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# Effect of Organic Fertiliser and Biofertiliser on Cadium Accumulation of the Fimbristylis Globulosa Plant

**Y. Sunarya[a], Y. Yulianto[b],** [a,b]Siliwangi University, Siliwangi Street, Tasikmalaya 46115, Indonesia, Email: [a*]yayasunarya@unsil.ac.id

The objectives are to find out the effect of organic fertiliser and biofertiliser on cadmium accumulation of the Fimbristylis globulosa plant. The experiment was set up in a randomised block design which consisted of four treatments and six replications. 2 mg kg-1 CdCl2 was added to growth medium of soil, a mixture of soil-animal manure, and soil treated with biofertiliser, and a mixture of soil-animal manure treated with biofertiliser. Cadmium accumulation is calculated using the translocation factor (TF) and Bioconcentration factor (BCF). The results showed that Cd-content and Cd-accumulation of root and shoot on soil, and soil treated with biofertiliser were greater than those on a mixture of soil-animal manure and a mixture of soil-animal manure treated with biofertiliser. Based on the BCF-, and TF-value, the Fimbristylis globulosa plant plays a role as phyitostabilator (BCF>1, TF<1) and phytoextractor (BCF<1,TF>1).

## Introduction

Cadmium (Cd), a heavy metal having a density higher than 5.g $cm^{-3}$, is an impotant factor in environmental pollution in an area with a high anthrpogenic activity (energy production, smelting and refining, manufacturing process, waste incineration, agricultural and animal wastes, logging and wood wastes, urban refuse, municipal sewage and organic waste, solid waste from metal fabrication, coal ashes, fertiliser and peat, discarded manufactured products and atmospheric fallout). It's presence in the environment (atmosphere, soil, and water) causes a dangerous impact to all organisms due to its accumulation in the food chain (Sanita di Toppi and Gabrbrielli, 1999), (Alloway, 1995).

The effects of cadmium in higher plants among others are root damage, reduction of nutrient absorption and their transport from rot to shoot, inhibition of nitrate reductase activity in the shoots, inhibition of Fe (III) reductase which affect photosynthesis, and overall it causes leaf roll and chlorosis, and reduces roots and stem growth (Alloway, 1995).

The plants uptake of heavy metals from the soil occurs either passively with the mass flow of water into the roots, or through active transport crossing of the plasma membrane of root epidermal cells. Metal accumulation by plants is affected by many factors, among others are variations in plants species, the growth stage of plants and element characteristics controlling absorption, accumulation and translocation of metals (Samarghandi et al., 2007*)*. There are plants that accumulate cadmium greater than the surrounding medium (Kim et al., 2003), and one of the plants is *Fimbristylis globulosa.*

Bioconcentration factor is the ratio of metal concentration in the plant's roots to soils, and the translocation factor (TF) is the ratio of metal concentration in plant shoots to roots (Yoon et al., 2006) (Nouri et al., 2011). Plants with a high bioconcentration factor (BCF) and low translocation factor (TF) have the potential for phytostabilisation, while plants with both BCFs and TFs greater than one have the potential to be used for phytoextraction (Yoon et al., 2006)

## Materials and Methods

### *Study Site*

A pot experiment was carried out in March until October 2017 in the Manonjaya sub-district Tasikmalaya regency at the altitude of about 292 m above sea level.

### *Experimental setup*

The experiment was set up in a randomizsd block design and consisted of four treatments and six replications. The treatments were soil, a mixture of soil and animal manure, soil treated with biofertiliser, and a mixture of soil and animal manure treated with biofertiliser.

### *Application of treatments an observation*

The soil, Lotosol soil of Cibeureum Tasikmalaya, was air dried and sieved usig 5 mm diameter sieve. The analysis of soil indicated that the content of organic-C total, total-N, total-P, and total-K are respectively 1.76%,0.14%, 23 mg 100 $g^{-1}$, and 11.56 mg 100 $g^{-1}$, with the pH of 6.0. The Fimbristylis globulosa plants were collected from the Manonjaya sub-district Tasikmalaya Regency, and about 3g of root cutting with three tillers were planted in the pot. Animal manure, cattle manure, was taken also from Manonjaya with the p of 7.89, 24.92% organic-C total, 2.62% total-N, 2.62% total-P, and 0.80% total-K respectively. M-Bio, Biofertilizer containing the mixture of microorganisms was used in this experiment.

A treatment of 2 mg kg$^{-1}$ $CdCl_2$ was added to the growth medium of soil, a mixture of soil-animal manure, soil treated with biofertiliser, and a mixture of soil-animal manure treated with biofertiliser. Further, 10 mg of $CdCl_2$ diluted in alcohol and the 1000 ml of water was added and poured into the pot containing 5000 g of soil, the mixture of soil and animal manure, soil treated with biofertiliser, and the mixture of soil and animal manure treated with biofertiliser; the treated growth medium were then incubated for 36 hours.

The indicators collected are the Cd-content of root, stem, and the Cd accumulation of root and stem. The data were analysed statistically using analysis of variance followed by Duncan's multiple range test at the significance level of 0.05 (Gomez and Gomez, 1995). Cadmium accumulation is calculated using the bioconcentration factor (BCF) and the translocation factor (TF). The Bioconcentration factor is the ratio of metal concentration in plant roots to soils and the translocation factor is the ratio of metal concentration in plant stem to root:

$$\mathrm{BCF} = \frac{[Metal]root}{[Metal]soil}$$

$$\mathrm{TF} = \frac{[Metal]stem}{[Metal]root}$$

**Results and Discussion**

Plant growth parameters

Table 4.1 indicates that the plant grown on the mixture of soil and animal manure treated with biofertiliser, tend to show a better plant height, number of tillers, and fresh and dry weight than those on the other growth medium. It is due to collective roles of biofertiliser and animal manure to provide with better growth environments to the plant. The plant content of Cd affects the growth parameters especially, distinctively indicated with a lesser number of tiller and plant weight (fresh and dry weight). It is due to the adverse effect of cadmium to the higher plant (Alloway, 1995).

**Table 1:** Plant growth parameters of the *Fimbristylis globulosa* plant

| Treatments | Plant growth parameters | | | | | |
|---|---|---|---|---|---|---|
| | Plant height (cm) | Number of tiller | Plant Wet weight (g) | Plant dry weight (g) | Root dry weight (g) | Stem dry weight (g) |
| Soil | 50.68 b | 28.16 b | 78.95 b | 32.26 b | 13.61 b | 17.95 b |
| Soil+animal manure | 53.20 ab | 58.95 a | 194.58 a | 60.22 a | 27.66 ab | 31.17 b |
| Soil+Biofertiliser | 53.33 ab | 31.20 b | 93.12 b | 35.03 b | 14.14 b | 20.23 b |
| Soil+animal manure+Biofertiliser | 55.33 a | 60.50 a | 231.45 a | 85.06 a | 42.02 a | 48.23 a |

Note: The values followed by the same lowercase are not significantly different according to Duncan's multiple range test at 5% significant level.

***Cd content and accumulation***

The Cd content of the root and stem and the Cd accumulation of root and stem is indicated in Table 2. The table indicates that the Cd content of root of soil and soil teated with biofertiliser is greater then those of the mixture of soil and animal manure and the mixture of soil treated with biofertiliser. The same figure is shown by the Cd content of the stem, and accordingly the same figure is shown by the Cd accumulation of the root and stem. Both the Cd content and Cd accumulation is greater in the roots (underground parts) than that in the stem (aerial parts). This is in accordance with Cataldo stating that Cd ions are mainly retained in the roots, and only small amounts are transported to the shoots (Cataldo et al., 1983).

The addition of animal manure decreased both the Cd content of the root and the stem of the Fimbristyls globulosa plants and accordingly decreased the accumulation of Cd in the plant root and stem.

**Table 2:** Cd content and accumulation and BCF- and TF-values

| Treatments | Cd-content of | | | Cd- accumulation | | BCF | TF |
|---|---|---|---|---|---|---|---|
| | Soil (ppm) | Root (ppm) | Stem (ppm) | Root (ppm) | Stem (ppm) | | |
| Soil | 2 | 20.79a | 4.18a | 282.95a | 75.03a | 10.40 | 0.20 |
| Soil+animal manure | 2 | 0.55b | 0.74b | 15.21b | 23.07b | 0.28 | 1.35 |
| Soil+Biofertiliser | 2 | 22.99a | 4.37b | 325.08a | 88.41a | 11.50 | 0.19 |
| Soil+animal manure+Biofertiliser | 2 | 2.45b | 0.64a | 102.95ab | 30.87b | 1.23 | 0.26 |

Note: The values followed by the same lower case are not significantly different according to

Duncan's multiple range test at 5% significant level

### *BCF and TF values*

The value of the bioconcentration factor (BCF) in soil and soil treated with biofertiliser is much greater than those with the mixture of soil and animal manure, and the mixture of soil and animal manure treated with biofertiliser. On the contrary, the value of the transportation factor (TF) in soil and soil treated with biofertiliser is much greater than those in the mixture of soil and animal manure, and the mixture of soil and animal manure treated with biofertiliser. Plants play a role as phytostabilator if (BCF>1, TF<1), and as phyitoextractor if (BCF<1,TF>1). Based on the values of BCF and TF above (Table 2), *Fimbristylis globulosa,* as affected by the characteristic condition of growth medium, can play a role as phytostabilator and as phytoextractor.

## Conclusion and Future Research

Cd-content and Cd-accumulation of root and shoot on soil, and soil treated with biofertiliser had greater performance than those on the mixture of soil-animal manure and mixture of soil-animal manure treated with biofertiliser. Based on the BCF-, and TF-value, the Fimbristylis globulosa plant plays a role as phyitostabilator (BCF>1, TF<1) and phytoextractor (BCF<1,TF>1).

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