Effect of chlorpyriphos in the soil on the onion cultivation and its declining

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Abstract. The use of chlorpyriphos to control the pest attack on onion is high. In certain concentrations, the chlorpyriphos is potentially toxic both to plant and soil organisms. It is important to know the effect of pesticide residue on the crop as supporting data to determine maximum residue limits in soil. This study aims to 1) determine the effect of chlorpyriphos residues in the soil on the growth of onion 2) determine the effect of chlorpyriphos residues on pest attacks and onion damage 3) determine the level of declining of chlorpyriphos in the soil. The study was conducted in June-August 2018 at the Indonesian Agricultural Environment Research Institute by using a lysimeter as a test site. This study using nine lysimeter plots where 6 plots were polluted with 100 ppm of insecticides formulation solution with active ingredients chlorpyriphos and 3 plots were not polluted. The results showed that contamination of 100 ppm of insecticides formulations with active ingredients of chlorpyriphos into the soil did not inhibit the growth of onion plants, pest attack, and damage. Chlorpyriphos insecticide residue was still detected on the soil on day 7th with a decrease rate of 65.77 % and day 30th with a decrease rate of 99.63 %.

1. Introduction

Onion is one of the commodities that are of concern to the government in terms of increasing production and quality. Pest attack is one of the obstacles in cultivating onion in which to control the pest, farmers usually use insecticides. Based on reports, the use of insecticides by farmers to control pests in onion is very high in which one of them is chlorpyriphos [4]. It is important to know the effect of pesticide residue on crop as supporting data to determine maximum residue limits in soil. Based on the results of the study, the use of chlorpyriphos has caused pesticide residues in the soil.

Chlorpyriphos is one of the broad-spectrum insecticides that widely used in agriculture all over the world. Chlorpyriphos is a moderately toxic insecticide that can persist in the environment for long period. It leads contamination of chlorpyriphos residue in the environment including soil, water, and crop [1-3]. Chlorpyriphos is contact and stomach poison insecticides. Chlorpyriphos is an acetylcholinesterase inhibitors insecticides that cut out synopsis processes in the neuron system of insect. Acetylcholinesterase as a part of enzymatic of invertebrate is potentially damaged by chlorpyriphos. So, it is not the only effect to insect but also non-target organisms include human healthy. In Indonesia, the chlorpyriphos residue has been detected in soil of some agricultural area at Java Island [4]. Many factors affecting the degradation of organophosphorus pesticides including chlorpyriphos such as water holding capacity of soil, pH, temperature [5]. Half-life of chlorpyriphos in the soil depends on climate, soil type, microbe and other environmental aspects that can reach 2 weeks until 1 year [6]. This study aims were 1) to determine the effect of chlorpyriphos residues in the soil on the growth of onion, 2) to determine
the effect of chlorpyriphos residues on pest attacks and onion damage 3) to determine the level of declining of chlorpyriphos in the soil.

2. Materials and methods

2.1. Time and place of experiment
The field experiment was carried out at Jakenan Experimental Station, Pati, Central Java during June to August 2018 using a lysimeter (size 1 m x 1.5 m) as a test site. Pesticides residue analysis was carried out in Integrated Laboratory in which both are belong to Indonesian Agricultural Environment Research Institute (IAERI). Experiment location lies at altitude 7 m asl, 111°40’ east longitude and 6°45’ south latitude. Vertic Endoaquert Soil in the location is Inceptisols with characteristic light texture, potassium deficiency, middle low pH, low EC, low organic matter, low CEC [7].

2.2. Field experiment
Nine lysimeter plots that used in this study in which 6 plots were contaminated and 3 plots were uncontaminated. Six plots were contaminated with 100 ppm chlorpyriphos (using Dursban 20 EC) in which 100 ppm is minimum concentration that usually drop to the soil. The contamination was at 2 days before planting (DBP) by spraying to the all soil surface and then flooding by water until spread evenly. Each plot contained 20 onion plants that separate to 2 rows with a planting distance of 20 x 15 cm. Base fertilizers were organic fertilizer 25 t ha\(^{-1}\) and SP-36 300 kg ha\(^{-1}\) that applied at 3 days before planting. The supplementary fertilizers were urea 300 kg ha\(^{-1}\), ZA 500 kg ha\(^{-1}\), KCl 200 t ha\(^{-1}\) that applied twice at 10 and 30 days after planting. Watering was conducted everyday while the application of biopesticide was done once a week. Observation parameters were plant high, number of leaves, number of tillers at 30, 45, 60 days after planting while pest attacking and damages at 60 days after planting.

2.3. Chlorpyriphos residue analysis
Soil samples were collected as a composite sample from 5 point diagonally at 7 and 30 days after planting. Chlorpyriphos residue analysis was using Quechers method with the step as follows: put 10 g of soil sample into a centrifuge tube then add 20 ml of acetone, 4 g of sodium chloride and also 4 g anhydrous sodium sulphate. After that, Shaking by hand for 1 minute then shaking for 20 minute sat 190 rpm using an automatic shaker. After that, filtering using Whatman filter paper and sample ready to inject to gas chromatograph (GC). GC condition was autoinjector AOC-20i with SPL temperature 250 °C, column Rtx-1 with temperature 230 °C, detector ECD with temperature 250 °C. The injection volume was 1 µL with analysis time at 20 minutes.

3. Results and discussion
Experiment location is rainfed land in which at that time weather condition had low rainy and high air temperature that causing limited water and high evaporation. This condition has probability to increase the degradation rate of pesticides but more beneficial to the growth of the onion plant. Singh [5] said that many factors affecting to the degradation of pesticides such as water holding capacity of soil, pH, temperature.

3.1. Effect of chlorpyriphos residue on the growth of onion
Chlorpyriphos is a poison that potentially toxic to the environment including plants and other useful biota. In certain concentrations, pesticides are toxic to the plant that able to inhibit the growth of the plant. Besides that, biota such useful microorganisms on soil fertility and absorption of nutrients could be damage caused by the residue of pesticides. But in this case, we did not see any disturbances that inhibit the growth of the plant including plant height, tiller number, and leave number. In table 1, we did not see the different results between treated and untreated on the growth factor of the onion plant. Surprisingly, the plant height, tiller number, and leaf number on the treated site were better than untreated site time by time from 30, 45, 60 DAP, respectively. It means 100 ppm of chlorpyriphos
contamination to the soil was not inhibit the growth. Pesticide residue is not directly affected by the crop growth but the residue can cause decrease of beneficial microbe population for crop growth such as azotobacter and actinomycetes. According to [8], the population of azotobacter decreased to the extent of 51.8% while actinomycetes were the least affected though accounted for 32% when compared to the soils with no residue. Otherwise in this experiment, there is a tendency that microbes can utilize 100 ppm of chlorpyriphos as a source of carbon on supporting their growth. According to other experiments in the laboratory, some soil microbial can adapt to pesticides and growing well in a certain concentration. Besides that, its microbial can boost plant growth while applied to the soil [9].

### Table 1. Effect of chlorpyriphos residue on the growth of onion

|                      | 30 DAP | 45 DAP | 60 DAP |
|----------------------|--------|--------|--------|
| Plant Height         |        |        |        |
| T                    | 32.7   | 40.5   | 41.9   |
| U                    | 29.1   | 35.5   | 37.4   |
| Tiller Number        |        |        |        |
| T                    | 7      | 9      | 10     |
| U                    | 7      | 9      | 9      |
| Leaves number        |        |        |        |
| T                    | 35     | 48     | 41     |
| U                    | 34     | 40     | 34     |

Remarks: DAP: days after planting, T: Treated, U: Untreated

### 3.2. Effect of chlorpyriphos residue on the harvest result of onion

Table 2 showed that the result of the harvest of onion in the treated site was better than untreated. According to other experiments in the laboratory, some soil microbial can adapt to the pesticides and growing well in a certain concentration. Besides that, its microbial can boosted plant growth while applied to the soil [9]. So, in 100 ppm concentration of chlorpyriphos contamination, there was no effect of the residue of chlorpyriphos on the number of tubers, wet weight of tuber and leaves. There is an indication that chlorpyriphos residue in certain concentration increase useful microorganism activity that causing an increase of soil fertility.

### Table 2. Effect of chlorpyriphos residue on the harvest result of onion

|                      |  |
|----------------------|---|
| Number of tuber      |   |
| T                    | 15|
| U                    | 14|

Wet weight of leaves

| g        |        |        |
|----------|--------|--------|
| T        | 65.3   |        |
| U        | 42.0   |        |

Wet weight of tuber

| g        |        |        |
|----------|--------|--------|
| T        | 124.9  |        |
| U        | 91.2   |        |

Remarks: T: Treated, U: Untreated
3.3. Effect of chlorpyriphos residue on crop damage caused by pest

The pest that attacks onion was *Spodoptera exigua* while the diseases were *Fusarium, sp.* This is in line with other researchers finding that the main pest that attacks onion is *Spodoptera exigua* while the diseases are *Phytiium, sp, Phytophthora, sp, Rizoctonia solani, Fusarium, sp.* The attacking of pest and disease on onion are usually massive if not controlled that can causing a big loss of yield [10, 11]. Figure 1 showed that the pest attack on the treated site was lower than the untreated site. Its probably caused by the systemic effect of chlorpyriphos that can absorb to the plant tissue. The pest is usually escaping the plant that contains systemic pesticides. The plant can deny of the existence of pest or has a repellent effect [12].

![Figure 1. Crop damage caused by pest attack](image1.png)

3.4. Chlorpyriphos residue declining

Figure 2. showed that chlorpyriphos residue in the soil was declining gradually time by time in which at 7 DAA decrease 65.77% and at 30 DAA decrease 99.63%. Many factors are affecting the degradation of pesticides such as water holding capacity of soil, pH, temperature. Half-life of chlorpyriphos in the soil depends on climate, soil type, microbe, and other environmental aspects that can reach 2 weeks until 1 year [6]. At that time weather conditions in the experiment location had low rainy and high air temperature that causing limited water and high evaporation. This condition has the probability to increase the degradation rate of pesticides. In this experiment, the chlorpyriphos residue in the leaching water was not detected (<LoD = 0.022 ppm).

![Figure 2. Chlorpyriphos residue declining rate](image2.png)
4. Conclusions
Contamination of 100 ppm of insecticides formulations with active ingredients of chlorpyriphos into the soil did not inhibit the growth of onion plants, pest attacks, and damage. Chlorpyriphos insecticide residue was still detected on the soil on day 7th with a decrease rate of 65.77 % and day 30th with a decrease rate of 99.63 %.

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