Acknowledgments. The authors thank Mr. Baorong Xu and the Medical Company of Tongxian for providing test fields and necessary help.

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