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DISAPPEARANCE OF IPRODIONE DEPOSITS ON PEPPERS, EGGPLANTS AND TOMATOES

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Abstract. Disappearance of iprodione deposits on peppers, eggplants and tomatoes grown in commercial greenhouses and in a foil tunnel were studied. It was found that iprodione residues on ripening fruits decreased according to simple regression lines. Their initial values dropped by half and reached zero levels within 2.5-2.8 and about 5 weeks after Rovral FLO 255 SC application, respectively. Iprodione deposits on pepper leaves dropped within four weeks only by 30% while on eggplant leaves in practice stayed at the same level. The chemical may be suitable for the comparative study of real disappearance of pesticides after their applications for the control of pests and diseases.

Key words: disappearance, iprodione residues, vegetables, greenhouse

I. INTRODUCTION

Iprodione, IUPAC name 3-(3,5-dichlorophenyl)-N-isopropyl-2,4-dioxoimidazolidine--1-carboxamide, is a contact fungicide with protective and curative action against a broad spectrum of plant pathogens. It is now used extensively world-wide in different types of formulations, and its residues have been commonly found in a great variety of fruit and vegetables. Iprodione seems to be a stable compound (Cabras et al. 1985) and, if so, its deposits should ensure long-term protection, especially for plants or their parts completely developed at the time of the treatment. The chemical may also be suitable for the comparative study of real disappearance of pesticide residues (Sadło 1997).

The objectives of this work were to determine the characteristic disappearance parameters of iprodione residues on pepper, eggplant and tomato fruits and leaves grown in commercial greenhouses or in a foil tunnel.

II. MATERIALS AND METHODS

The trials (Tab. 1) were carried out in commercial greenhouses and in a foil tunnel. Pepper, eggplant and tomato plants, receiving routine horticultural practices, were sprayed in the evening with Rovral FLO 255 SC (active ingredient: 255 g of iprodione per 1 l of the agrochemical) in

Table 1

Disappearance studies

Plant	Variety	Greenhouse area (m^2)	Plant density (plant m^{-2})
pepper	Mazurca F_1	86.4	4.2
pepper*	Dolmy F_1	180.0	12.5
eggplant	Madonna F_1	86.4	4.2
tomato	Aromata F_1	15,000	2.5

* foil tunnel.

the form of homogeneous aqueous slurry in a concentration of 0.2%. Laboratory samples were taken in the morning (about 12 or 36 hrs after treatments) and carried on thereafter at weekly intervals, always on the same day. A completely randomised block design was adopted with four replications.

Extraction Procedure

One hundred grams of each vegetable sample was weighed into a 250-ml screw-capped flask and then stored at -18°C until analysis. After the end of experiment, the analytical portions were transferred to the laboratory of the Institute of Plant Protection and homogenised with 150 ml of acetone. An aliquot of filtrate, equivalent of 20 g of the analytical portion, was placed in a separatory funnel. Iprodione residues were extracted by the method published in the scientific journal of the Plant Protection Institute (Sadło 1998), based on solvent system proposed by Luke et al. (1975) with its subsequent modification (Ambrus et al. 1981), and combined extracts were evaporated to dryness with a Waring apparatus (Rotavapor-R of Büchi) below 40°C. Residues were transferred quantitatively with n-hexane to a 25 ml flask and, after proper dilution, were analysed with a Gas Chromatograph equipped with a Electron Capture Detector (ECD) in the linear range of its indications (below 0.5 ng). Iprodione residues were expressed in $\mu g\ g^{-1}$ and then their average residue values and Variation Coefficients (Relative Standard Deviations; RSD) were calculated.

16 discs were cut from the sampled leaves using a leaf punch sampler (0.5 cm of inner diameter), placed in a 100 ml screw-capped flask containing about 20 ml of acetone and then stored at -18°C. After the end of experiment, the analytical portions were transferred to the laboratory and homogenised with 100 ml of distilled water and 150 ml of acetone. An aliquot of filtrate, equivalent of one fifth of the analytical portion, was taken and further analysis followed as described above. Iprodione deposits were expressed in $\mu g\ cm^{-2}$ of the total leaves surfaces and then their average value and Relative Standard Deviation (Variation Coefficient) were calculated.

Disappearance studies of iprodione residues

There are many statistics available to measure the degree of relationship between two variables, but the most commonly used is the Pearson Correlation Coefficient, commonly symbolised as *r*. The Pearson's *r* contains two pieces of information: an estimate of the strength of the relationship, as indicated by the number, and a statement about the direction of the relationship, as shown by the sign. Because of its abstract nature, *r* must be interpreted with care. Some authors have suggested that an *r* between 0.40 and 0.70 expresses a moderate relationship, while an *r* of 0.71 to 0.90 very high. The highest and lowest absolute values that the *r* can achieve indicate perfect or no relationship between two variables.

Simple Linear Regression is a way of using the association between two variables as a method of prediction. The general equation for a line is $Y = a + bX$, where *Y* is the variable we are trying to predict, *X* is the independent variable we are predicting from, *a* represents the point at which the line crosses the *Y*-axis and *b* is a measure of the slope of the line.

In the case of disappearance study, the dependent variable Y represents residue level (R) at a given moment (t) after treatment, while the a and b values express the initial deposit of pesticide (R_0) and rate of its decrease with time. Thus, the final linear regression takes the form of $R = R_0 + bt$.

III. RESULTS OF STUDIES

Tables 2-7 show respectively the data of the evolution of iprodione residus on peppers, eggplant and tomato fruits and on pepper and eggplant leaves after single spraying carried out with Rovral FLO 255 SC.

Iprodione residues on greenhouse pepper

The first laboratory samples were taken the next day, about 12 hrs after treatment. They consisted of smaller pepper fruits, omitted during the harvest carried out just before spraying. Thus, iprodione residues in those samples averaged 0.21 μg g^{-1}, with variation coefficient amounting to 38%, and were over twofold lower than a week later (Tab. 2).

Table 2

Iprodione residues (μg g^{-1}) on pepper fruits grown in commercial greenhouse

Sampling	Mass of single pepper (g)	Mean	Variation Coefficient (%)	Median
1996-06-27	111	0.21	38	0.20
1996-07-03	140	0.50	16	0.48
1996-07-10	132	0.39	20	0.43
1996-07-17	157	0.27	14	0.26
1996-07-24	139	0.07	25	0.06
1996-07-31	135	0.04	32	0.04

The average iprodione recoveries were close to 100% with Variation Coefficient of the analytical method not exceeding 5%.

Starting from the second week after treatment the average iprodione residues on ripening pepper fruits decreased in a perfect relation with passing time (r = -0.984), according to simple regression line $R = 0.626 - 0.124t$. The course of the line indicated that initial residues, R_0 = 0.626 μg g^{-1}, decreasing by 0.124 μg g^{-1} per week, dropped by half ($t_{1/2}$) and reached the zero level 2.5 and about 5 weeks after treatment, respectively.

Iprodione residues on pepper from foil tunnel: fruits. The first laboratory samples were taken 36 hrs after treatment. Iprodione residues in those samples averaged 1.17 μg g^{-1}, with variation coefficient amounting to 50%, and were lower than a week later (Tab. 3).

Starting from the second week after treatment the average iprodione residues on ripening pepper fruits decreased in a perfect relation with passing time (r = -0.976), according to simple regression line $R = 2.31 - 0.443t$. The course of the line indicated that initial residues, R_0 = 2.31 μg g^{-1}, decreasing by 0.443 μg g^{-1} per week ($t_{1/2}$ = 2.6 weeks), reached the zero level also about 5 weeks after treatment.

Table 3

Iprodione residues (μg g^{-1}) on pepper fruits grown under commercial foil tunnel

Sampling	Mass of single pepper (g)	Mean	Variation Coefficient (%)	Median
1997-09-03	174	1.17	59	1.10
1997-09-10	161	1.81	61	1.92
1997-09-17	165	1.58	42	1.42
1997-09-24	102	0.84	29	0.81
1997-09-31	113	0.58	26	0.53

Table 4

Iprodione deposits (μg cm^{-2}) on pepper leaves grown under commercial foil tunnel

Sampling	Mean	Variation Coefficient (%)	Median
1997-09-03	8.25	24	8.40
1997-09-10	8.55	26	7.95
1997-09-17	8.65	19	9.05
1997-09-24	7.10	25	6.80
1997-09-31	8.15	49	6.30

Iprodione residues on pepper from foil tunnel: leaves. Iprodione deposits on pepper leaves decreased in a moderate relation with passing time (r = -0.439) (Tab. 4). Their medians diminished in a very high relation with passing time (r = -0.742), according to simple regression line $M = 8.75\text{-}0.53t$. The perfect negative correlation between medians and passing time (r = -0.999) was found after excluding the results obtained for pepper leaves in the third week after treatment. Initial iprodine deposits decreased according to the equation $M = 8.4 - 0.53t$. The course of the line indicated that iprodione deposit, M_0 = 8.4 μg cm^{-2}, decreasing by 0.53 μg cm^{-2} per week, 4 weeks after treatment yet constituted almost 70% of its initial value.

Iprodione residues on greenhouse eggplants: fruits. The first laboratory samples were taken just before treatment. They contained iprodione residues at the level of 0.05 μg g^{-1} resulting from a spraying carried out four weeks earlier. Iprodione residues on fruits immediately after Rovral FLO application averaged 0.19 μg g^{-1}, with variation coefficient amounting to 50%, and were slightly lower than a week later (Tab. 5).

Starting from the second week after treatment the average iprodione residues on ripening eggplant fruits decreased in a very high relation with passing time (r = -0.864), accord-

Table 5

Iprodione residues (μg g^{-1}) on eggplant fruits grown in commercial greenhouse

Sampling	Mass of single eggplant (g)	Mean	Variation Coefficient (%)	Median
1998-06-02*	523	0.05	0	0.05
1998-06-03	416	0.19	53	0.23
1998-06-10	457	0.26	38	0.29
1998-06-17	693	0.16	63	0.16
1998-06-24	464	0.11	27	0.09
1998-07-01	475	0.09	44	0.09

* Iprodione residues (μg g^{-1}) on eggplant fruits before the treatment.

ing to simple regression line $R = 0.268 - 0.048t$. The course of the line indicated that initial residues, $R_0 = 0.268$ μg g^{-1}, decreasing by 0.048 μg g^{-1} per week ($t_{1/2} = 2.8$ weeks), reached the zero level about 5 weeks after treatment.

Table 6

Iprodione deposits (μg cm^{-2}) on eggplant leaves grown in commercial greenhouse

Sampling	Mean	Variation Coefficient (%)	Median
1998-06-02*	0.21	71	0.19
1998-06-03	0.56	41	0.55
1998-06-10	0.93	18	0.94
1998-06-17	1.58	66	1.65
1998-06-24	1.61	32	1.53
1998-07-01	0.56	36	0.60

* Iprodione deposits (μg cm^{-2}) on eggplant leaves before the treatment.

Iprodione residues on greenhouse eggplants: leaves. The average values and medians of iprodione deposits changed irregularly (Tab. 6). Low value that the Pearson's r achieved in the case of eggplant leaves ($r = 0.212$) indicated no relationship between R or M and t (the two variables were uncorrelated). A random change of initial iprodione deposit resulted from uneven and different coverage of eggplant leaves with the chemical.

Iprodione residues on greenhouse tomatoes. The first laboratory samples were taken the next day after treatment. The fruits contained iprodione residues at the level 0.40 μg g^{-1}, similar to those found a week later, with variation coefficient not exceeding 10% (Tab. 7).

Table 7

Iprodione residues (μg g^{-1}) on tomato fruits grown in commercial greenhouse

Sampling	Mass of single tomato (g)	Mean	Variation Coefficient (%)	Median
1997-07-22	138	0.40	23	0.43
1997-07-29	127	0.40	15	0.42
1997-08-05	117	0.29	31	0.26
1997-08-12	123	0.10	100	0.08
1997-08-19	135	0.11	73	0.12
1997-08-26	130	0.03	67	0.02

Starting from the second week after treatment the average iprodione residues on ripening tomato fruits decreased in a perfect relation with passing time ($r = -0.948$), according to simple regression line $R = 0.445 - 0.089t$. The course of the line indicated that initial residues, $R_0 = 0.445$ μg g^{-1}, decreasing by 0.089 μg g^{-1} per week ($t_{1/2} = 2.5$ weeks), reached the zero level 5 weeks after treatment.

IV. CONCLUSIONS

1. Initial iprodione residues on pepper, eggplant and tomato ripening fruits decreased in a good relation with passing time, according to simple regression lines. Their average values dropped by half and reached zero levels within 2.5-2.8 and about 5 weeks after Rovral FLO 255 SC application, respectively.
2. Iprodione deposits on pepper leaves within four weeks dropped only by 30% while on eggplant leaves in practice stayed at the same level.

3. Plants or their parts almost fully developed during treatment should be protected for a period of four weeks.
4. Iprodione deposit due to its persistence may serve as a reference compound in disappearance study of any chemical with comparative method.
5. Acceptable Daily Intake, established for iprodione at the level of 0.2 mg kg^{-1} body weight (Tomlin 1994), shows that a 60 kg person could eat even 5.2 kg ripe pepper fruits per day.

V. LITERATURE

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ZANIKANIE DEPOZYTÓW IPRODIONU NA PAPRYCE, OBERŻYNACH I POMIDORACH ROSNĄCYCH W KOMERCYJNYCH SZKLARNIACH I TUNELU FOLIOWYM

STRESZCZENIE

Przeprowadzono badania nad zanikaniem depozytów iprodionu na papryce, oberżynach i pomidorach. Stwierdzono, iż pozostałości iprodionu na dojrzałych owocach zmniejszały się w czasie liniowo. Ich początkowe poziomy spadły o połowę po upływie 2,5-2,8 tygodnia, a poziom zerowy osiągnęły po około 5 tygodniach od dnia aplikacji Rovralu FLO 255 SC.

Depozyty iprodionu na liściach papryki w okresie 4 tygodni spadły o około 30%, podczas gdy na liściach oberżyny utrzymywały się w przedziale wyznaczonym zmiennością metody. Fungicyd ten jest zatem odpowiedni do porównawczych badań zanikania środków ochrony roślin stosowanych do zwalczania szkodników i chorób.