An estimation of agrochemicals spray amount on vegetables in Japan

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Abstract

Spray amount (especially, the minimum which is effective to pests) in vegetable fields were estimated mainly for evaluation of exposure to operators. The spray amounts on 5 crops were measured in 2 years. Consequently, when crop height or crop wall area (= row length × crop height) was over 1.7 m or 20 m^2, respectively, the spray volume might be exceed registered upper limit (300 L/10a). The information of spray volume of the tests which conducted in the past were collected. As a result, the spray volume tend to increase in a small scale experiment, in efficacy and phyto-toxycity tests. Tests on residues in crops did not appropriate to estimate requiring spray amount because the amount might be set following the registered range. In addition, efficacy of chlorothalonil against pumpkin powdery mildew was evaluated in the field at 4 different concentrations and spray amounts with the same active substance application rate. In conclusion, efficacy was the lowest in the smallest spray volume treatment. Judging from the mechanism of action, coverage of spraying may important factor such as protective fungicides.

Keywords: agrochemical, fungicide, efficacy, phyto-toxicity, spray amount, residues in crops, powdery mildew, chlorothalonil, mechanism of action, protective, systemic

1. Introduction

Ministry of agriculture, forestry and fisheries (MAFF) introduced the 2 new evaluation factors in the process of agrochemicals registration, in 2019[1)]. The first one is the evaluation of agrochemicals exposure against users. The other one is the evaluation of adverse effects of agrochemicals on honeybees (*Apis* spp.). In the United States, already started the evaluation of agrochemicals exposure to the operators[2)]. Similarly, in the European Union, guidance document on plant protection products exposure to operators and others was published in 2014[3)]. The guidance documents are available on the evaluation of bees[4, 5)]. These evaluations are urgent issue and amount of spraying against crops is a critical factor.

Nowadays, registered spray amount in Japan is generally 60-150 L/10a on cereals, 100-300 L/10a on vegetables and 200-700 L/10a on fruits trees. These ranges were determined from common Japanese agricultural practices in 1990s. The users may regulate spray amount based on size, growth stage and cultural practices of target crops in the ranges of stated above. However, recent common spray amounts in Japanese fields are unclear. In particular, the minimum spray amount which has significant effectiveness to pests is an important information to evaluate exposure against the users and honeybees. Though, it is expected that there are many difficulties to determine the effective minimum spray amount because many factors affect the spray amount and effectiveness in actual fields. There were a few studies on the effective minimum spray amount of agrochemicals. In the previous study, the impact on the effectiveness of spray machines difference was investigated in vine field in the United States [6]. Although, from the aspect of the registration of agrochemicals in Japan, case studies of spray amount in Japan might be more important than foreign data because crop cultural practices are different in each country or region.

Main factors which affect spray amount might be crop height and numbers of leaves (or leave area). These factors are varied by variation of crops, climate, cultural practices and/or other conditions. Therefore, as a case study, the spray amount against some vegetables were investigated in this report. In addition, to estimate the minimum effective spray amount, effectiveness of chlorothalonil (TPN) under a certain condition was evaluated.

The aims of this study were (1) to determine a common spray amount on some vegetables and (2) to investigate the minimum effective spray amount against a disease.

2. Materials and methods

2.1. Estimation of common spray amount on vegetables in Japan

The spray amounts on some vegetables were quantified in the field of Food and Agricultural Materials Inspection Center, Agricultural Chemicals Inspection Station (Kodaira city, Tokyo, Japan), for 2 years (2019-2020). In the first year, cucumber (*Cucumis sativus*, cv. 'VR-natsu-suzumi', TAKII & Co., Ltd., Japan), eggplant (*Solanum melongena*, cv. 'Togenashi-senryo-nigou', TAKII & Co., Ltd., Japan) and okra (*Abelmoschus esculentus*, cv. 'Early-five', TAKII & Co., Ltd., Japan) were grown[7]. In the second year, eggplant (cv. 'Chikuyou', TAKII & Co., Ltd., Japan), sweet pepper (*Capsicum annuum*, cv. 'Kyo-hikari', TAKII & Co., Ltd., Japan) and tomato (*Solanum lycopersicum*, cv. 'CF-puti-puyo', WATANABE SEED Co., Ltd., Japan) were cultivated. All the crops were grown until the harvest stage (Table 1). Five liters (5 kg) of the water containing spreading agent (Gramin S, Mitsui Chemicals Agro, Inc., Japan; diluted in 0.1 mL/L water) was filled in a battery-powered sprayer (MUS153D, Makita Corporation, Japan) and the spray nozzle with 3 heads (ring shape, NAGATA SEISAKUSYO Co., Ltd., Japan) was applied.

Table. 1. Summary of the crops conditions in 2020.

Crop	Growth Stage	Crop height (m)	Row width (m)	Row length (m)	Number of crops/row	Date of spraying	Days after planting
Tomato	Beginning of harvest	1.7	0.7	10.6	25	26, June	45
Eggplant	Beginning of harvest	1.1	0.7	10.3	17	20, July	67
Sweet pepper	Middle of harvest	1.0	0.7	10.0	20*	20, July	67

* In 1 row, 19 was planted because of the lacking.

In the first year, spraying was done with 5, 5 and 4 replicates (operators), in cucumber, eggplant and okra, respectively. In the second year, spraying was done with 5, 3 and 3 replicates (operators), in tomato, eggplant and sweet pepper, respectively. In each spraying, an "adequate amount" of the water was sprayed, and in this report "adequate" means the water amount dripping from leaves after spraying. The spraying was done on the each rows and the remaining water amount was measured. Then the actual spray amount was calculated by subtracting the remaining water volume from the initial water volume. After that, based on the width and length of the fields, spray amount on the fields were estimated. The unit of spraying amount for a certain area is expressed with "L/10a", following Japanese agrochemicals registration system. In addition, the crop in a row was regarded as a wall and the areas of the wall (crop wall area; CWA) was calculated by the length of row and each crop height. Pieces of Water sensitive paper (Teejet® Technologies, the United States) were placed on 2 to 3 points in each rows with 2 to 3 vertical position in order to check spraying heterogeneity. There was no remarkable heterogeneity of the spraying by visual observation.

2.2. Investigation of spray amount in test results

The spray amounts in the test results which were conducted in the past were investigated. The information were collected from the tests for efficacy and phyto-toxicity and residues in crops those of conducted in Japan. The investigated crops were pumpkin (*Cucurbita* spp.), sweet pepper and tomato (these crops were the same as served for the field experiments in 2020). The results from 2013 to 2019, and the results from 1970 to 2015 were collected on the test of efficacy and phyto-toxicity, and on the test of residues in crops, respectively, but in some year, tests on these crops were not conducted. The crops formerly surveyed[7] were not researched again.

2.3. Estimation of the minimum effective spray amount against pumpkin powdery mildew

The effect of chlorothalonil (TPN) in different spray amount with the same amount of active substance was evaluated. As a formulation, ST Daconil 1000 (TPN 40.0%, Sumitomo Chemical company, Ltd., Japan) was used. Pumpkin (cv. ‘Kuribou’, SAKATA SEED Corporation, Japan) were grown in concrete frames (0.7 × 0.7 m). Five treatments were established with 3 replicates in each and placed following randomized block design. Treatments were (1) 2000 fold dilution and 200 L/10a spray, (2) 1000 fold dilution and 100 L/10a spray, (3) 500 fold dilution and 50 L/10a spray, (4) 250 fold dilution and 25 L/10a spray, and (5) untreated control (Fig. 1). The treatment (2) is the registered minimum amount on pumpkin in Japan, and the amount of active substance per unit area was equivalent to 40.0 g/10a. Eventually, the amount of active substance in the unit area was the same in all the treatments. Spraying was done by using a pressure sprayer (No. 4130, FURUPURA Co., Ltd., Japan) with 1 L tank. Five hundred mili liter of the each dilution was filled in the sprayer and pressure was adjusted at ca. 330 kPa. The spraying rate of the sprayer was 4.08 mL/s (average of 3 measurements), thus the spraying time was determined as 24 seconds in treatment (1), 12 seconds in (2), 6 seconds in (3) and 3 seconds in (4). The spraying was conducted twice at August 5 and 12, 2020. The efficacy was evaluated 7 days after the second treatment (19 August, 2020).

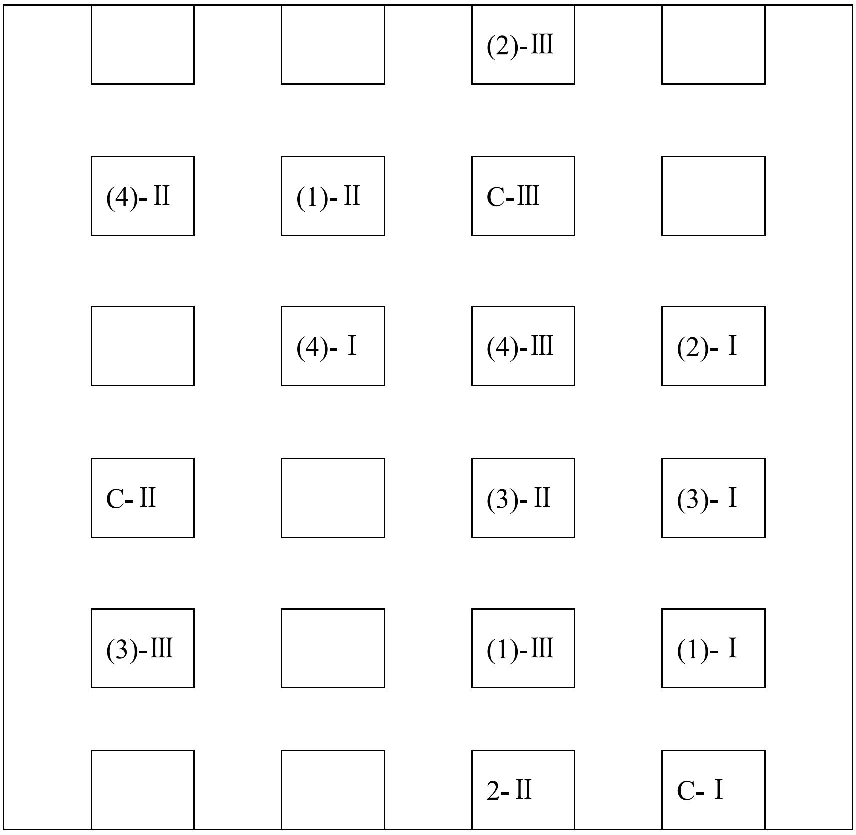

Fig. 1. The layout of the experimental plots. The roman numerals mean replicate number, numbers in parenthesis mean each treatment and "C" means untreated control.

Powdery mildew (naturally occurred and the species was unknown) was already occurred at the beginning of the experiment and diseased leaves were not removed. The effectiveness was evaluated based on disease index (DI). The index was determined based on the proportion of denoting area of symptoms on the leaves (0: No symptoms, 1: less than 5%, 2: 5-25%, 3: 25-50%, and 4: more than 50%). Ten leaves (with disease indices 0 or 1) were marked in each plots and observation of progress of the disease was conducted on these leaves. Disease severity (%) and disease suppression rate (DSR; %) was calculated with the following equation.

$$\text{Disease severity (\%)} = \Sigma\ (\text{Disease index} \times \text{The number of investigated leaves}) / (\text{The number of investigated leaves} \times 4) \times 100$$

$$\text{DSR (\%)} = 100 - (\text{The disease severity in the treatments} / \text{The disease severity in the untreated control}) \times 100$$

2.4. Statistical analysis

The free software R (ver. 4.0.3) was used for statistical analysis.

On the results of investigation 2.2, the data containing crop height were extracted and the relationship between the height and the spray amount was analyzed. At first, normality of the data was checked by the Shapiro-Wilk test. The Pearson correlation coefficient was calculated when the data indicate normality, otherwise, the Spearman's rank correlation coefficient was determined. In the case of correlation was observed, test of correlation was done ($p = 0.05$).

On the results of experiment 2.3, disease severity was submitted for statistical analysis. At first, to check normality of the data, the Shapiro-Wilk test was done on the disease severity of each treatment. As a result, all of the data was not normally distributed, therefore the Kruskal-Wallis test was applied ($p = 0.05$). When significance was detected in the Kruskal-Wallis test, the Steel-Dwass test was employed ($p = 0.05$).

3. Results and discussion

3.1. Estimation of common spray amount on vegetables in Japan

3.1.1. Results of the spray amount on each crops and the prediction of spray amount

The maximum, the minimum and the average spray amounts are shown in Table 2. Cucumber, eggplant (in 2019[7]) and tomato needed the spray amounts above the registered range (100-300 L/10a; Fig. 2). On cucumber, 4 of 5 operators sprayed more than 300 L/10a[7], however on tomato, only 2 of 5 operators exceeded for 300 L/10a. Based on this result, crop height of ca. 1.7 m with tomato-like shape was considered to be the upper limit which can be uniformly sprayed with the 300 L/10a spray volume.

Table 2. The maximum, the minimum and the average spray amounts on each crops.

Crop	Spray amount		
	Maximum	Minimum	Average
Tomato	372.3 L/10a	282.0 L/10a	310.1 L/10a
Eggplant	147.0 L/10a	105.1 L/10a	134.1 L/10a
Sweet pepper	167.7 L/10a	116.1 L/10a	139.7 L/10a

Even though, the spray amount for eggplant with 1.2 m height in 2019 was exceeded the upper limit[7]. The spray amounts on eggplant was 314.6 L/10a in 2019[7] but 134.1 L/10a in 2020. Their heights were similar in these 2 years (1.2 m in 2019[7] and 1.1 m in 2020). The area of the field was larger for 0.9 m^2 in 2020 than in 2019[7] and this was from the length of rows (+1.3 m). The decrease of the spray amount may be caused by the difference of the number of leaves. The number of leaves in all the field were 3760 (actually counted) and 3468 (estimated from a photo), thus the leaves was 292 (-7.8%) less in 2020 than in 2019. The difference of the number of leaves was not obvious, but operators got the impression that the number of leaves (and stems) were less in 2020 than in 2019 by visual observation. Especially, the horizontal area which stems were exiting seemed to be smaller in 2020 than in 2019. Compared to the conditions in 2019, it was decreased that the necessity to move the spray nozzle horizontally in 2020, and this might lead the reduction of the spray amount.

The spray amount for sweet pepper was within registered range. The height of sweet pepper was 1.0 m, and shorter than the other crops. Main stem of sweet pepper was along a pole and 2 lateral stems were pulled up with wires thus stems grew vertically. These agricultural practices cause decrease of the horizontal area to spray and the spray amount.

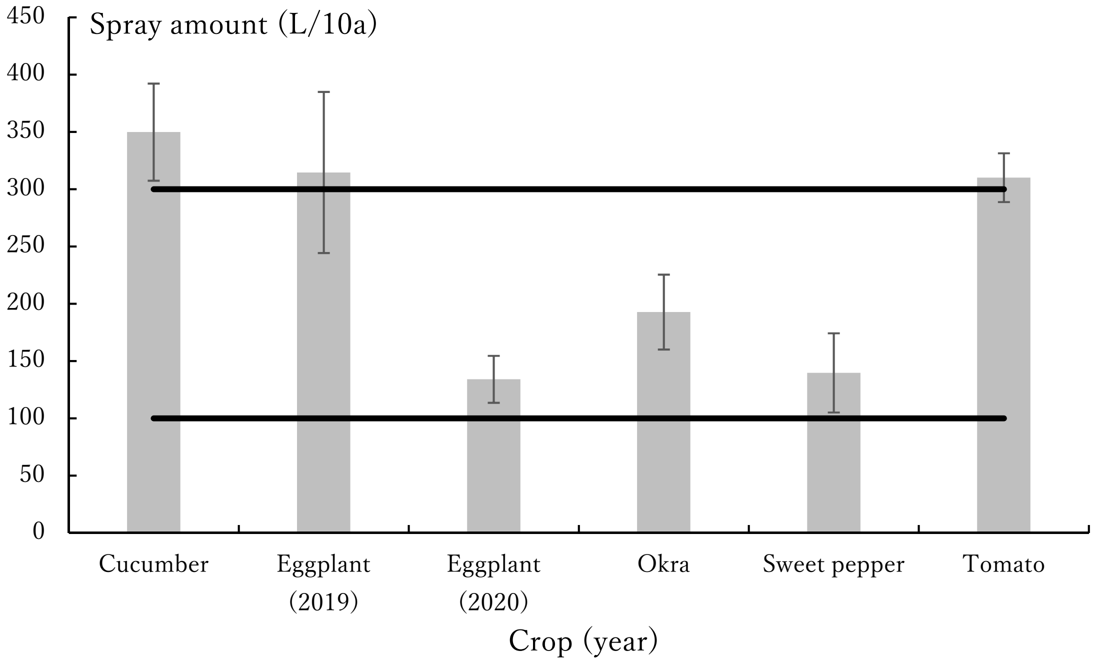

Fig. 2. The spray amounts on each crops in 2 years experiments. Error bars indicate standard deviation, upper line and bottom line means 300 L/10 and 100 L/10a, respectively (the range of spray amounts in registration).

The spray amount can be predicted by crop height and crop wall area (CWA) in some cases. Based on the obtained results, in the case of crop height is taller than 1.7 m (e.g. cucumber and tomato; Fig. 3) or CWA is over 20 m^2 (e.g. cucumber; Fig. 4), the spray amount will possibly exceed 300 L/10a.

Although the spray amount was more than 300 L/10a on eggplant in 2019, even the height was 1.2 m and CWA was 10.8 m^2. Therefore, the spray amount may not be predictable for all the crops based on height and CWA. The number of leaves or total leaf area might be related to the spray amount on eggplant-like shape crops with horizontally spread leaves. The spray amounts for eggplant were varied in 2019 and 2020, and this may be caused by the difference of the number of leaves. This indicated that it is effective to predict the spray amount by the number of leaves or total leaf area for eggplant-like shape crops.

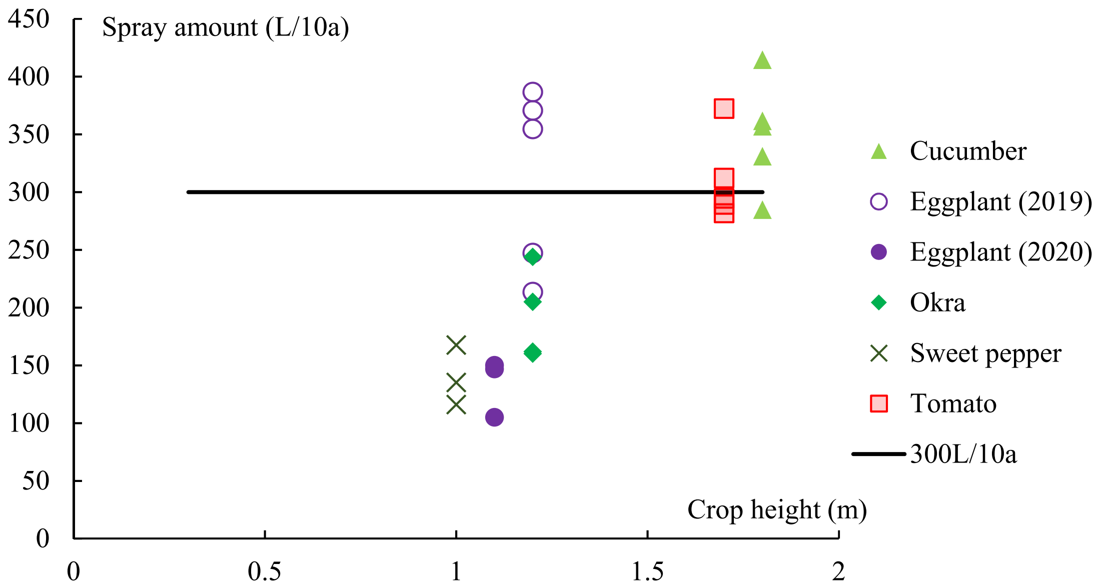

Fig. 3. The relationship between crop height (m) and spray amount.

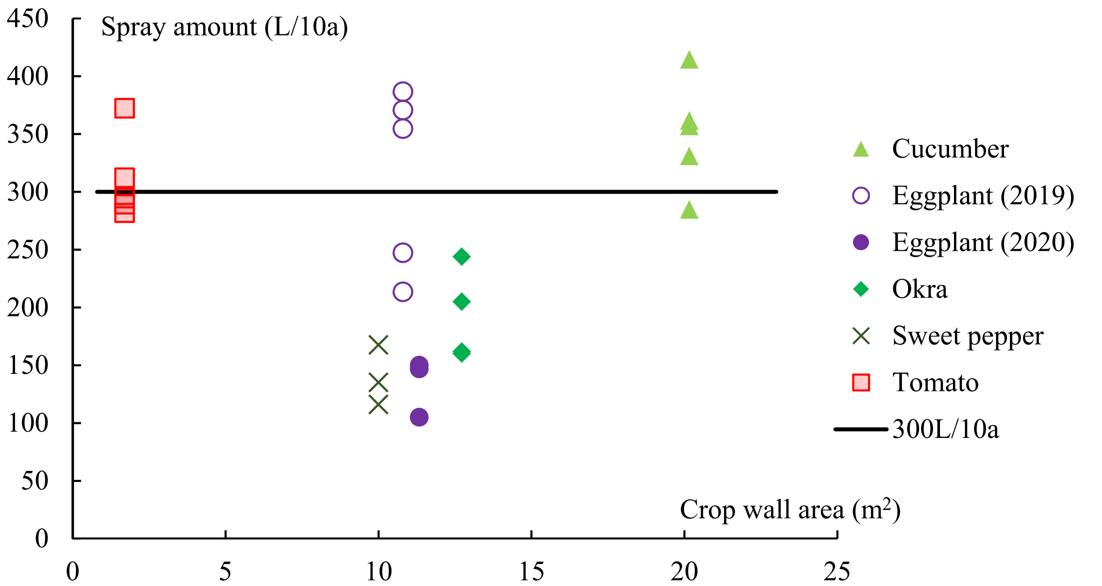

Fig. 4. The relationship between crop wall area (CWA) and spray amount.

As a conclusion, in the case of crops grown in vertically using poles, nets or wires, crop height or CWA may be effective to predict the spray amount. On the other hand, in the case of crops with horizontally spread stems, like eggplant, crop height and CWA should not be applicable to predict spray amount but the number of leaves or leaf area might be useful to predict the spray amount. Inversely, when crops of which height is shorter than 1.6 m and leaves are extending vertically, it is predicted that the spray amount unlikely to exceed 300 L/10a. Further investigation is necessary to reveal the relationship between the number of leaves (total leaf area) and the spray amount.

3.2. Investigation of spray amount in test results

3.2.1. Tests on efficacy and phyto-toxicity

The numbers of tests on efficacy and phyto-toxicity for investigation were 149, 444 and 575, for pumpkin, sweet pepper and tomato, respectively. The maximum, the minimum and the average spray amounts on each crops are shown in Table 3.

Table 3. The numbers of tests, the maximum, the minimum and the average spray amounts on each crops from the tests on efficacy and phyto-toxicity.

Crop	The number of tests	Spray amount		
		Maximum	Minimum	Average
Pumpkin	149	500 L/10a	36.0 L/10a	185.4 L/10a
Sweet pepper	444	510 L/10a	50 L/10a	235.1 L/10a
Tomato	575	500 L/10a	55.6 L/10a	268.6 L/10a

The most frequently applied spray amount range for pumpkin was 151-200 L/10a (Fig. 4). Three of one hundred forty nine tests exceeded 300 L/10a. The results containing the information of crop height were extracted and there was no normality of the data, thus the Spearman's rank correlation coefficient was determined from the test results of pumpkin. The weak correlation was observed between pumpkin height and spray amount, but the correlation was not significant (Fig. 7, $r = 0.46$, $p = 2.0 \times 10^{-5}$).

Among the tests for sweet pepper, the most frequently sprayed volume was 251-300 L/10a (Fig. 5). Based on the Spearman's rank coefficient correlation, a little coefficient was observed and there was no significance (Fig. 8, $r = 0.28$, $p = 2.0 \times 10^{-3}$).

For the tests for tomato, 251-300 L/10a spraying range was the most frequently appeared (Fig. 6). Judging from the average spray amount, most of the tests for tomato were conducted between 100-300 L/10a range. Similarly with the other crops, the Spearman's rank correlation coefficient was determined. There was weak correlation between tomato height and spray amount but the correlation was not significant (Fig. 9, $r = 0.46$, $p = 2.8 \times 10^{-11}$).

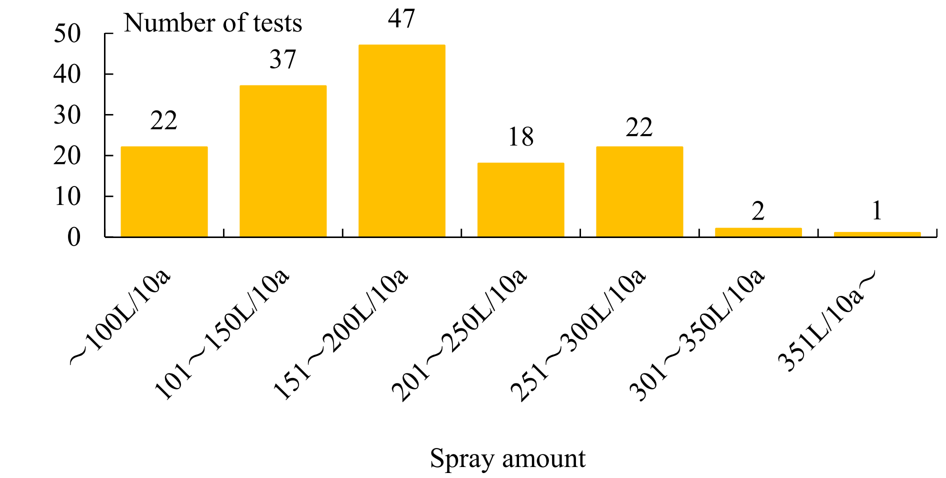

Fig. 4. The number of tests of pumpkin on efficacy and phyto-toxicity. The numbers above the graphs indicate the number of tests which were conducted with the spray amount range written in the bottom.

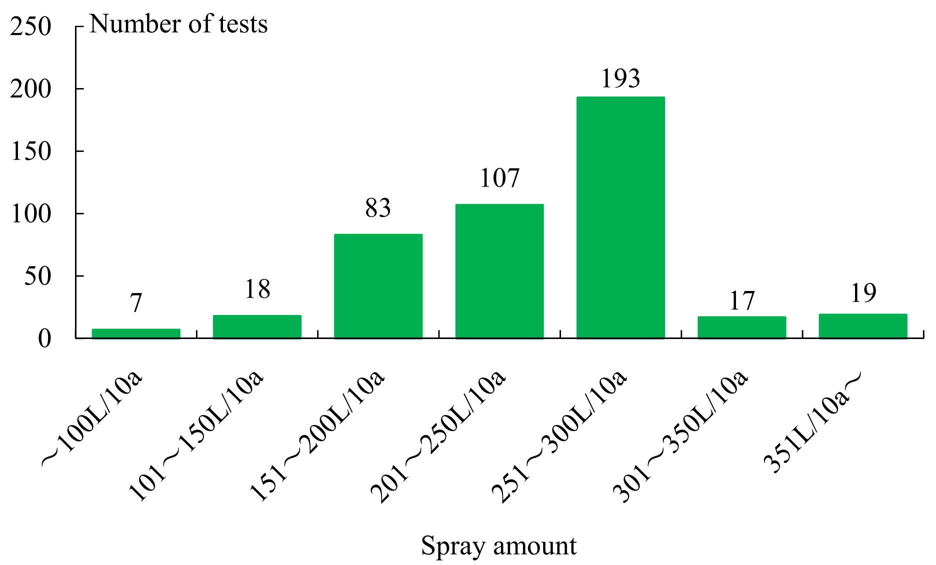

Fig. 5. The number of tests of sweet pepper on efficacy and phyto-toxicity. The numbers above the graphs indicate the number of tests which were conducted with the spray amount range written in the bottom.

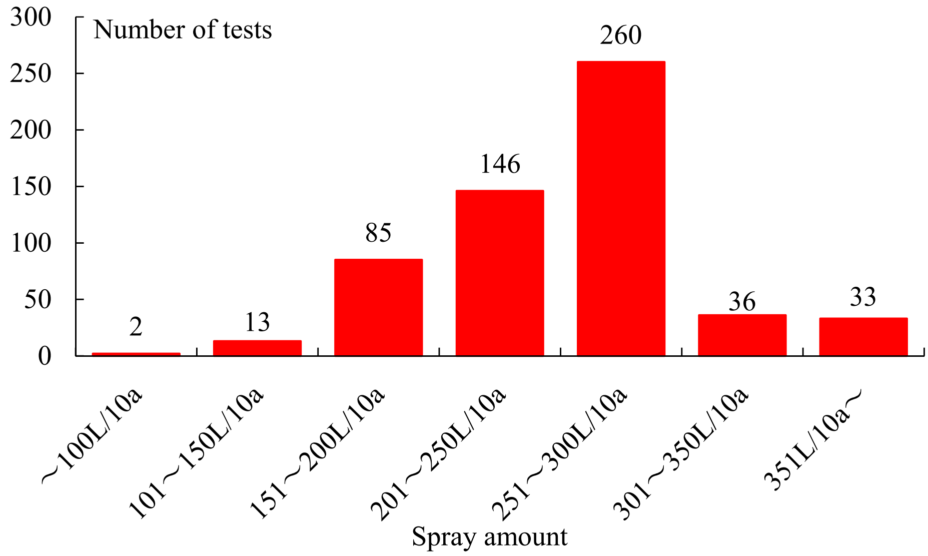

Fig. 6. The number of tests of tomato on efficacy and phyto-toxicity. The numbers above the graphs indicate the number of tests which were conducted with the spray amount range written in the bottom.

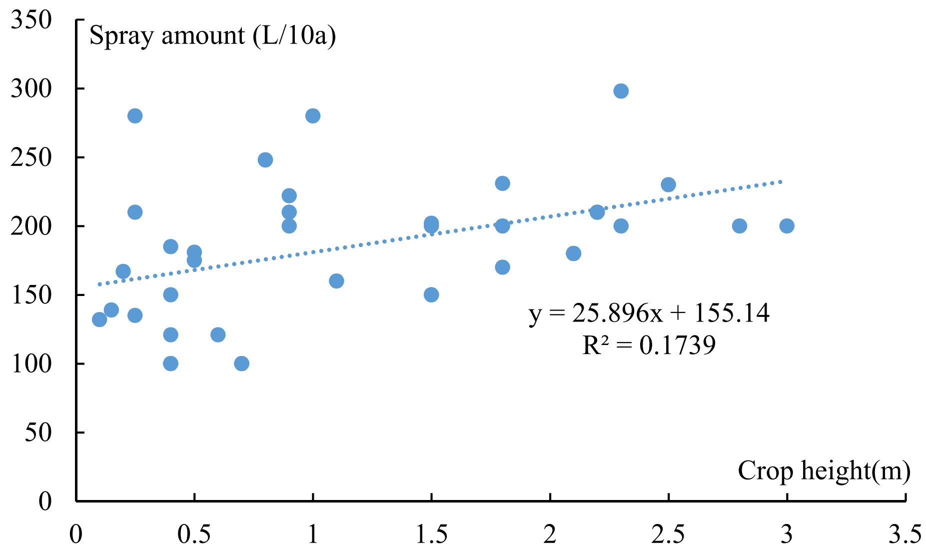

Fig. 7. The relationship between crop height and spray amount on pumpkin.

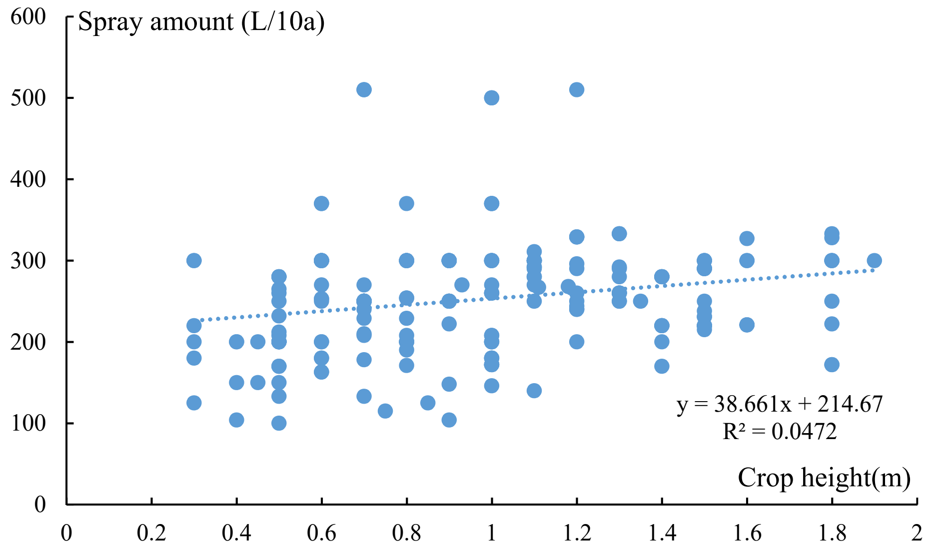

Fig. 8. The relationship between crop height and spray amount on sweet pepper.

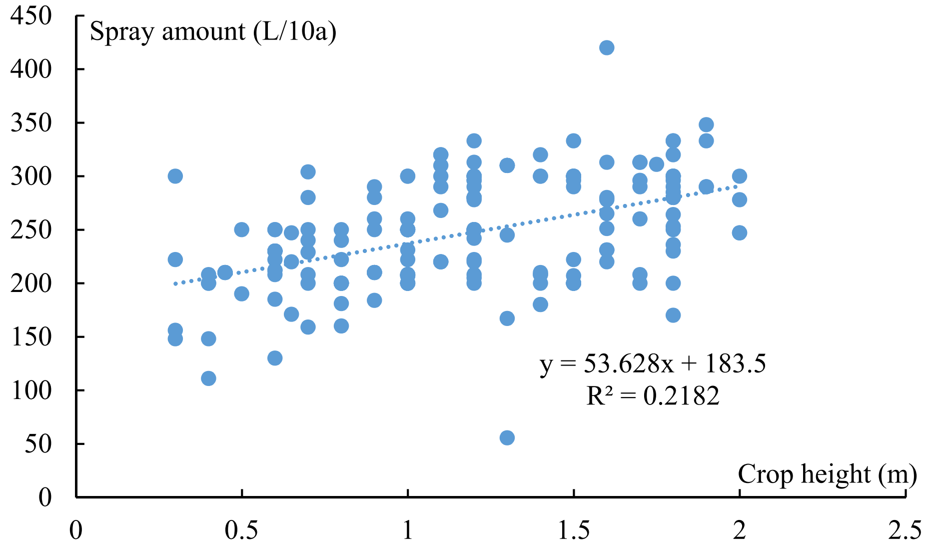

Fig. 9. The relationship between crop height and spray amount on tomato.

In most cases, spray amounts for the tests on efficacy and phyto-toxicity presumed to be determined by crop size (e.g. height) but there was no significant correlation between crop height and the spray amount in this survey. One of the main purpose of these tests is to confirm effectiveness of the novel agrochemicals thus spray amounts may set more than the required minimum amount. To avoid the test failure caused by such as heterogeneity of spraying, possibly investigator may apply much more amount of agrochemicals dilution than the required minimum amount. Therefore, it was difficult to determine the minimum spray amount based on the data from efficacy and phyto-toxicity test.

Possible causes were explored why more than 300 L/10a of spray amount was needed in some of the examinations. Firstly, on tomato, it is tend to increase the spray amount in the case of the small experimental plot area (less than 7 m^2, Fig. 12). Especially, equivalent to 500 L/10a water volume was sprayed in the 2 tests conducted in 1.5 m^2 plots. These experiments were done in the smallest area but the spray volume was the largest among the tests which experimental areas were stated. In general, it may be more difficult to spray in small area uniformly than in large area because of decline of the total liquid volume.

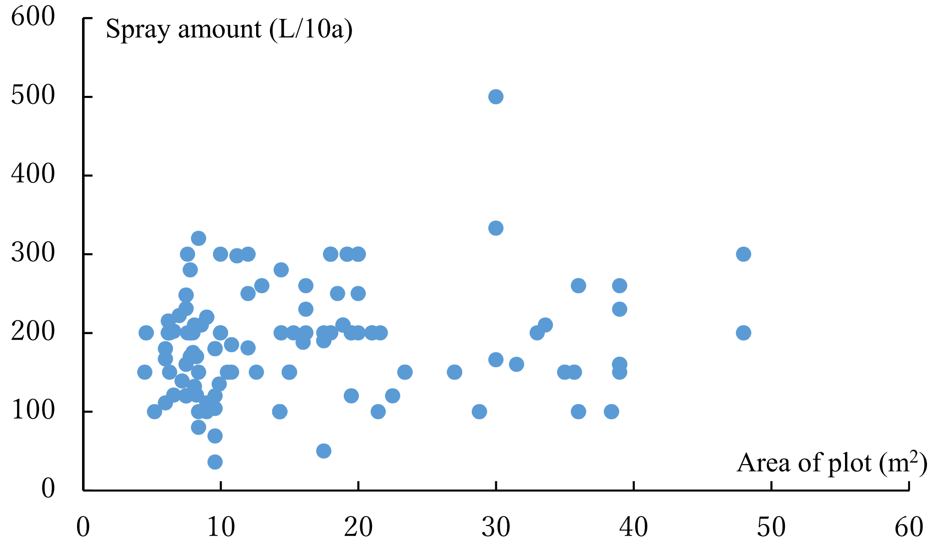

Fig. 10. The relationship between the area of plots and the spray amounts of pumpkin on the efficacy and phyto-toxicity tests.

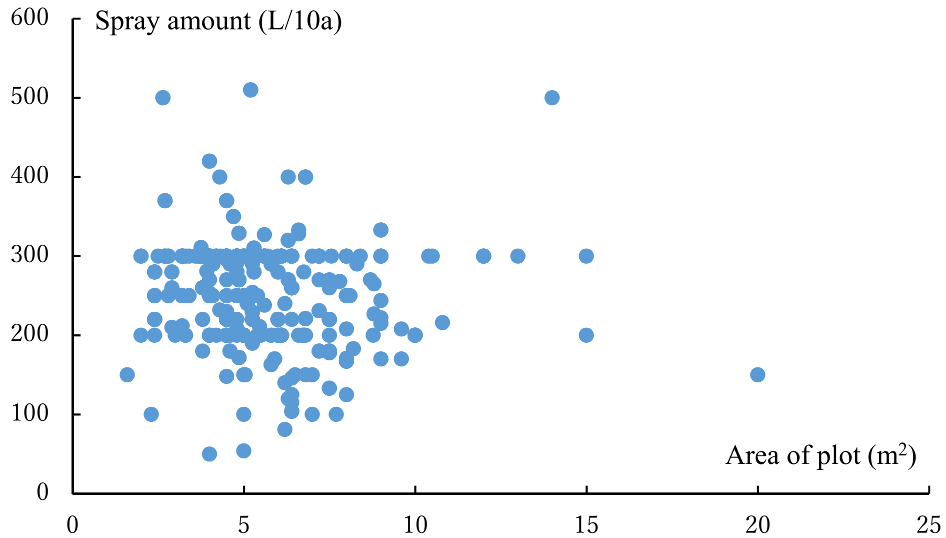

Fig. 11. The relationship between the area of plots and the spray amounts of sweet pepper on the efficacy and phyto-toxicity tests.

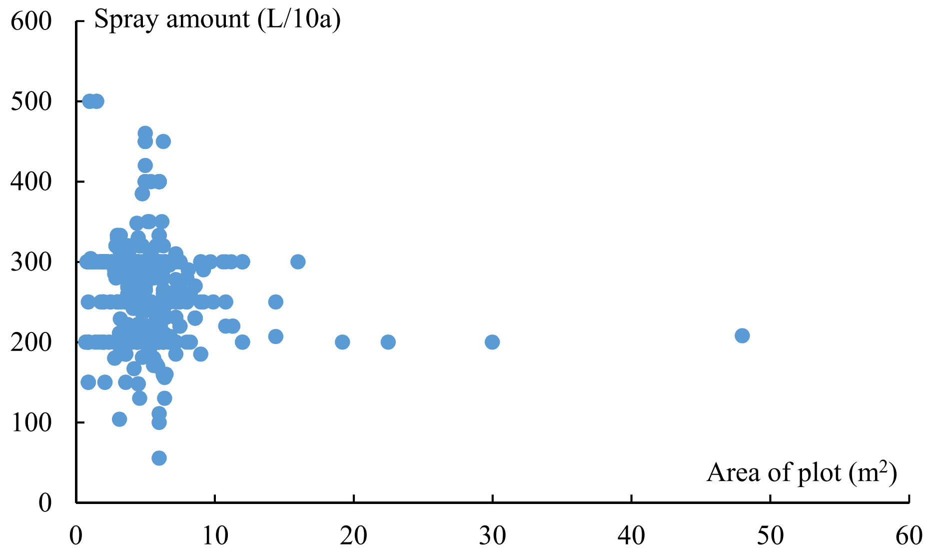

Fig. 12. The relationship between the area of plots and the spray amounts of tomato on efficacy and phyto-toxicity tests.

The battery-powered sprayer which used in our experiment ejects ca. 580 mL/min. As an example, in the case to spray 3 L water in 10 m^2 by using this sprayer, required spraying time is about 5.2 minutes. This time is considered enough to spray for all of the examination area uniformly. However, in the case to spray 0.3 L water in 1 m^2, required spraying time is about 31 seconds. It may difficult to spray uniformly in a small plot using common battery- or gasoline-powered sprayer. To prevent heterogeneity of spraying, it is required to increase the total spraying volume and this might be the main cause of the excess spraying. When the test is conducted in small experimental area, specific sprayer (e.g. small amount spraying applicable) or some other techniques may be necessary.

Among the tests on sweet pepper, the minimum experimental area was 2.7 m^2. Similarly to the tests of tomato, a main factor of the increase of the spray amount may be the area of experimental plots. On the other hand, among the tests on pumpkin, the minimum experimental area was 4.5 m^2 and relatively larger than tomato (1.5 m^2) and sweat pepper (2.7 m^2). Thus, the experimental area was not considered as a main factor of the increase of the spray amount on the tests of pumpkin. The reason of the increase of the spray volume in pumpkin was still unclear.

3.2.2. Tests of residues in crops

The numbers of tests of residues in crops are shown in Fig. 13～15, and the maximum, the minimum and the average spray amounts are stated in Table 4. As a result, 1 of 149 tests exceeded 300 L/10a in pumpkin. Similarly, 1 of 217 tests and 8 of 370 tests applied more than the upper limit in sweet pepper and tomato, respectively. In these tests, only a few of them stated crop height thus the relationship between the height and the spray volume could not be evaluated. All of the tests exceeding 300 L/10a were conducted before 2003, and the difference of the test rules between the past and the present must be the main factor of the increase of the spray volume.

It was indicated that the spray amount in tests of residues in crops may be set following the registration range (100-300 L/10a). Therefore, it may be not effective to refer these tests to determine spray amounts on each crops.

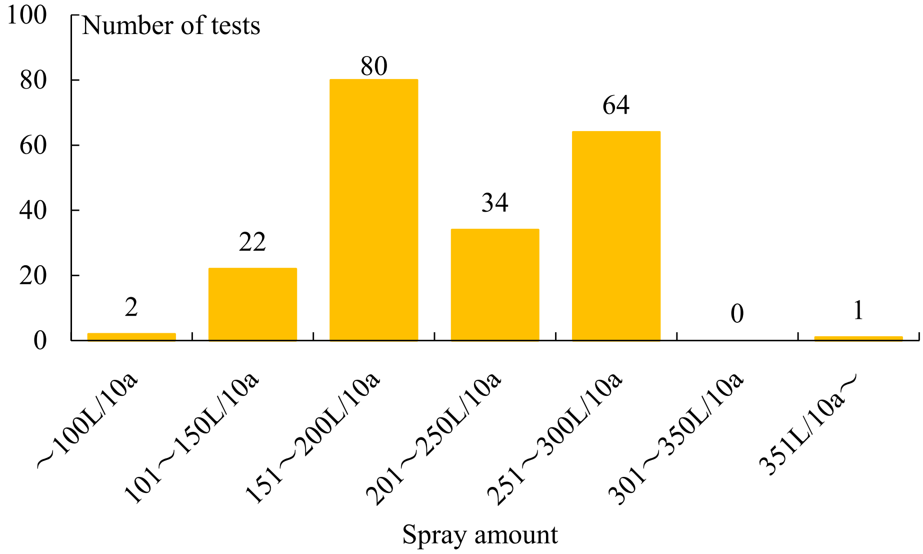

Fig. 13. The number of tests of pumpkin on residues in crops. The numbers above the graphs indicate the number of tests which were conducted with the spray amount range written in the bottom.

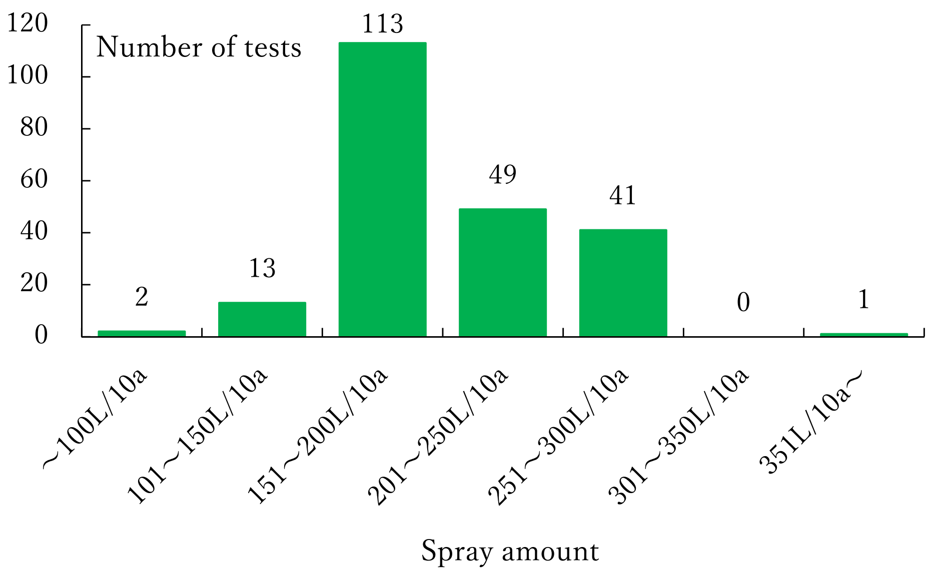

Fig. 14. The number of tests of sweet pepper on residues in crops. The numbers above the graphs indicate the number of tests which were conducted with the spray amount range written in the bottom.

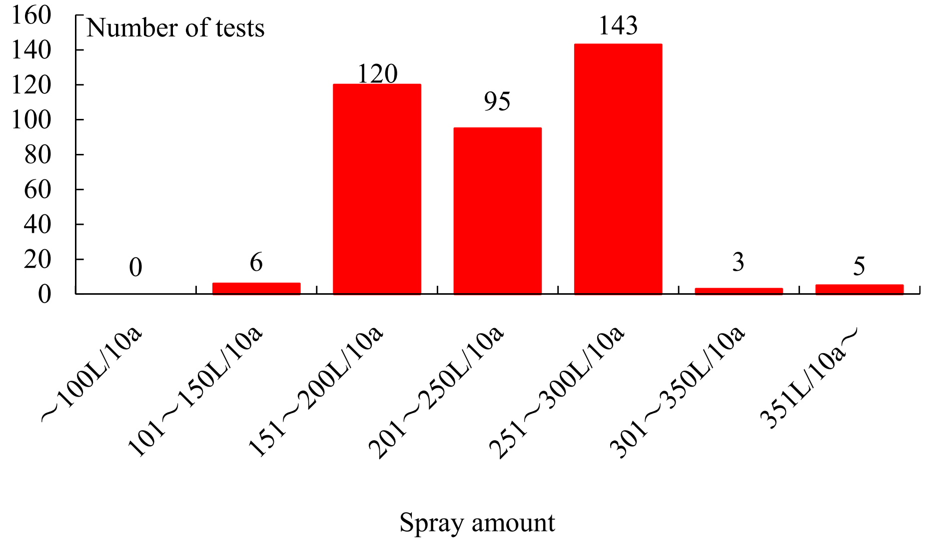

Fig. 15. The number of tests of tomato on residues in crops. The numbers above the graphs indicate the number of tests which were conducted with the spray amount range written in the bottom.

Table 4. The numbers of tests, the maximum, the minimum and the average spray amounts on each crops from the tests on residues in crops.

Crop	The number of tests	Spray amount		
		Maximum	Minimum	Average
Pumpkin	203	400 L/10a	50 L/10a	229.6 L/10a
Sweet pepper	219	400 L/10a	70 L/10a	224.0 L/10a
Tomato	372	500 L/10a	144 L/10a	251.2 L/10a

3.3. Estimation of the minimum effective spray amount against pumpkin powdery mildew

The result is shown in Table5. In the untreated control, the average of DI was 4. The suppression rate was similar in the treatment (1), (2) and (3), but lowered in (4). Significant difference was observed by the Kruskal-Wallis test among the treatments ($p = 0.046$) however there was no significance by the Steel-Dwass test ($p > 0.05$, among all the treatments).

Table 5. The result of the experiment on the effect of TPN against pumpkin powdery mildew (The evaluation of effectiveness was conducted in 7 days after the second treatment).

Treatment	Replicate	The number of investigated leaves	Disease index 0	1	2	3	4	Disease Severity (%)	Disease suppression rate (DSR, %)
Treatment (1) ×2000 200 L/10a	I	10	5	3	2	0	0	17.5	
	II	10	5	5	0	0	0	12.5	
	III	10	2	6	2	0	0	25.0	
	Average							**18.3**	**70.3**
Treatment (2) ×1000 100 L/10a	I	10	0	6	4	0	0	35.0	
	II	10	2	8	0	0	0	20.0	
	III	10	4	6	0	0	0	15.0	
	Average							**23.3**	**64.9**
Treatment (3) ×500 50 L/10a	I	10	3	6	1	0	0	20.0	
	II	10	2	6	2	0	0	25.0	
	III	10	5	5	0	0	0	12.5	
	Average							**19.2**	**68.9**
Treatment (4) ×250 25 L/10a	I	10	1	6	3	0	0	30.0	
	II	10	3	4	3	0	0	25.0	
	III	10	0	9	0	1	0	30.0	
	Average							**28.3**	**54.1**
Untreated control	I	10	0	0	5	4	1	65.0	
	II	10	0	0	2	3	5	82.5	
	III	10	0	6	3	1	0	40.0	
	Average							**61.7**	—

Though the applied active substance amounts in each plots were the same, DSR was lower in the treatment (4) by 10.8 points compared to the treatment (2), i.e. the approved application method. This means the spray volume, more specifically, coverage of spray affected effectiveness. In addition, in the treatment (1), the concentration of the dilution was half against the approval application method but the efficacy was almost the same level as the treatment (2). Therefore, coverage of spray may be more important on the effectiveness of TPN than concentration. Based on this result, at least 50 L/10a spraying proportion may be required for a certain control level, in the tested conditions. Although, it should be noted that this experiment conducted in exceedingly small area thus reliability is much lower than common effectiveness tests.

Wise et al. (2010)[6] studied on the impact of sprayer type and spray volume against efficacy of 2 fungicides (ziram and azoxystrobin) in the United States vine field. According to this report, spray volume of the airblast sprayer significantly affected fungicide performance against foliar powdery mildew of vine (*Vitis labrusca*) with 468 L/ha (high water volume) being better than 187 L/ha (low water volume). This was most apparent in the case of ziram[6]. The effectiveness of azoxystrobin with 187 L/ha and 468 L/ha did not show significant difference. Ziram is protective fungicide but azoxystrobin is systemic fungicide. This result indicates the spray amount is important factor especially in protective fungicide. Additionally, in the above study, the type of fungicide affected disease control more than did water volume, in general[6].

In this study, TPN was applied to pumpkin powdery mildew, and TPN is protective fungicide[8]. In the previous study[6], the amounts of active substance were different among the treatments. Whereas in this study, the amounts of active substance in each treatments were the same but the effectiveness was weaken in the least spray volume treatment. As a conclusion, mechanism of action should be included in consideration to establish proper application method as well as dilution rate or spray volume. Specifically, protective fungicides or spiracle-blocking insecticides may require relatively much amount of the spraying. In contrast, agrochemicals with systemic action can be effective at the low application rate. Further study is necessary to evaluate the effectiveness of each active substances at different level of spray volume.

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日本における農薬の散布液量実態調査

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摘要

農薬使用者への曝露評価に資することを主な目的として，野菜類に対する散布液量を推定した．特に，病害虫に対して効果を得られる最小量に着目した．2 か年で 5 作物に対する散布液量を評価した．この結果，作物の草丈が 1.7 m を超える場合や，畝の長さと草丈を乗算して求められる散布壁面積が 20 m^2 を超えるような場合に，登録上の上限値である 300 L/10a を超える散布液量を要することが示唆された．また，過去に実施された薬効・薬害試験及び作物残留試験における散布液量の情報収集を行った．この結果．薬効・薬害試験においては，小面積で実施された試験では散布液量が増加する傾向がみられた．作物残留試験では，登録上の使用液量を前提として散布液量が設定されていると思われ，散布液の必要量を推定する資料とするには不適であると考えられた．さらに，かぼちゃのうどんこ病を対象として，クロロタロニル(TPN)の効果を評価した．異なる 4 段階の希釈液を調製し，有効成分投下量が全ての処理区で同等となるよう散布を実施した．この結果，散布液量を最小とした処理区(250 倍液，25 L/10a 相当を散布)において，最も効果が低かった．保護殺菌剤のような作用性をもつ農薬においては，散布液の付着範囲は効果に影響を及ぼすことが示唆された．