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Evaluation of *Ipomea carnea* Growth Response in Plant Media That was Exposed by Sidoarjo Mud

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Abstract. Krangkungan (*Ipomea carnea* ssp. *Fistulosa*) is a wild plant that has the ability to remediate wetlands polluted by toxic substances. Investigation of *I. carnea*'s ability to survive and thrive on land exposed to Sidoarjo mud is needed to enrich information for future management. This study aims to determine the relationship of Sidoarjo mud concentration to 30% levels and incubation period of planting up to 70 days after planting on the growth rate and production of plant biomass. Sidoarjo mud-free krangkungan seedlings were transferred into polybags containing planting media with Sidoarjo mud composition and normal soil 0: 100%, 10: 90%, 20: 80%, and 30: 70% each as many as four plants. Observation of plant growth starts from 10 days after planting (HST) to 80 HST. The incubation period or observation time with the 10-day interval (10-70 HST) and sludge concentration are independent variables in the linear regression model related to growth and production of biomass as the dependent variable at the 5% real level. Linear regression analysis of data obtained using the SPSS statistical analysis package (version 18). Sidoarjo mud and incubation time affect the decrease in height growth rate, stem diameter, number of leaves, leaf area, and weight of *I. carnea* in 70 days after incubation of planting. *I. carnea* is able to grow well in soil mixed with mud up to a concentration of 30% even though the rate of growth and production of biomass decreases compared to lower mud concentration and without mud. Conservation of *I. carnea* on land that has been exposed to Sidoarjo mud has a prospect for the use of this weed for various purposes

1. Introduction

The world-known choking event that is the Sidoarjo mudflow in Renokenongo Village, Porong District, Sidoarjo Regency, East Java, which occurred since May 27, 2006, has affected the pollution of agricultural land around the blast centre. Land exposed to mud contains heavy metals and toxic hydrocarbons and cannot be utilized for the cultivation of agricultural crops [1].

Polluted land will have an impact on changes in the structure of vegetation in the following years. This polluted land then gave rise to a different structure of wild vegetation compared to before the mudflow occurred. Various types of plants dominate the land exposed to this phytotoxic mudflow in Sidoarjo; there are at least 11 types of ground cover plants [2], and bush plants, including krangkungan (*Ipomea carnea*).

I. carnea, known as a weed plant, is relatively poisonous to livestock spread from North Africa, Nepal, to the Asia Pacific. It is found to contain various compounds that can be used as plant-based pesticides that control insect pests. [3], antibacterial and compost [4] and are



functional for various plant pathogens [5] in addition to potential pharmaceutical chemicals. [6]. Thus this plant needs attention and protection in the future.

The ability of the *krangkungan* to grow well and dominate the land contaminated with toxic substances indicates that these wild plants have the ability to overcome the stress of hazardous substances and remediate the land. Growth response can be an indicator of the ability of plants to cope with stress and potential indicators as bioremediation agents of agricultural land. Thus the *krangkungan* needs to get attention in land management, especially in the context of remediating land so that later it can be reused as agricultural land and the biomass can be used for various human needs.

This study aims to determine the growth response of *Ipomea carnea* in overcoming the stress of mud solids up to their maximum concentration as happened in the land exposed to Sidoarjo mud.

2. Methodology

The *krangkungan* (*Ipomea carnea*) plant used in this experiment was obtained from land that was never exposed to the Sidoarjo Mudflow in 2006 in Siring village, Tanggulangin District, Sidoarjo Regency, East Java. The experiment was carried out in a plastic house in a village in Kalipecabean Village, Candi District, Sidoarjo Regency. *Krangkungan* nurseries are done by cuttings. The *krangkungan* plant stems are cut straight along 30 cm, and the stems are cut straight, then implanted into a container containing soil with a volume of 15-litre planting media so that about 10 cm of stem cuttings are embedded into the soil. The nursery media soil is maintained in a variety of conditions by adding one litre of water each day. After two weeks of incubation in nurseries, each cutting that has become seedlings are transferred to a polybag containing planting media with Sidoarjo mud composition and normal soil 0%, 10%, 20%, and 30% each as many as four plants. Consideration of determining the rate of 30% silt solids is in accordance with the characteristics of a mixture of mud which overflowed from its source consisting of 70% water and 30% solids that settle on exposed land [7]. Observation of plant growth starts from 10 days incubation of planting (DIP) to 70 DIP. In this case, each observation time with a 10-day interval is used as a fixed variable in the regression model.

The research is a correlational study that connects the concentration of Sidoarjo mud in planting media and plant age to the growth rate of plant height, stem diameter, and a number of plant leaves up to 70 DIP as well as between mud concentration with broad wet and dry weight plant stover at the end of observation (70 DIP). The concentration of sludge used is 0% (without sludge), sludge content of 10%, 20%, and 30%. In this experiment, 40 seed samples of the same age were used, which were taken randomly from the nurseries available. The incubation period is determined to include 10 to 70 DIP at 10-day intervals.

Variables observed every ten days include: plant height (cm), number of leaves, stem diameter (cm), leaf area (cm²). Stover weight, both wet and dry (g) was observed at 70 DIP as support analyzed the content of Pb and Cd in plant tissues treated with mud (concentrations of 10, 20, and 30%) as metals which are widely found in mud crops [1]. Analysis of the two metals from the network was carried out by the FAAS method [8].

Data on the results of the sub-district were processed using SPSS version 18 software so that a regression model was obtained and the effect of each variable was found on the regression model and its correlation at a confidence level of 5 and 1%.

3. Result and Discussion

Consecutive Observation

The results of the regression analysis showed that there was a relationship between the concentration of Sidoarjo mud (0-30%) and the incubation time or planting time with a decrease in the growth rate of plant height, the number of leaves expressed in the regression model as stated in Table 1.

Table 1. Model of Plant height regression, number of leaves, and stem diameter of *I. carnea*

Independent variable	Regression model	P-value of X1	P-value of X2	R2
Plant height	$Y = 0.1779 + -82,997 X1 + 1.0213 X2$	1.82258E-21	6.6266E-67	0.88
Leaf number	$Y = 5.7078 -34,901X1 + 0.3219X2$	6.03E-46	3.18E-67	0.95
Stem diameter	$Y = 4.4793 -10,761X1 + 0.080X2$	1.25874E-43	2.58763E-55	0.93

Note. X1: sludge levels, X2: incubation time of planting.

Both the mud content and the time had a very significant effect ($p < 0.01$) on the growth of plant height, number of leaves, and stem diameter with a high close relationship with the R2 range between 0.88-0.95. The mean of the three observational variables aged 40 and 70 DIP is shown in Table 2. It appears that increasing the concentration of sludge decreases the growth lanes of the three vegetative growth variables of the cage.

Table 2: The mean of plant height, number of leaves, and stem diameter of *I. carnea* in several sludge concentration at 40 and 70 DIP

Mud concentration ¹	Plant height (cm)	Leaf number	Stem diameter (mm)
	40 DIP	70 DIP	40 DIP
0%	38,53 ± 0,43	101,11 ± 0,35	17,31±0,25
10%	23,67 ± 0,16	62,97 ± 0,42	14,03±0,21
20%	20,19 ± 0,23	56,42 ± 0,11	10,89±0,18
30%	16,42 ± 0,11	49,75 ± 0,43	8,19±1,05

Observation of Leaf Area and Biomass

The results of the regression analysis showed that there was a relationship between Sidoarjo mud concentration (0-30%) and incubation time or planting time with a decrease in the growth rate of plant height and number of leaves (Table 3).

Table 3. Regression model of leaf area, wet weight stover, and dry weight stover at 70 DIP

Independent variable	Regression model	P-value of X1	R2
leaf area	$Y = 64.454-78.535X1$	7.43E-06	0.72
Wet weight stover	$Y = 150.4056 -161.50X1$	1.51527E-09	0.93
Dry weight stover	$Y = 42.8833 -69.50X1$	1.28E-12	0.98

Note. X1 Sludge levels

The sludge content and time had a very significant effect ($p < 0.01$) on leaf area, wet stover weight and dry stover weight with high closeness (R2 0.72-0.98). The mean of the three variables in 70 DIP observations is shown in Table 3. Increasing the concentration of sludge in growing media decreases the vegetative growth rate of plants *I. carnea* (Table 4).

Table 4. The average leaf area and the weight of the *I. carnea* stover were grown on the media with some mud concentration at 70 DIP

Mud concentration ¹	Leaf area (cm ²)	Stover wet weight (gr)	Stover dry weight (gr)
0%	38,53 ± 0,43	155.00 ± 1,76	43,17 ± 0,91
10%	23,67 ± 0,16	128,75 ± 1,53	36,33 ± 0,89
20%	20,19 ± 0,23	115,33 ± 2,01	27,33 ± 0,89
30%	16,42 ± 0,11	105,64 ± 4,62	23,00 ± 0,67

Plant *I. carnea* accumulates metals contained in the mud including Pb and Cd as shown by the results of plant tissue analysis in the treatment of mud concentration of 10, 20 and 30% (Table 5).

Table 5. The Content of Pb and Cd in the *I. carnea* grown on muddy media

Mud concentration	The content of metals in <i>I. carnea</i> stover (ppm)	
	Pb	Cd
10%	80	40
20%	48	54
30%	21	31

4. Discussion

Krangkungan (*I. carnea*) grown on normal soil media without mud shows all the highest growth variables. Plant height, stem diameter, number of leaves, and leaf area showed performance according to their genetic potential. *I. carnea* leaves that grow perfectly have a length of 13-23 cm and a width of 5.5-9.5 cm [9]. All growth and biomass variables show a strong correlation with a decrease in R² values ranging from 0.72 to 0.98 (Tables 1 and 3). The higher concentration of sludge in the planting medium indicates a decreased plant growth response (Tables 2 and 4). This indicates that mud has inhibited the growth of *I. carnea*. The mechanism of extrusion of H⁺ across the membrane of root cells driven by proton pumps exchanges metal ions which then enter and are mechanized into the vacuola [10] occurring in this experiment as evidenced by the high Pb and Cd uptake in mud concentration 10%, 80 and 40 ppm (Table 5). The decreasing metal content in stover with increasing concentration of sludge shows the level of tolerance of plants to the stress metals Pb and Cd as well as the possibility of other toxic materials. Various toxic hydrocarbons, sulfides, lead, cadmium, copper, and various other heavy metals can damage and inhibit the regeneration of hair roots and interfere with the absorption of nutrients by plants [11]. The mud substance contains dominant sand and little organic material [12], so it lacks the ability to bind or maintain heavy metals [13]. In this experiment, it appears that the krangkungan plant was able to maintain its growth at the highest concentration of mud (30%) even though the growth rate was low. This is made possible by the maintenance of the photosynthesis process, which guarantees the supply of sugar from the work of the krangkungan leaf cells. When the intensity of sunlight and the availability of enough water in the growing media, then the sugar from photosynthesis is available optimally; this condition can support the resistance of young plants under conditions gripped by hazardous materials [14]. Photosynthetic sugar plays an important role in the growth of adolescent plant tissue [15]. Thus the maximum sludge concentration (30%) shows that in 70 DIP the average growth of plant height, stem diameter, and the number of leaves has increased about twice compared to 40 DIP (Table 2). At high concentrations, the plant survives and shows its growth performance. This has the meaning that the krangkungan has characteristics as plant land remediation agents. Plants use an adaptive mechanism that translocates metals through the xylem and then builds up, sequesters, or detoxifies the metal so that growth can be maintained [16].

5. Conclusion

Sidoarjo mud affects a decrease in height growth rate, stem diameter, and a number of leaves and leaf area, wet weight, and dry weight of *Ipomea carnea* stover. Incubation time or plant age affects the growth rate of height, stem diameter, and number of leaves. In soils affected by mud up to a concentration of 30%. *I. carnea* is able to grow well even though it has reduced growth rates and biomass production compared to lower sludge concentrations and without mud.

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