【Original Article】

Pesticide Residues in Pre-shipment Agricultural Products Grown in Gunma Prefecture

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Summary

An inspection of pesticide residues in 615 samples of pre-shipment agricultural products (total number of samples tested for individual pesticides, hereinafter referred to as "total number of samples": 50,782) grown in Gunma Prefecture was performed from FY 2003－2006. Traces of residues were detected in 154 (25.0%) of the pre-shipment products and in 233 (0.46%) of the total number of samples. None of these products contained pesticide residues exceeding the specified limits set by the Food Sanitation Law, securing the safety of all those products at the pre-shipment stage. However, 10 pesticides that were not registered with the Japanese Ministry of Agriculture, Forestry and Fisheries (non-MAFF-registered pesticides) were detected in 8 types of products and in 16 samples. Records of pesticide purchase and use maintained by relevant farming families showed no history of use of these pesticides in 14 cases (drift: 7 cases; soil contamination: 5 cases; and inadequate machinery/tool washing: 2 cases). In the remaining 2 cases involving minitomatoes, incorrect use of pesticides was evident, as they were confused for tomatoes. A comparison of different categories of agricultural products showed that the pesticide detection rate was highest in fruits, followed by fruit-type, leaf-and-stem, and root vegetables ($p < 0.05$).

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Key words: pesticide residues, pre-shipment agricultural products, non-MAFF-registered pesticides, drift

Introduction

With the diversification of diet in recent years, the quantity of imported agricultural products has increased leading to problems such as detection of pesticide residues at levels exceeding the pesticide residue specifications stipulated under the Food Sanitation Law[1)] and nationwide use of non-MAFF-registered pesticides. Consumer interest regarding the presence of pesticide residues in foodstuffs has lately increased to a greater extent with the growing apprehension about food safety. Under these circumstances, a positive-list system has been introduced since May 29, 2006 pursuant to the amended Food Sanitation Law, and legal specifications and test methods have been established for approximately 700 types of pesticides.

The "Local Ordinance Concerning Proper Sale, Use and Management of Pesticides in Gunma Prefecture" (hereinafter referred to as the Local Ordinance) was enacted in Gunma Prefecture in the fiscal year (FY) 2002 to prevent the use of non-MAFF-registered pesticides and ensure the proper use of pesticides. Efforts have thus been taken to implement the proper use of pesticides with emphasis on the following three approaches: maintenance of records of pesticides used, voluntary inspection, and confirmatory inspection by an administrative body.

Gunma Prefecture bilaterally represents the consumer and the producer. As provided for by the Local Ordinance, agricultural products are subject to pre-shipment confirmatory pesticide residue tests to ensure safe supply of agricultural products to consumers. The tests need to be completed within the limited time to allow maximum provision of fresh agricultural products. By using the supercritical fluid extraction (SFE) method, we made it possible to attain test results within 2 days[2-13].

The use of hazardous organic solvents is minimized with SFE compared to conventional extraction with organic solvents, and purification can be omitted because of the scanty amount of interfering substances that are extracted. Thus, SFE has an advantage of lesser analytical time.

Only pre-shipment agricultural products were subjected to inspection in this study. Those products containing pesticide residues prior to the circulation stage were excluded. Therefore, sample products found to contain residues were examined for contamination based on the records of pesticide purchase and use maintained by pesticide users. Actual data of pesticide residue detection obtained in the study were statistically evaluated with respect to categorization of agricultural products with high rates of pesticide detection.

Materials and Methods

1. Food materials

Pursuant to the Local Ordinance, this study aimed to survey locally grown pre-shipment agricultural products obtained at collection centers in Gunma Prefecture from April 2003 to March 2007. This study included 615 samples from 28 pre-shipment agricultural products, as shown in Table 1.

2. Pesticides included in the study

A total of 163 pesticides were investigated, as shown in Table 2. They included 35 organophosphorus compounds, 17 organochlorine compounds, 18 carbamate compounds, 15 pyrethroid compounds, 76 organonitrogen compounds, and 2 other compounds.

3. Pesticides and reagents

(1) Standard pesticide materials

Standard materials for residual pesticide testing, manufactured by Wako Pure Chemical Industries, Ltd. (Osaka, Japan) and Kanto Chemical Co., Inc., (Tokyo, Japan), were used.

(2) Organic solvents

Solvents for residual pesticide testing were used for extraction and purification, and solvents for liquid chromatography/mass spectrometry (LC/MS) were used as mobile phases.

(3) Others

ENVI-Carb/NH_2 (500 mg/500 mg) cartridges

Table 1. The List of Investigated Samples

Domestic (615)
【Fruits(96)】 Apple(28)、Japanese apricot(27)、Japanese pear(31)、Plum(10)
【Leaf and stem vegetables(242)】 Cabbage(30)、Chinese cabbage(20)、Garland chrysanthemum(20)、Komatsuna(20)、Lettuce(19)、Qing geng cai(19)、Spinach(30)、Udo(10)、Brocoli(17)、Nira(19)、Negi(38)
【Fruits vegetables(195)】 Cucumber(30)、Eggplant(30)、Green soybeans(10)、Strawberry(40)、Tomato(39)、Sweetcoon(10)、Kodamasuika(10)、Suika(10)、Minitomato(16)
【Root vegetables(82)】 Edible burdock(20)、Root of Japanese radish(22)、Konnnyakuimo(20)、Yamato imo(20)

manufactured by Supelco GmbH (Sigma, St. Louis, MO, USA) were used for mini-column purification.

4. Instruments

(1) GC/MS: Model 5973N (Agilent Technologies, Inc. Santa Clara, CA, USA)

(2) GC/FPD: Model GC2010 (Shimadzu Corp., Kyoto, Japan)

(3) LC/MS/MS: Model AP12000 (Applied Biosystems, Inc., Foster City CA, USA)

Table 2. The List of Pesticides Tested

Organophosphorus pesticides (35)
【Insecticide】acephate, cadusafos, chlorfenvinphos, chlorpyrifos, chlorpyrifos-methyl, cyanophos(CYAP), diazinon, dichlorvos(DDVP), dimethoate, dimethylvinphos, disulfoton, EPN, ethoprophos, etrimfos, fenitrothion(MEP), fensulfothion, fosthiazate, isofenphos, isoxathion, malathion, methamidophos, methidathion, monocrotophos, phenthoate, phosalone, pirimiphos-methyl, prothiofos, pyraclofos, quinalphos, terbufos, thiometon, vamidothion 【Fungicide】edifenphos(EDDP), tolchlophos-methyl 【Herbicide】butamifos
Organochlorine pesticides (17)
【Insecticide】α -BHC, β -BHC, γ -BHC, δ -BHC, o,p'-DDT, p,p'-DDT, p,p' -DDD, p,p' -DDE, aldrin, chlorobenzilate, dieldrin, dicofol、endrin 【Fungicide】captan、HCB, procymidone, quintozene(PCNB)
Carbamate pesticides (18)
【Insecticide】aldicarb, bendiocarb, benfuracarb, carbaryl(NAC), carbosulfan, ethiofencarb, fenobucarb(BPMC), isoprocarb(MIPC), methomyl, methiocarb, oxamyl, pirimicarb, propoxur(PHC), XMC 【Herbicide】chlorpropham(CIPC), esprocarb, pyributicarb, thiobencarb
Pyrethroid pesticides (15)
【Insecticide】acrinathrin, bifenthrin, cyfluthrin, cyhalothrin, cypermethrin, deltamethrin, etofenprox, fenpropathrin, fenvalerate, flucythrinate, fluvalinate, halfenprox, permethrin, silafluofen, tefluthrin
Organonitrogen pesticides (76)
【Insecticide】acetamiprid, chlorfluazuron, chromafenozide, clofentezine, clothianidin, diflubenzuron, fenpyroximate, fipronil, flufenoxuron, imidacloprid, lufenuron, methoxyfenozide, pyridaben, pyrimidifen, pyriproxyfen, quinomethionat, tebufenozide, tebufenpyrad, teflubenzuron 【Fungicide】azoxystrobin, bitertanol, carpropamid, cyazofamid, cymoxanil, cyproconazole, cyprodinil, dichlofluanid, diethofencarb, difenoconazole, dimethomorph, famoxadone, fenarimol, fenhexamid, ferimzone, fluazinam, flusilazole, flusulfamide, flutolanil, hexaconazole, imazalil, iprodione, mepronil, metalaxyl, myclobutanil, oxadixyl, penconazole, pencycuron, propiconazole, pyrifenox, tebuconazole, tetraconazole, thiabendazole(TBZ), thifluzamide, triadimefon, triadimenol, trifloxystrobin, triflumizole 【Herbicide】alachlor, cafenstrole, diflufenican, dimethametryn, lenacil, linuron, mefenacet, metolachlor, naproanilide, napropamide, pendimethalin, prometryn, propanil, pyributicarb, simazine, simetryn, terbacil, trifluralin 【Plant growth regulator】paclobutrazol
Other pesticides (2)
【Herbicide】benfuresate 【Plant growth regulator】dimethipin

(4) Extractor: SFE apparatus Model SFX 220 (ISCO Inc., Lincoln, NE, USA)

5. Measurement conditions

(1) GC/MS conditions

(i) GC section: Model 6890 (Agilent Technologies, Inc.)

(ii) MS section: Model 5973N (Agilent Technologies, Inc.)

(iii) Column: DB-XLB

(iv) Column temperature: 80-300°C; initial time, 1 min at 80°C; rise, 20°C/min to 140°C -0 min; rise, 4°C/min to 200°C -0 min; and rise, 8°C/min to 300°C -5 min

(2) GC/FPD conditions

(i) Column: DB-210 (Internal diameter: 0.53 mm, length: 15 m, membrane thickness: 1 μm)

(ii) Column temperature: 100 -240°C; initial time, 1 min at 100°C; rise, 10°C/min to 240°C -10 min

(iii) Injection port temperature: 220°C

(iv) Injection volume: 1.0 μl

(v) Detector temperature: 250°C

(vi) Carrier gas: Helium

(3) LC/MS/MS conditions

(i) HPLC pump: Model 1100 (Agilent Technologies, Inc.)

(ii) MS section: Model AP12000 (Applied Biosystems, Inc.)

(iii) Column: Ascentis C18 or Zorbax Eclipse XDB -C18

(4) SFE extraction conditions

(i) Extraction vessel: Polymer cartridge 10 ml

(ii) Extraction vessel oven temperature: 50°C

(iii) Pressure: 2500 psi

(iv) CO_2 density: 0.749 g/ml

(v) CO_2 flow rate: 3 -4 ml/min

6. Methods

Pesticide components were extracted from the samples by SFE[2-13], followed by dissolution in acetone and subsequent concentration. These components were then quantified, according to the procedures described previously[14], by gas chromatography (GC) with a flame photometric detector (GC/FPD), GC with mass spectrometry (GC/MS), and liquid chromatography with tandem mass spectrometry (LC/MS/MS). When the results of the analysis suggested a possible violation of Food Sanitation Law specifications or when non-MAFF-registered pesticide components were detected, confirmatory tests were conducted using the test methods described in a previous report[14].

The analytical values were considered acceptable when the recovery rates were between 70% and 120% and the relative standard deviations were within 20%. The lower limit of quantification was set at 0.005 μg/g.

7. Statistical analysis

Statistical comparisons among groups of agricultural products were performed using Fisher's χ^2 test. The SPSS software package (version 10.0, SPSS Inc., Chicago, IL) was used for the statistical analysis. A p value of <0.05 was considered statistically significant.

Results and Discussion

1. Pre-shipment inspection of agricultural products for residual pesticides

Table 3 shows the pesticide detection status of pre-shipment agricultural products tested during the period FY 2003 -2006. Of the 615 samples tested, 154 (25.0%) contained pesticide residues exceeding the lower limits of quantification, and 233 (0.45%) of the 50,782 samples tested for individual pesticides contained detectable pesticides. However, the levels of the pesticides detected were extremely low and none of the tested products contained pesticide residues exceeding

Table3. Detected pesticides of domestic agricultural products

Groups	Commodity	samples		pesticide		Detected pesticide	No. of positive	Detected value(mg/kg)	Geometric mean
		Total number	detected [a)]	Total of tested number	detected [b)]				
Fruits	Apple	28	20	2,664	31	Iprodione	3	0.006~0.04	0.017
						Chlorpyrifos	13	0.009~0.08	0.017
						Silafluofen	4	0.017~0.14	0.041
						Tebufenpyrad	1	0.01	0.01
						Trifloxystrobin	7	0.01~0.18	0.042
						Bifenthrin	1	0.01	0.01
						Flufenoxuron	1	0.03	0.03
						Prothiofos	1	0.06	0.06
	Japanese pear	31	19	2,678	28	Carbaryl	6	0.017~0.23	0.045
						Acetamiprid	2	0.011、0.011	0.011
						Iprodione	4	0.02~0.111	0.041
						Chlorpyrifos	3	0.01	0.01
						Clothianidin	1	0.017	0.017
						Difenoconazole	3	0.007~0.02	0.015
						Cypermethrin	3	0.04~0.099	0.058
						Diflubenzuron	1	0.007	0.007
						Methomyl	1	0.016	0.016
						Fenvalerate	1	0.09	0.09
						Fenitrothion	1	0.029	0.029
						Flufenoxuron	1	0.027	0.027
						Fluvalinate	1	0.01	0.01
	Plum	10	4	990	6	Iprodione	4	0.08~0.45	0.139
						Chlorpyrifos	1	0.02	0.02
						Difenoconazole ※	1	0.01	0.01
	Japanese apricot	27	9	2,307	11	Iprodione	2	0.019、0.031	0.024
						Difenoconazole	7	0.009~0.17	0.041
						Bitertanol	1	0.03	0.03
						Fenitrothion	1	0.03	0.03
	Subtotal	**96**	**52**	**8,639**	**76**				
Leaf and stem vegetables	Udo	10	0	1,270	0				
	Cabbage	30	11	2,700	19	Acephate	5	0.009~0.09	0.037
						Oxadixyl	2	0.01、0.02	0.014
						Tefluthrin	1	0.015	0.015
						Tolchlophos-methyl	1	0.006	0.006
						Procymidone	6	0.011~0.027	0.017
						Metalaxyl	1	0.015	0.015
						Methamidophos	3	0.03	0.03
	Komatsuna	20	5	1,500	9	Cyazofamid	1	0.03	0.03
						Cypermethrin	3	0.096~0.15	0.113
						Tefluthrin	1	0.01	0.01
						Procymidone ※	2	0.007、0.008	0.007
						Fosthiazate ※	1	0.008	0.008
						Metalaxyl	1	0.01	0.01
	Garland chrysanthemum	20	6	2,020	8	Oxadixyl	2	0.007、0.071	0.022
						Trifluralin ※	2	0.02、0.04	0.028
						Fenitrothion	1	0.01	0.01
						Fenpyroximate ※	1	0.007	0.007
						Fosthiazate ※	2	0.005、0.021	0.01
	Qing geng cai	19	4	1,368	5	Acetamiprid	2	0.018、0.094	0.041
						Flufenoxuron	1	0.08	0.08
						Procymidone ※	1	0.007	0.007
						Fosthiazate ※	1	0.01	0.01
	Nira	19	0	1,180	0				
	Negi	38	4	2,496	4	EPN	2	0.02、0.04	0.028
						Cypermethrin	1	0.016	0.016
						Permethrin	1	0.013	0.013
	Chinese cabbage	20	6	1,830	9	Acephate	1	0.01	0.01
						Iprodione	3	0.006~0.011	0.009
						Etofenprox	1	0.005	0.005
						Fenvalerate	3	0.006~0.041	0.012
						Methomyl	1	0.018	0.018

Groups	Commodity	samples: Total number	samples: detected a)	pesticide: Total of tested number	pesticide: detected b)	Detected pesticide	No. of positive	Detected value(mg/kg)	Geometric mean
Leaf and stem vegetables	Brocoli	17	1	939	1	Chromafenozide	1	0.01	0.01
	Spinach	30	6	2,590	7	Imidacloprid	3	0.005~0.59	0.042
						Clothianidin ※	1	0.01	0.01
						Cyazofamid	1	0.17	0.17
						Cypermethrin	2	0.03、0.13	0.062
	Lettuce	19	4	1,346	4	Iprodione	2	0.01、0.016	0.013
						Fenvalerate	1	0.01	0.01
						Procymidone	1	0.03	0.03
	Subtotal	**242**	**47**	**19,239**	**66**				
Fruits vegetables	Strawberry	40	18	3,140	37	Acetamiprid	6	0.01~0.81	0.076
						Azoxystrobin	4	0.006~0.097	0.028
						Acrinathrin	2	0.012、0.088	0.032
						Dicofol	1	0.06	0.06
						Tetraconazole	2	0.014、0.019	0.016
						Tebufenpyrad	4	0.011~0.146	0.044
						Triflumizole	3	0.02~0.48	0.122
						Bitertanol	3	0.018~0.154	0.038
						Pyridaben	1	0.026	0.026
						Fenarimol	1	0.11	0.11
						Procymidone	1	1.7	1.7
						Fosthiazate	1	0.012	0.012
						Myclobutanil	6	0.012~0.211	0.049
						Metalaxyl	1	0.02	0.02
						Lufenuron	1	0.02	0.02
	Green soybeans	10	1	420	1	Tebufenpyrad ※	1	0.043	0.043
	Cucumber	30	10	2,510	15	Acrinathrin	1	0.03	0.03
						Acetamiprid	2	0.006、0.028	0.013
						Clothianidin	1	0.01	0.01
						Cymoxanil	1	0.008	0.008
						Methomyl ※	1	0.013	0.013
						Triflumizole	1	0.023	0.023
						Flufenoxuron	1	0.006	0.006
						Procymidone	1	0.12	0.12
						Fosthiazate	3	0.006~0.007	0.006
						Metalaxyl	3	0.005~0.017	0.009
	Kodamasuika	10	0	500	0				
	Sweetcorn	10	0	1,450	0				
	Suika	10	5	1,510	6	Acetamiprid	3	0.009~0.018	0.012
						Iprodione	2	0.008、0.014	0.011
						Oxadixyl	1	0.008	0.008
	Tomato	39	9	3,276	17	Acetamiprid	2	0.015、0.026	0.02
						Azoxystrobin	1	0.049	0.049
						Iprodione	2	0.016、0.38	0.078
						Diethofencarb	7	0.015~0.21	0.041
						Pyridaben	2	0.006、0.006	0.006
						Procymidone	1	0.12	0.12
						Metalaxyl	2	0.01、0.04	0.02
	Eggplant	30	3	2,750	3	Cyazofamid	1	0.007	0.007
						Triflumizole	2	0.015、0.019	0.017
	Minitomato	16	2	1,000	2	Captan ※	1	0.2	0.2
						Quinomethionat ※	1	0.1	0.1
	Subtotal	**195**	**48**	**16,556**	**81**				
Root vegetables	Edible burdock	20	1	1,850	1	Fosthiazate	1	0.006	0.006
	Konnnyakuimo	20	1	1,310	1	Metalaxyl	1	0.01	0.01
	Root of Japanese radish	22	5	2,108	8	Oxamyl	2	0.011、0.018	0.014
						Disulfoton	4	0.006~0.026	0.01
						Fosthiazate	2	0.05、0.051	0.05
	Yamanoimo	20	0	1,080	0				
	Subtotal	**82**	**7**	**6,348**	**10**				
Total		**615**	**154**	**50,782**	**233**		**233**		

a) Number of Samples in which pesticide was detected
b) Total number of pesticide detected in commodity
※ non-MAFF-registered pesticide

the pesticide residue specifications stipulated under the Food Sanitation Law.

(1) Pesticide detection rates according to agricultural product category

The pesticide detection rate according to agricultural product category was highest in fruits, followed by fruit-type vegetables, leaf-and-stem vegetables, and root vegetables (4 types) in order, with significant inter-category differences ($p < 0.05$).

When compared with previously reported data concerning domestic agricultural products[14], the pesticide detection rate for fruits among the pre-shipment agricultural products was significantly higher that that previously reported for fruits among domestic agricultural products ($p < 0.01$).

The detection rate for products in pre-shipment stage was higher than that for those in the distribution stage due to their shorter periods after exposure to pesticides.

(2) Detection of pesticides according to agricultural product category

Nineteen types of pesticides were detected in fruits, the most frequent being chlorpyrifos, followed by iprodione, difenoconazole, trifloxystrobin, and silafluofen in order. Twenty-three pesticides were detected in leaf-and-stem vegetables, the most frequent being procymidone, followed by acephate and cypermethrin, iprodione, oxadixyl, fosthiazate, and fenvalerate in order. Twenty-six pesticides were detected in fruit-type vegetables, the most frequent being acetamiprid, followed by diethofencarb, triflumizole, metalaxyl, myclobutanil, and azoxystrobin in order. Four pesticides were detected in root vegetables, and the most frequent being disulfoton followed by fosthiazate and others.

Overall, the fungicide iprodione was most frequently detected in pre-shipment agricultural products, followed by chlorpyrifos and acetamiprid (insecticides), procymidone (fungicide), and difenoconazole (fungicide).

When compared with previously reported data concerning domestic agricultural products[14], fungicides tended to be relatively more frequent among the pesticide categories detected in pre-shipment agricultural products, whereas insecticides were considerably more frequently detected in previously reported domestic agricultural products. Generally, fungicides applied to kill microorganisms pathogenic to plants are used when vegetables are prone to contract a plant disease due to elevated humidity in plastic hothouses or due to long spells of rainy weather. The relatively frequent detection of fungicides in pre-shipment agricultural products during this study might be attributed to the fact that a considerable proportion of agricultural products tested were those grown in vinyl plastic hothouses.

(3) Detection of non-MAFF-registered pesticides

The present results showed that none of the tested samples violated the Food Sanitation Law, but 10 non-MAFF-registered pesticides were detected in 16 samples among 8 agricultural product categories (Table 4).

Among the agricultural products tested positive for pesticide detection, garland chrysanthemum reported positive for pesticide detection the maximum number of times (detected in 5 samples) followed by komatsuna (detected in 3 samples), and qing geng cai and minitomato (detected in 2 samples each). Of the non-MAFF-registered pesticides, the most frequently detected was the insecticide fosthiazate in 4 samples, followed by the fungicide procymidone in 3 samples, and the herbicide trifluralin in 2 samples. Akiyama et al.[15] also documented a case of methomyl, a non-MAFF-registered insecticide, detected in unripe kidney beans as a case indicative of improper use of pesticides.

2. Sources of non-MAFF-registered pesticides

Table 5 shows the results of an investigation, based on pesticide category, exploring the causes that led to the detection of non-MAFF-registered pesticide components in this study, on the basis of records of pesticide purchase and usage maintained by the users.

The most frequently detected non-MAFF-registered pesticide was fosthiazate (insecticide), followed by procymidone (fungicide), trifluralin (herbicide), and others. The most frequently estimated cause for detecting pesticides in pre-shipment products was drift (7 samples, 44%), followed by possible soil residues (5 samples, 31.3%), inadequate washing of farm machinery/tools (2 samples, 12.5%), and misuse (2 samples, 12.5%).

Table 4. Detection of non-MAFF-registered pesticides

Groups	Commodity	non-MAFF-registered pesticides	Detected	Sources
Fruits	Plum	Difenoconazole	1	Drift
Leaf and stem vegetables	Komatsuna	Procymidone	2	Drift
		Fosthiazate	1	soil contamination
	Garland chrysanthemum	Trifluralin	2	Drift
		Fenpyroximate	1	inadequate machinery/tool washing
		Fosthiazate	2	soil contamination
	Qing geng cai	Procymidone	1	soil contamination
		Fosthiazate	1	soil contamination
	Spinach	Clothianidin	1	Drift
Fruits vegetables	Green soybeans	Tebufenpyrad	1	Drift
	Cucumber	Methomyl	1	inadequate machinery/tool washing
	Minitomato	Captan	1	incorrect use
		Quinomethionat	1	incorrect use
Total			16	

Table 5. Sources of non-MAFF-registered pesticides

No	non-MAFF-registrred pesticide	Detected	Sources			
			Drift	soil contamination	inadequate machinery /tool washing	incorrect use
1	Captan	1				1
2	Clothianidin	1	1			
3	Difenoconazole	1	1			
4	Fenpyroximate	1			1	
5	Fosthiazate	4		4		
6	Methomyl	1			1	
7	Procymidone	3	2	1		
8	Quinomethionat	1				1
9	Tebufenpyrad	1	1			
10	Trifluralin	2	2			
Total		16	7	5	2	2

Procymidone and trifluralin were detected in 2 samples each, and the cause was speculated to be drift. Soil residues were suspected to be the cause for detecting fosthiazate in 4 samples, accounting for 80% of those suspected to be due to soil residues. Carron et al.[16] discussed the aspect of drift, voicing concern about environmental pollution based on near-field air concentration of pesticides as a function of distance from the measurement site and time elapse after pesticide spraying. White et al.[17] also discussed drift with concerns about the influence of pesticides on environmental pollution based on farm and non-farm ambient air pesticide concentrations. These studies do not necessarily consider the detection of non-MAFF-registered pesticide components in agricultural products as major, which is currently an issue in Japan, but raise a question about their effects on the environment, particularly about the influence on wild animals. Schampheleire et al.[18] have reported major factors contributing to drift based on the evaporation of active pesticide ingredients. Procymidone, among others detected in the present study, can be used on cucumbers, tomatoes, and eggplants even until the day before shipping. Therefore, adjustments with neighboring farming families enabling mutually concerted cooperation are essential.

Regarding pesticide residues in soil, Giannakou et al.[19] and Tsiropoulos et al.[20] discussed the efficacy of fosthiazate and other agents as soil nematocides based on their characteristic of remaining in the soil, whereas Bedos et al.[21] demonstrated that incorporating pesticides into the soil resulted in a reduction in the ambient pesticide concentration based on its volatilizing effect by measuring the pesticide half-life in soil. Sakai et al.[22] proposed that dieldrin pollution in soil can be estimated by measuring the organic carbon quantity.

Captan and quinomethionat became unusable for minitomatoes because of legally required separate registration of agricultural products and the definition that tomatoes no more than 3 cm in diameter are not included in the tomato category pursuant to the 2002 amendment to the Agricultural Chemicals Regulation Law. Thorough guidance of farming families needs to be recognized.

Good Agricultural Practice (GAP) is already an effective means to secure safety of agricultural products and conserve the environment by improving the quality of agricultural products and ensuring labor safety. A report has documented the effectiveness of GAP implementation which requires an explanation to be provided to consumers and food workers regarding field activities to be practiced to ensure agricultural product safety and quality, planning of farming operations from the viewpoint of quality assurance as well, and keeping records of operations and confirmed outcome thereof[23]. Pre-marketing tests/inspections of pre-shipment agricultural products are considered to yield effective and efficient results for GAP implementation.

Furthermore, the mutually concerted cooperation among farming families is of importance to ensure smooth negotiations, which are inevitable, between neighboring farming families.

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群馬県内で生産された出荷前農産物の残留農薬実態

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要　旨

2003 年度から 2006 年度に、出荷前農産物 615 検体（農薬別延べ検体;以下延べ検体: 50,782）の残留農薬検査を実施した。その結果、出荷前農産物の 154 検体（25.0%）、延べ検体の 233 検体（0.46%）から極めて微量の農薬が検出された。すべての農産物において、食品衛生法に定められた残留基準を超えるものはなく、出荷前の段階での安全性が確保された。しかし、8 種類の農産物から農薬取締法での登録が適用されていない農薬（以下、登録適用外農薬）の 10 種類が、延べ 16 検体から検出された。この検出された 16 事例について、適用外農薬の検出原因について、生産農家の農薬購入履歴や農薬使用記録等を全国に先駆け調査したところ、このうち 14 事例（ドリフト：7 事例、土壌汚染：5 事例、器具の洗浄不足：2 事例）で農薬使用履歴がなった。一方、誤使用の 2 事例のミニトマトについては、トマトとして使用したものであった。また、農産物の分類別農薬検出状況について、果実類＞果菜類＞葉茎菜類＞根菜類の順で高く、それぞれの分類間で有意差が認められた（p<0.05）。

キーワード：残留農薬、出荷前農産物、登録適用外農薬、ドリフト

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