

# Role of Organic Matter in Mitigation of Pesticides on Cabbage [*Brassica oleracea* (L.)] Cropping

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**Abstract**—The use of pesticides to increase agricultural productivity is very worrying. Excessive application of pesticide will leave residues in the soil giving a negative impact on the environment. So that mitigation measures to restore soil conditions are very important. Study on pesticide mitigation using chicken manure organic matter on cabbage crop has been conducted with a randomized block design arranged in factorial. Factor A was an organic fertilizer with three doses and factor B was the use of pesticides Proclaim® 5 SG with five doses and spraying variations of up to 20 times applications. The study examined the interaction between pesticides with organic matters by measuring the levels of pesticides after treatments. Data were analyzed with analysis of variance and continued with LSD 5%. The results showed a positive interaction between organic matter and pesticide residues resulting in a reduction in the levels of residues in the soil. The low residue was obtained on treatment of 8 tons of organic matter without spraying pesticide, and the highest residue was found in treatment combination with no organic matter and 2.0 g pesticide with 20 times spraying, which was 27.59 mg/kg. Residue on cabbage plants measured between 1.3 and 5.9 mg/kg.

**Index Terms**— pesticides, mitigation, Proclaim® 5 SG, cabbage

## I. INTRODUCTION

AN increasing number of population in Indonesia from year to year leads to the need for more food. The growing need for food such as vegetables not only is in every family, but also at homes and restaurants. A growing number of restaurants means the demand on vegetables, such as cabbage, also is increased.

Cabbage was originally planted in gardens in Europe in the 9th century and brought to America by European immigrants and other parts of the world, including Indonesia, in 16th or 17th century. In earlier days, the cabbage was grown for its

seeds. Later people began to consume the leaves. Cabbage (*Brassica oleracea* L.) is grouped in Capitata. The leaves are arranged very tightly to form crops.

Cabbage can grow optimally at an altitude of 200–2000 meters above sea level (masl). For upland varieties, cabbage grows well at altitudes 1000–2000 masl. Although it is relatively resistant to high temperatures, its production would be maximum if the cabbage is grown in the tropical highlands, i.e. at an altitude of 400 masl and above with a large crop yield, while in lowland crop size is smaller.

The diamondback moth (DBM) larvae [*Plutella xylostella* (L.)] are one of the major pests in cabbage crops. The caterpillars eat the bottom part of leaves and leave the upper epidermis. Various methods have been pursued to eradicate such pest, for example by planting pest-resistant varieties, crop rotation, simultaneous planting, and use of pesticides [1, 2]. The use of pesticides, especially of synthesis, is the most widespread as it is considered fast and powerful in tackling the pests. However, its use is resulting in negative impacts, such as pest resistance, pest resurgence, killing natural enemies and environmental pollution problems and is very harmful to humans [3-6].

Pest attack usually comes during high rainfall season, because the water content in the leave attracts pests, such as *Plutella* caterpillars. Tomohon area is an excellent place for cabbage plantation, but rainfall in the area is very high. Data from the Meteorology and Geophysics Agency at Tomohon show the average rainfall from 2007 to 2009 was 626.7 mL. This situation can lead cabbage contain lots of fluids and be easily attacked by pests; especially *Plutella* sp. *Plutella* caterpillars eat cabbage leaves resulting in holes on leaves and thus decrease quality and quantity of crop yields.

Since late 80s when the rapid development of pesticides, pesticide use was also growing, either in type combinations or increase in concentration/dose. Pesticide is used from well before the attack up to the occurrence of pests. However, the use of pesticides is like a double-edged sword, on the one hand it inhibit plant pests thus increasing crop production, but on the other side it can upset the balance and health of the soil. This is due to pesticide residues on plants and in the soil can lead to death of the non-target predators. One example of the consequences of the effect of pesticides on insects and birds that is caused by the toxic effects of pesticides, usually 2-3

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days after planting insect of *Gryllotalpidae* who intends to eat sprouts from the soil dead in mass and lying on the ground. Insect carcasses are of course an easy food for *Anduhur Bolon* birds, but at the same it kills the natural controller bird species.

Another impact is the contamination of the river water when pesticides used in the paddy fields flow with irrigation water into the river. There are pesticides left to dissolve in the surface water flow, contained in soil and dissolved along with the groundwater flow. Water quality is influenced by the pesticide associated with its presence and level of toxicity, where its ability to be transported is a function of its solubility and soil ability to absorb the particles. In Indonesia the case of contamination by pesticides causes many losses. In Lembang and Pangalengan the soil around the carrot, tomato, cabbage and bean gardens have been contaminated by organochlorine residues. The Cimanuk river water is also polluted by agricultural chemicals. In agriculture, the emamectin benzoate pesticide is a semi-fermented and semi-synthesized and is environment-friendly pesticide classified as biological pesticides.

Proclaim® 5 SG with active ingredient emamectin benzoate is a semi-fermented and semi-synthesized insecticide from avermectin type [7, 8]. Emamectin is made up of emamectin B1A and emamectin B1b, and is produced in the form of emamectin benzoate, a mixture of benzoic acid salt of the two complex structures heterocyclic compounds. Benzoic acid salt of 4'-epi-methylamino-4'-19 deoxyavermectin B1A and 4"-epi-methylamino-4'-deoxyavermectin B1b (Proclaim 5 SG) is widely used in Tomohon to control *Plutella* pests on cabbage plants. However, the use of pesticides by farmers often does not comply with the recommendation. Dose and timing of pesticides often exceed the recommended prescription so to give negative impacts on the environment such as residues in soil and plants.

To address the pesticide contamination, organic matter can be used as soil that contains a lot of organic matter has a lot of soil microbes to accelerate degradation of pesticide residues in soil [9]. This manuscript discusses the role of organic matter in mitigation of pesticide residues in the soil due to the excessive use of pesticide.

## II. MATERIALS AND METHODS

The study was conducted in the village of Matani Tomohon within approximately 35 km from the City of Manado from February to December 2012.

### Materials

The materials used were the seeds of cabbage, organic chicken manure, and pesticides (insecticides) Proclaim® 5 SG (manufactured by PT Syngenta Indonesia).

### Field Experiments

The field experiments were conducted over four months. The study employed a factorial randomized groups design.

The study consisted of two factors where the first factor was the dose of organic matter (A), which consisted of three dose levels:

- A0 = without chicken manure;
- A1 = 4 tons of chicken manure/ha;
- A2 = 8 tons of chicken manure/ha.

The second factor was the dose and frequency of pesticide spraying (with spraying interval of three days) (B), which consisted of five levels:

- B0 = without pesticides;
- B1 = pesticide concentration of 0.5 g/liter of water with 5 times spraying;
- B2 = pesticide concentration of 1.0 g/liter of water with 10 times spraying;
- B3 = pesticide concentration of 1.5 g/liter of water with 15 times spraying;
- B4 = pesticide concentration of 2.0 g/liter of water with 20 times spraying.

Each unit of experiment was repeated three times to obtain 45 experimental lots.

### Observed Variables

- Pesticide residues in soil, measured one week before harvest.
- Pesticide residues on cabbage plants, measured at harvest.

### Residue Analysis

#### • The first phase of the study

The first phase of the study was sampling the soil one week before planting cabbage seeds to obtain supporting data on pesticide residues on the soil prior to plantation. Soil samples were taken randomly to a depth of 30 cm, then wrapped in plastic bags and labeled. Analysis of pesticide residues in soil and plant residue was performed at the Laboratory of Agrochemical Material Residue, Research Center for Agricultural Environment at Bogor.

### Analysis Procedure of Emamectin Benzoate Insecticide Residues in Soil and Cabbage Samples

Residue examination procedures in soil and plants were as follows: soil/cabbage samples as much as 25 grams were put into 500 mL Erlenmeyer flask and dissolved in 100 mL of acetone and water in the ratio (70:30). Later, the solution was shaken with an electric shaker for 2 hours and then filtered with a 500 mL separating funnel. The collected extracts were partitioned with 50 mL of dichloromethane (DCM) and shaken again for 2 minutes. To funnel containing aqueous layer (upper sample) was added 50 mL of dichloromethane (DCM) and then shaken for another 2 minutes. The lower layer (lower dichloromethane) was transferred to a 300 mL round flask. Purification was undertaken via a column chromatography containing two grams of florisil and two grams of anhydrous sodium sulfate (anhydrous  $\text{Na}_2\text{SO}_4$ ). The mixed

dichloromethane extracts were evaporated once again in a rotary evaporator at 50 °C to collect the dried powder. The remaining extract was then rinsed with methanol in gradual by 10 mL and poured into test tubes while being filtered. The solution was ready to be injected to the HPLC (VP-ODS 250 LX 4.6) with a flow rate of 0.5 mL/min and 10 mL sample volume, a procedure according to Amechi et al. (1996).

- *The Second Phase of the Study*

In the second part of the study, soil samples were collected from each experimental lot one week prior to harvest time. The working procedures of the second stage were similar to the first stage, which measures the level of pesticide residues in soil.

#### Data Analysis

The data obtained from the pesticide residue examinations (pesticide levels in soil) were analyzed by analysis of variance (ANOVA) at a level of 5%. An LSD 5% test followed when the ANOVA results show any effects of treatment.

### III. RESULTS AND DISCUSSION

#### *Pesticide Residues in Soil Prior to Seed Planting*

Pesticide residues in soil before the study were measured one week before seed planting. These observations were made to obtain the figures of left over pesticide residues that may remain from the previous planting cycle. The examination showed that pesticide residues were detected and were from the avermectin group (emamectin benzoate) at 55.972 mg/kg.

#### *Proclaim 5 SG Residues in Soil*

Effects of interaction between organic and Proclaim 5 SG Proclaim were significant in reduction of 5 SG residues in soil. Sole influences of organic matter and Proclaim 5 SG are also significantly. The LSD 5% test results are listed in Table I.

Treatment	B0	B1	B2	B3	B4
A0	5.49 ab	10.75 de	13.98 fgh	16.47 hi	27.59 k
A1	4.84 ab	8.35 cd	13.36 fg	15.53 ghi	22.19 j
A2	3.55 a	7.08 bc	11.83 ef	14.34 fgh	18.07 i
BNT 5% = 2.58					

Remark: values followed by different letter are significantly different ( $p < 0.05$ ).

The lowest Proclaim 5 SG residue was obtained from treatment A2B0 followed by A1B0 and A0B0. This was because there was no pesticide spraying in the treatments. In these treatments of the residue was originally the one presented before cabbage planting (before the study began). This is consistent with the result obtained from the first phase of the study that the Proclaim 5 SG residue one week before the cabbage seedlings planted was 55.972 mg/kg. The highest residue was found in treatment A0B4 (combination of no

organic matter and 2.0 g Proclaim 5 SG with 20 spraying times) that was 27.59 mg/kg.

Proclaim 5 SG residue concentration in soil was lowered by organic matters present in soil. This can be seen in treatment with the highest dose of Proclaim 5 SG of 2.0 g with 20 sprays where without provision of organic matter (A0B4) the residue was 27.59 mg/kg. When 4 tons/ha of chicken manure was introduced (A1B4) the residue dropped to 22.19 mg/kg, and the residue further decreased to 18.07 mg/kg when the dose of organic matter was topped to 8 tons/ha (A2B4). The LSD tests at 5% level to the three treatments were different (see Table I). This result was very high compared with the result of Lei *et al.* [10] in which residue of Proclaim 5 SG in cabbage and apple planted soil was 0.001 to 0.089 mg/kg soil. The reduction mechanism was by consumption of the pesticide traces by the microorganisms of the chicken manure [11]. Therefore, this process also benefits the soil as increasing microbial activity in soil will supply plants with nutrients.

#### *Residues Proclaim 5 SG on Cabbage Plants*

Residue of Proclaim 5 SG in cabbage plants were also measured and the results are presented in Table II.

Treatment	B0	B1	B2	B3	B4
A0	1.38	2.15	2.47	2.51	5.83
A1	0.72	1.49	2.39	2.64	5.03
A2	0.74	1.98	2.16	2.50	5.38

Proclaim 5 SG residue as presented in Table II was the value from laboratory analysis. Although not Anova analyzed, the values show that the higher the dose of Proclaim 5 SG followed by more frequent spraying, the higher the residue on the cabbage. Residue of Proclaim 5 SG on cabbage plants ranged from 0.73 mg/kg to 5.83 mg/kg that exceeded the limit where MRL for cabbage is 0.1 mg/kg [12]. Furthermore, compared with the results of Wang *et al.* [10] who found that the final residue of emamectin benzoate ranged from 0.001 to 0.052 mg/kg in cabbage, our results were higher. The figures were influenced by the time of the last application before harvest. The use of pesticides on crops in particular will leave residues on agricultural products. Other factors that affect the amount of pesticide residues are the doses used, application interval, the physical environment, plants, pesticide formulations, active ingredients and persistence. Emamectin benzoate is grouped in the avermectin group that can be stored in the parenchymal tissue of plants.

### IV. CONCLUSION

The interaction between organic chicken manure and Proclaim 5 SG pesticide had a significant impact in reducing the pesticide residue in soil. The highest residue 27.59 mg/kg was found in combination with no organic matter and 2.0 g Proclaim 5 SG with 20 sprays. Increasing the doses of organic

matter will decrease the concentration of residue in soil. Proclaim 5 SG pesticide residues were also found in cabbage in all treatment combinations.

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