The Study of Heavy Metal Accumulation in Shallots and its Relation to Farmers' Behavior
(Srigading Village, Kapanewon Sanden, Bantul Regency)

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ABSTRACT
Shallot farmers in their farming often use agrochemicals intensively which can pollute their land and agricultural products with an increase in the heavy metal content in them. Based on this, this research was conducted with three objectoves. The first one is to determine the status of heavy metal contamination in shallot agricultural products. The second one is to asses farmer behavior regarding fertilizers and pesticides and their use. The last one is to analyze the relationship between farmer behavior in using fertilizers and pesticides with the value of heavy metal accumulation content in shallots in Srigading Village, Kapanewon Sanden, Bantul Regency. The sampling location was selected by carrying out purposive sampling method on 30 points of ready-to-harvest shallots cultivation land. The shallot samples were tested for the heavy metal content of Pb, Cd, and Co. Furthermore, interviews were conducted with land owners or cultivators at the shallot sampling location. Then. the interview data analysis was carried out by giving a score for each qualitative data into quantitative data through a questionnaire and a correlation test was carried out between farmer behavior and heavy metal content. The results of the study found that the heavy metal content of Pb, Cd and Co in shallots in Srigading Village had exceeded the quality standard at all sampling points. In addition, the majority of respondent farmers have bad behavior regarding the use of fertilizers and pesticides. Farmers' behavior has a significant and negative relationship or is in reverse to the heavy metal content in shallots.

***Keywords**: heavy metals, shallots, behavior, farmers*

1. INTRODUCTION

Nowadays, shallots still become a superior commodity for farmers in Yogyakarta Special Region. The high economic value makes the shallots one of the leading vegetable commodities that are widely cultivated by farmers. Bantul Regency is an area that has the largest harvest area, which is 770 hectares or 59% of the total shallots harvest area in Yogyakarta Special Region [1]. Additionally, the cultivation of shallots in Bantul Regency not only utilizes rice fields but also uses sand for agricultural land. The sand land of the south coast, which is marginal land, can be developed into productive land for agricultural business.

One area that uses rice fields and coastal sand for shallots farming in Bantul Regency is Srigading Village. For decades, the agricultural land in Srigading Village has been cultivated for shallots plants with a cropping pattern twice a year with the intensive use of chemical fertilizers and chemical pesticides. Moreover, the use of agrochemicals for a long time,

carried out continuously can pollute agricultural land as the presence of heavy metal content in agrochemicals which will be accumulated in the soil. Furthermore, the use of these chemicals can also reduce the quality of agricultural products in terms of safety due to heavy metal contamination and pesticides on shallots.

Several types of fertilizers that are often used by shallots farmers during the planting period include urea fertilizer, Za fertilizer, SP-36 fertilizer, KCl fertilizer, NPK Phonska fertilizer and NPK Mutiara fertilizer. The most widely used fertilizer in shallots cultivation in Srigading Village is NPK-Phonska of 291.96 kg / ha so that the fertilizer exceeds the recommended limit of use of 125 kg / ha [2]. Several fertilizers allegedly contained heavy metals such as lead (Pb), cadmium (Cd), nickel (Ni), cobalt (Co), and chromium (Cr) [3]. Heavy metal Pb is also found in several types of pesticides such as Antracol 70 WP, Dithane M 45 80 WP and Buldog 25 EC [4].

Heavy metal contamination on agricultural land not only causes changes in the composition, structure and function of agricultural land but can also inhibit plant root growth and can reduce crop production [5]. The symptoms of toxicity or contamination of plants due to heavy metals are similar to plants that suffer from nutrient deficiencies and show obvious symptoms of deficiency [6]. Therefore, the heavy metal contamination on agricultural land is an important problem not for the plants on which it will be damaged or die but rather the accumulation of heavy metals in agricultural products [7].

Besides, heavy metal contamination of soil and agricultural products can also be harmful to human health through the food chain, either directly or indirectly [8]. Metals will accumulate in body tissues and can be poisons to humans, animals and plants if they get over doses. Another dangerous thing that might happen is that the metals accumulate in the human body will cause tissue damage, especially detoxification and excretion of tissues (liver and kidney). Some metals have carcinogenic (cancer-causing) and teratogenic properties (they interfere with fetal growth) [9].

The use of fertilizers and pesticides in the cultivation of shallot is closely related to the behavior of farmers. It is hoped that farmers will have good behavior in the use of fertilizers and pesticides. Counseling, education and training can affect the level of awareness of farmers about the dangers of pesticides to the environment and are the main determinants of environmentally friendly behavior in controlling plant pests [10][11]. Farmers who receive training on pesticide management will tend to pay more attention to the environment in choosing the pesticides to be used and in their use compared to farmers who do not receive counseling [12]. Based on this, this research conducted aimes at ; (1) identifying the status of heavy metal contamination of Pb, Cd, and Co on shallots in Srigading Village, (2) examining the behavior of farmers in Srigading Village regarding fertilizers and pesticides and their use, and (3) analyzing the relationship between farmer behavior in the use of fertilizers and pesticides with the status of heavy metal content in shallots in Srigading Village.

2. RESEARCH METHOD

This research was conducted in the agricultural land of Srigading Village, Kapanewon Sanden, Bantul Regency. The data used were obtained directly either through direct observation in the field, interviews or through analysis in the laboratory. The primary data sources of this study include heavy metal content in shallots and farmer behavior related to the use of inputs (fertilizers and pesticides).

The sampling location was determined by the purposive sampling method on the ready-to-harvest shallot cultivation land. There are 30 shallot sampling points. Shallot samples were taken in a composite manner with each plot of land consisting of 3 individual samples (subsample). Shallot samples obtained from the field were analyzed for the heavy metal content of Pb, Cd, and Co. The method of heavy metal analysis on shallot samples was carried out using the Atomic Absorption Spectrophotometer (AAS) with modifications to the volume of the sample analyzed, the volume of administration of concentrated nitric acid solution and the digestion stage [13][14]. The observation of heavy metal parameters in the sample was carried out at the Integrated Laboratory of the Agricultural Environment Research Institute (Balingtan), Agricultural Research and Development Agency, Ministry of Agriculture. The results of the analysis of heavy metals in shallot were compared with the quality standards set by BPOM (2017) and Alloway (1995).

Table 1. Heavy metal quality standard

Heavy metal type	BPOM, 2017 (ppm)	Alloway, 1995 (ppm)
Pb	0.15	50
Cd	0.01	4
Co	-	4

The data collection related to farmer behavior in using fertilizers and pesticides was carried out by interviewing respondents. Respondents were determined based on the sampling points of shallots that are ready to harvest, namely 30 location points. Where each shallot sample point is taken 1 farmer sample as a respondent so that there are as many as 30 respondents. Farmers who become respondents can be landowners or cultivators of shallot land. Some of the

information extracted includes farmer/respondent identity, farmer socio-economic conditions, an agricultural area, agricultural activities carried out, and farmer behavior in using fertilizers and pesticides.

Data analysis regarding farmer behavior in using fertilizers and pesticides was carried out by giving a score for each qualitative data into quantitative data through a questionnaire. In the questionnaire, there are 13 questions with alternative choices that have been arranged based on the score value of each answer choice, from low to high score which is from a score of 1 to 3. The relationship between farmer behavior and heavy metal content in shallots was tested using correlation analysis on the SPSS program. The score values for each parameter in the question are then combined and class interval calculations are carried out with the following formula:

maximum score = 13 x 3= 39
minimum score= 13 x 1= 13

$$\text{interval} = \frac{\max score - \min score}{number\ of\ classes}$$

$$= \frac{39-13}{2} = 13$$

Table 2. Categories of farmer behavior regarding fertilizers and pesticides based on scores

Total score	category
13-26	not good
26-39	good

3. RESULT AND DISCUSSION

The type of shallot grown by farmers in the Sub-district of Srigading is the Thai variety of red shallots. This type of red shallots was introduced from Thailand, which has a harvest age of 52 - 59 days after planting, marked by the leaves and stems that have relaxed (80%) with a weight loss of tubers (wet-dry storage) of 22 - 25%, and have good adaptability. in the dry season and resistant to the rainy season, adapts well to the lowlands with an altitude of 46 - 95 masl, especially in the dry season and has a very sharp aroma (Dinas Pertanian Daerah Kabupaten Nganjuk, 2016).

Shallots are plants that are consumed by humans, so it is very important to know the heavy metal content in them. It is hoped that the content of heavy metals in shallots does not exceed the established quality standards because it is related to the health of humans who consume them.

3.1. Heavy Metal Content in Shallots

Based on the quality standard set by Alloway [15], the heavy metal content of Pb and Cd in shallots is still below the quality standard, this is different when compared to the quality standard set by BPOM RI [16]. The quality standard for heavy metals based on BPOM RI is very small which is 0.15 ppm for Pb and 0.01 ppm for Cd. As a result, when it is compared to the heavy metal content of Pb and Cd in shallots in the research location, it is almost uncomparable. This case which is far from the quality standard has been determined as harmful, especially if they are consumed continously, it will damage the body system.

The content of heavy metal Co in shallots at all research location points is in the quality standard range, which is between 4-40 ppm based on Alloway [15]. Like the heavy metal content of Pb and Cd in shallots which also have a value above the predetermined quality standard, the heavy metal content Co is also dangerous if consumed by the public because it will can cause health problem.

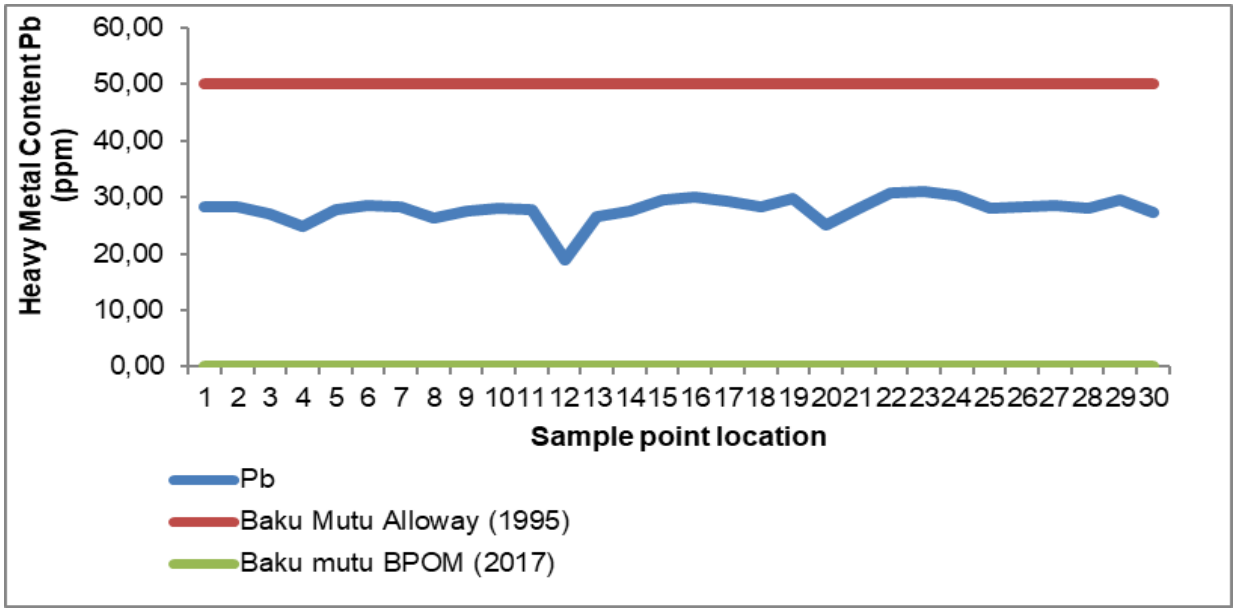

Figure 1. Heavy Metal Content Pb in Shallots in Srigading Village

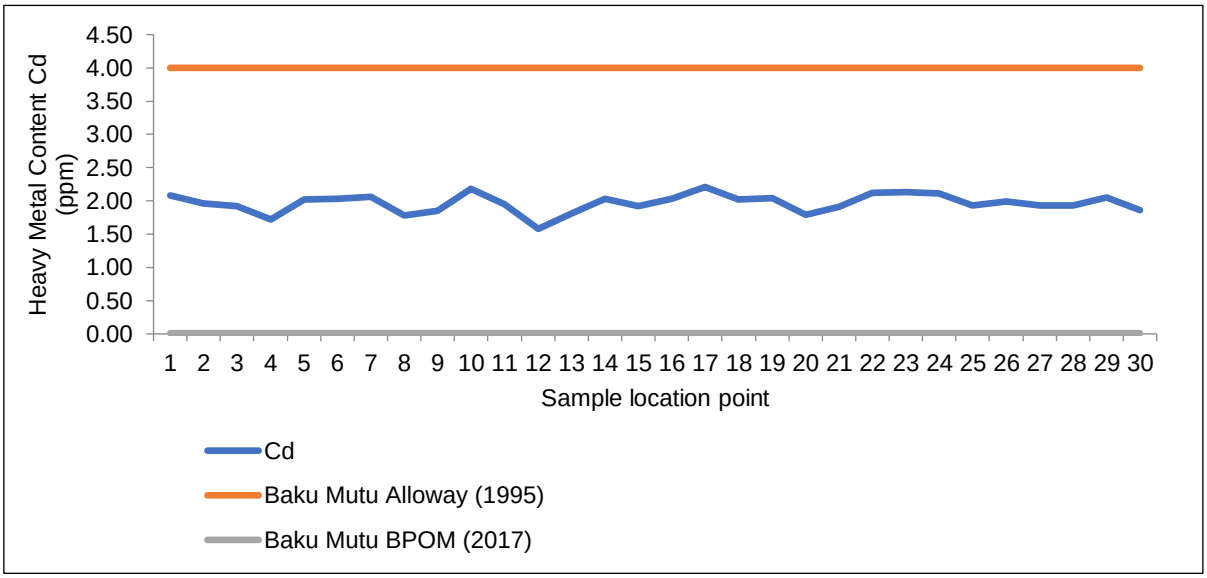

Figure 2. Heavy Metal Content Cd in Shallots in Srigading Village

All samples of shallots analyzed for heavy metal content have heavy metal content Pb, Cd and Co which have exceeded the quality standard. The presence of several heavy metals in red shallots that have exceeded this quality standard is very dangerous so that efforts are needed to reduce the value of the heavy metal content in these shallots.

The high content of heavy metals in onion tubers can be caused because the tubers are the part of the plant closest to the roots. Plant roots are the first part of plants that can absorb heavy metals from the soil, with large atomic weights and diameters causing heavy metals to have relatively small mobility so that when absorption occurs, heavy metals will accumulate in the nearest place from the roots, namely the tubers. In addition, heavy metals are not a component of tissue so that when photosynthesis occurs in tubers, heavy metals will also accumulate in tubers [17].

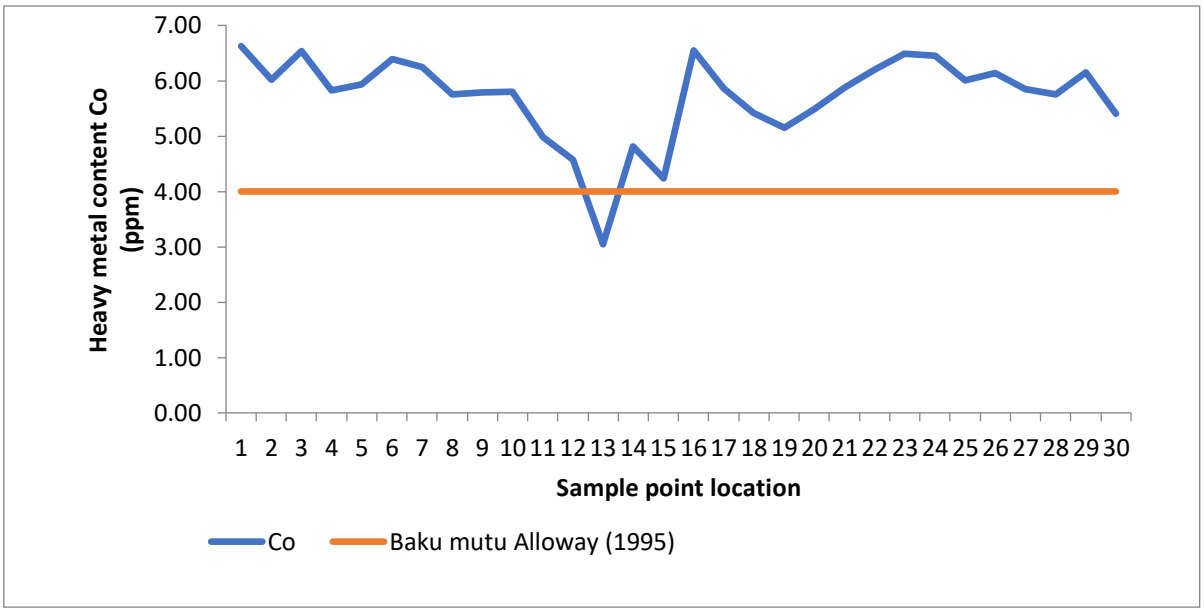

Figure 3. Heavy Metal Content Co in Shallots in Srigading Village

3.2 The Behavior of Shallots Farmers

In this study, the behavior of farmers means the behavior of the farmers in using fertilizers and pesticides, which consists of selecting fertilizers and pesticides, doses of fertilizers and pesticides, the habits of farmers when using fertilizers and pesticides and the behavior of using personal protective equipment during use. pesticides and the possibility of farmers switching to organic fertilizers and vegetable pesticides. The behavior of farmers in using pesticides is categorized into good and not good. Specifically, the behavior of farmers in using fertilizers and pesticides based on the results of the interviews can be seen in Table 3.

Table 3. The shallot farmers' category

No.	The farmers' behavior	Amount	
		n	%
1	Not Good	22	73,33
2	Good	8	26,67
Total		30	100

Based on the table above, it can be seen that 73.33% of all respondent farmers have not good behavior in using fertilizers and pesticides and only 26.67% of farmers have good behavior in using fertilizers and pesticides. Therefore, it can be concluded that the majority of farmers who became respondents have not good behavior towards the use of fertilizers and pesticides.

.Based on the results of interviews with onion farmers, it shows that the majority of farmers who have not good behavior use doses of fertilizers and pesticides that are not in accordance with the dose, frequency of pesticide application 3 times a week, and are still hesitant if asked to reduce or use chemical fertilizers and pesticides. Lack of education on fertilizer doses and pesticide spraying as well as crop disturbance and lack of training on safe pests by implementing officers and lack of information provided on labels and leaflets (sometimes information is published in foreign languages) are considered as the main obstacles to farmers in using pesticides [18].

Table. 4. The results of the correlation analysis of farmer behavior and heavy metal content in shallots

		Perilaku petani	Pb	Cd	Co
Perilaku Petani	Pearson Correlation	1	**-.385***	**-.364***	**-.472****
	Sig. (2-tailed)		**.036**	**.048**	**.009**
	N	30	30	30	30
Pb	Pearson Correlation	-.385*	1	.821**	.398*
	Sig. (2-tailed)	.036		.000	.029
	N	30	56	30	30
Cd	Pearson Correlation	-.364*	.821**	1	.462*
	Sig. (2-tailed)	.048	.000		.010
	N	30	30	30	30
Cr	Pearson Correlation	-.014	.035	.367*	.030
	Sig. (2-tailed)	.942	.855	.046	.874
	N	30	30	30	30
Co	Pearson Correlation	-.472**	.398*	.462*	1
	Sig. (2-tailed)	.009	.029	.010	
	N	30	30	30	30
Ni	Pearson Correlation	-.555**	.447*	.455*	.962**
	Sig. (2-tailed)	.001	.013	.012	.000
	N	30	30	30	30

In the application of fertilization, majority of farmers use chemical fertilizers with doses that are not adjusted to the needs of the land. Farmers still feel doubts about reducing fertilizer dosages and adjusting fertilizer application according to their needs

The relationship between farmer behavior in using fertilizers and pesticides with heavy metals Pb and Cd in shallots has a weak relationship, but the relationship between farmer behavior and Pb metal and between farmer behavior and Cd metal influence each other and are significant. The relationship between heavy metal Co and farmer behavior has a strong and mutually influencing relationship between the two. The results of the correlation analysis between farmer behavior and heavy metal content of Pb, Cd, and Co in shallots can be seen in Table 2

The relationship between farmer behavior in the use of fertilizers and pesticides with heavy metal content in shallot products for all heavy metals has a negative relationship which is the opposite relationship. This means that the better the farmer's behavior, the smaller the heavy metal content in shallots, and conversely the worse the farmer's behavior, the higher the heavy metal content in shallots. The behavior of onion farmers and the use of pesticides have a significant effect on the impact on the environment [19]

.4. CONCLUSION

The results of the study found that the heavy metal content of Pb, Cd and Co in shallot products had exceeded the quality standard at all sampling points. Furthermore, the majority of farmers behavior who became respondents showed not good behavior in using fertilizers and pesticides. In addition, the relationship between farmer behavior and heavy metal content in shallots has a significant and negative relationship or in reverse. A strong relationship is found in the relationship between farmer behavior and heavy metal Co in shallots and a weak relationship is in the relationship between farmer behavior and heavy metals Pb and Cd in shallots.

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