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Response of *Eichhornia crassipes* weeds to various doses of florpyrauxifen-benzyl herbicide application in cirata reservoir, Cianjur regency

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ABSTRACT

The water hyacinth (*E.crassipes*) invasion has created a concerning ecological crisis in Cirata Reservoir, which is home to Southeast Asia's largest hydroelectric power plant and threatening the balance of freshwater ecosystems. Florpyrauxifen-benzyl herbicide emerges as a potential solution due to its high effectiveness and biodegradable nature. This study looked for to evaluate the efficacy of the herbicide containing Florpyrauxifen-benzyl in mitigating the presence of water hyacinth weeds at Cirata Reservoir, Cianjur Regency. This study utilized a Randomized Block Design containing four replications and seven treatments, including herbicide doses of 500, 750, 1000, 1250, and 1500 ml/ha, compared with hand weeding and control (without herbicide). Results showed that Florpyrauxifen-benzyl herbicide effectively suppressed water hyacinth growth up to 12 weeks after application (WAA). All tested herbicide doses resulted in lower weed biomass and weed damage percentage reaching 100% compared to control and hand weeding treatments. This study concludes that Florpyrauxifen-benzyl herbicide at doses of 500-1500 ml/ha effectively controls water hyacinth weeds in freshwater ecosystems, also providing a potential solution to the invasive aquatic weed problem at Cirata Reservoir.

Keywords : *Eichhornia crassipes*, Florpyrauxifen-benzyl, Herbicide, Weed Control.

INTRODUCTION

The rapid global proliferation of *Eichhornia crassipes* (water hyacinth) in aquatic systems has intensified ecological disruptions across freshwater ecosystems (Amalina et al. 2022). They exhibit a significant reproductive potential, enabling them to double their body weight within 6 to 24 days under optimal growing conditions (Gao et al. 2013; Rezkia et al. 2023). Water hyacinth is known to invade freshwater habitats quickly (Janssens et al. 2022). Uncontrolled water hyacinth populations pose severe threats to aquatic ecosystems. The dense mats reduce species diversity by blocking sunlight penetration, affecting water turbidity, depleting dissolved oxygen and nutrients (Zeleke et al. 2024; Yang et al. 2025)

Cirata reservoir is one of three large reservoirs whose waters inundates three regencies in West Java, namely Purwakarta Regency, Cianjur Regency and West Bandung Regency. Cirata is the largest hydroelectric power center in Southeast Asia (Ministry of Energy and Mineral Resources 2020). Cirata reservoir which faces complex problems that include

environmental and socio-economic aspects. Water quality has declined dramatically due to pollution from various sources, high sedimentation, and uncontrolled water hyacinth growth (Irwan et al. 2020). Currently, weed control in Cirata Reservoir is done by mechanical control. However, the problem is that it requires a long time and a lot of labor. The use of water hyacinth dredging machines has been used but has not been effectively used.

Various strategies have been implemented to remove water hyacinth, including human removal, biological management, and chemical removal (Gupta and Yadav 2020). Strategies for addressing invasive species like water hyacinth encompass physical removal, the application of herbicides for chemical control, and the implementation of biological control by leveraging natural predators (Djihouessi et al. 2023). Herbicides that contain novel active compounds can enhance selectivity towards aquatic plant species, allow for lower application doses, and decrease the likelihood of weeds developing resistance to herbicides (Richardson et al. 2016).

As a systemic post-emergence insecticide, Florpyrauxifen-benzyl is a brand-new synthetic auxin herbicide from the arylpicolinate class. Unlike other auxin mimics that bind to TIR1, it strongly binds to auxin receptor (AFB) proteins in the auxin signaling system (Epp et al. 2016). This broad-spectrum herbicide effectively controls grasses, broadleaves, and sedges sedges. While classified as an auxin herbicide, its specific characteristics in terms of efficacy, crop tolerance, dosage, persistence, and selectivity distinguish it from other molecules in this category (Maienfisch and Mangelinckx 2021).

This research aims to assess how effectively Florpyrauxifen-benzyl herbicide controls the invasive water hyacinth population in Cirata Reservoir. Due to the scarcity of Indonesian research regarding herbicide-based management of aquatic weeds, Florpyrauxifen-benzyl can be alternative solution that potentially preserves ecological equilibrium and water resource functionality while combating this invasive species.

MATERIALS AND METHODS

Location

The study was executed at Cirata Reservoir in Cianjur Regency, West Java, located at 6°46'10"S 107°16'16"E, and at the Weed Science Laboratory, Faculty of Agriculture, UNPAD.

Materials

This experiment utilized various equipment including a knapsack sprayer, high tub bucket, flat fan nozzle, scientific balance, measuring cylinder, half-inch paralon pipes with connections, analytical scales, measuring cup, and 2 cm × 2 cm netting, cable tie, ½ inch pipe wrapping foam, cable tie, pipet filler, 1 ml pipette, room thermometer and hygrometer, measuring instruments, stationery, filter, plastic tray, and oven. Water transportation tools used in Cirata reservoir using a speed boat. The materials utilized in this experiment included water, weed propagules, and herbicide containing the active component Florpyrauxifen-benzyl.

Methods

This study used a reservoir-based Randomised Block Design and generated 28 experimental unit plots from seven treatments and four replications. A square (1x1 m) pipe box housed 50 propagules of water hyacinth (Figure 1). Eight treatments were replicated four times, using 1,400 propagules. The line of sight between the treatments became one meter, and the distance between replications were two meters. The treatments assessed comprised doses of Florpyrauxifen-benzyl herbicide at 500, 750, 1000, 1250, and 1500 ml/ha, alongside hand weeding and a control group (without herbicide).

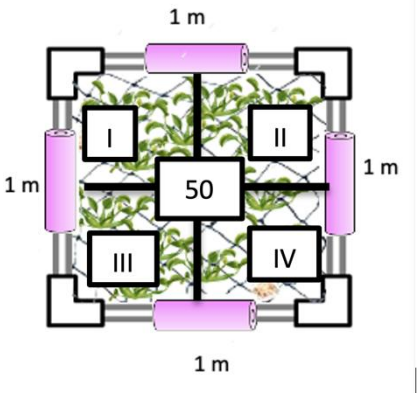

Figure 1. Quadrant Plot Experimental

Parameters and data analysis

Water hyacinths used in this study were collected from the Cirata Reservoir area, with homogeneous samples of 8–12 leaves planted in 1 m x 1 m square pipes, totaling 1,400 propagules. The weeds went through a three-week acclimation period prior to herbicide application, and their dry weight was assessed following a drying process at 80°C for 48 hours to calculate growth reduction; %The GR = (1- T / C X 100%). %GR refers to Growth Reduction, where T represents the dry weight of weeds treated with herbicide and C represents the dry weight of control weeds. After applying the herbicide, weed coverage was visually assessed every two weeks for a total of 12 weeks.

RESULT AND DISCUSSION

Weed Dry Weight (g)

Results regarding the dry weight of the water hyacinth vegetation at Cirata Reservoir are detailed in Table 1.

Table 1. Average Dry Weight of Water Hyacinth Weeds at Cirata Reservoir

No.	Treatments	Doses	Observation Time (Week)			
		(ml/ha)	2WAA	4WAA	8WAA	12WAA
A	Florpyrauxifen-benzyl	500	3.75 c	0.00 c	0.00 c	0.00 c
B	Florpyrauxifen-benzyl	750	0.00 c	0.00 c	0.00 c	0.00 c
C	Florpyrauxifen-benzyl	1000	0.00 c	0.00 c	0.00 c	0.00 c
D	Florpyrauxifen-benzyl	1250	0.00 c	0.00 c	0.00 c	0.00 c
E	Florpyrauxifen-benzyl	1500	0.00 c	0.00 c	0.00 c	0.00 c
F	Hand Weeding	-	100.25 b	148.11 b	312.27 b	400.50 b
G	Control (without herbicide)	-	285.78 a	341.50 a	505.82 a	678.88 a

Notes : *T-test analysis shows no statistically significant differences at the 5% level between mean values with the same letter in the same column. The column shows no notable difference at the 5% level as determined by Duncan's test. WAA refers to the period following the application of herbicide.*

Table 1 shows that in the observation of 2 WAA to 12 WAA (week after herbicide application), the treatment of Florypyrauxifen-benzyl herbicide doses of 500 ml/ha to 1500 ml/ha exhibits the lowest average dry weight of water hyacinth weeds and is statistically distinct from both the control treatment and the hand weeding treatment. The reduction in weed dry weight is associated with Florpyrauxifen-benzyl herbicide's ability to mimic IAA hormone (Liu et al. 2023). The herbicide triggers excessive gene expression leading to ABA accumulation.

Consequently, stomata close, inhibiting CO2 assimilation, and producing ROS that causes weed cell death (Grossmann 2007).

The hand weeding treatment exhibited an average weed dry weight that was particularly differing from both the control treatment and all herbicide treatments. Hand weedings that are not maximized can increase the biomass of new weeds because the remaining weeds get full access to resources such as sunlight, nutrients, and growing space without competition. This is in line with the research of (Vera et al. 2020), the hand weeding frequency factor independently affects the population of weed species, and the total weed population produces higher biomass.

The control treatment at 2–12 WAA had the greatest average dry weight of water hyacinth weeds and was substantially distinct from other treatments. The control treatment indicated a progressive increase in vegetative growth, characterized by a gradual rise in the number of leaves, which was subsequently accompanied by an increase in weed biomass. Weeds that are not exposed to herbicides will continue their lives without any growth inhibition and continue to actively photosynthesize. Key elements influencing the proliferation of water hyacinth weeds include sunlight, nutrient availability, pH levels, salinity, methods of reproduction and dispersal, as well as various biotic factors (Soedarsono et al. 2013). The results indicate that the use of Florpyrauxifen-benzyl herbicide at the dose between 500 ml/ha and 1500 ml/ha efficiently controls the aquatic weed water hyacinth in Cirata Reservoir for up to 12 weeks after application.

Percentage of Water Hyacinth Weed Damage (%)

Table 2 presents the findings from the statistical analysis regarding the percentage value of damage caused by water hyacinth weed.

Table 2. Percentage of Water Hyacinth Weed Damage at Cirata Reservoir

No.	Treatments	Doses (ml/ha)	Observation Time (Week)			
			2WAA	4WAA	8WAA	12WAA
A	Florpyrauxifen-benzyl	500	98.67 b	100.00 a	100.00 a	100.00 a
B	Florpyrauxifen-benzyl	750	100.00 a	100.00 a	100.00 a	100.00 a
C	Florpyrauxifen-benzyl	1000	100.00 a	100.00 a	100.00 a	100.00 a
D	Florpyrauxifen-benzyl	1250	100.00 a	100.00 a	100.00 a	100.00 a
E	Florpyrauxifen-benzyl	1500	100.00 a	100.00 a	100.00 a	100.00 a
F	Hand Weeding	-	64.93 c	56.64 b	37.02 b	40.16 b
G	Control (without herbicide)	-	0.00 d	0.00 c	0.00 c	0.00 c

Notes: *T-test analysis shows no statistically significant differences at the 5% level between mean values with the same letter in the same column. The column shows no notable difference at the 5% level as determined by Duncan's test. WAA refers to the period following the application of herbicide.*

According to the observation results at 2 WAA, the herbicide Florpyrauxifen-benzyl applied at a rate of 500 ml/ha exhibited a value that was substantially distinct from all other treatments. The rapid growth of water hyacinth with a relatively short life span greatly affects the ecosystem and is a threat especially in tropical waters (Gaikwad and Gavande 2017). The percentage value of weed damage in all Florpyrauxifen-benzyl herbicide treatments at doses of 500 ml/ha to 1500 ml/ha reached 100% from 4 WAA until the 12 WAA observation. The results demonstrate that the use of Florpyrauxifen-benzyl herbicide at concentrations between 500 ml/ha to 1500 ml/ha effectively controls water hyacinth in freshwater ecosystems for a period of up to 12 weeks after application.

Weed Damage Symptoms

The reaction of weeds to the application of Florpyrauxifen-benzyl herbicide at doses between 500 and 1500 ml/ha, evaluated two weeks after application, demonstrated a significant reduction in growth, along with alterations in leaf coloration to yellow or pale, almost white,

and dry (Figure 2). Florpyrauxifen-benzyl represents a classification of agricultural chemicals known as synthetic auxin herbicides, notable for its inhibitory effects on plant cellular processes and chloroplast function (Grossmann 2007). Damage to the chloroplasts within the leaf significantly impacts the color pigments, as chloroplasts are essential for chlorophyll production. This results in the degradation of leaf color pigments, leading to a gradual pale appearance from the top to the bottom.

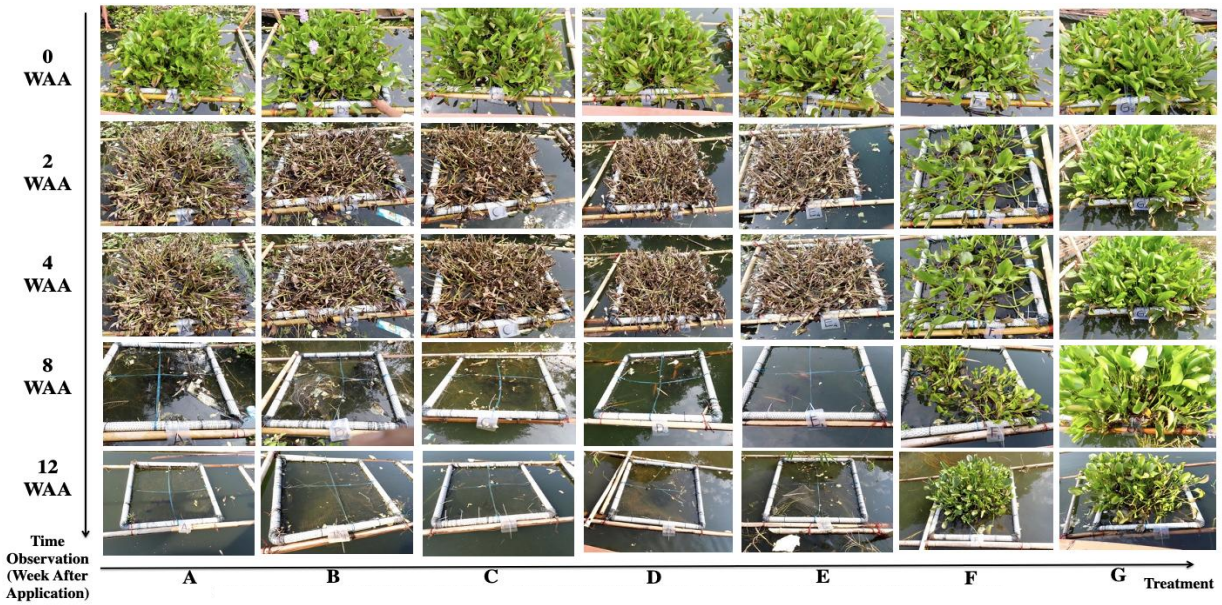

Figure 2. Weed Damage in the Experiment at Cirata Reservoir. A) Florpyrauxifen-benzyl 500 ml/ha;B) Florpyrauxifen-benzyl 750 ml/ha, C) Florpyrauxifen-benzyl 1000 ml/ha;D) Florpyrauxifen-benzyl 1250 ml/ha, E) Florpyrauxifen-benzyl 1500 ml/ha;F) Hand Weeding;G) Control (Withour Herbicide).

Observations of weeds at 4 WAA began to show symptoms of severe damage. Florpyrauxifen-benzyl herbicide at a dose of 1500 ml/ha caused chlorosis to occur more quickly as a whole to all parts of the weed body compared to the lowest dose of 500 ml/ha. The changes experienced by *Eichhornia crasipess* weeds are very clearly visible from changes in leaf organs that experience curling and also petioles or petioles that are increasingly opening and an imbalance in the shape of the weed body (Figure 3). This is characterized by the growth of petioles that begin to lose their body shape and are increasingly stretched out.

Water hyacinth used in field experiments is a type of water hyacinth with slender petioles. Morphological and physiological responses that occur due to auxin synthetic herbicides, such as petioles bending downward and stimulation of ethylene and abscisic acid (ABA) biosynthesis. Growth inhibition, desiccation, and tissue decay, and ultimately weed death, occur due to exposure to auxin synthetic herbicides (Grossmann 2010).

When observing at 8 WAA to 12 WAA, the weeds have begun to rot and degrade so that there are no petioles visible above the water surface. Leaves were curling, petioles that have died will separate from other organs such as roots, and petiole becomes more exposed and loses balace. Thus, the weeds can be completely decomposed at week 8 after herbicide application. Systemic herbicides like floralpyrauxifen-benzyl, which is categorized as a synthetic auxin herbicide, have an impact on plant development and cell division (Johnson et

al. 2023). This leads to accelerates leaf deterioration, cellular demise, and a reduction in plant turgor pressure (Grossmann 2007).

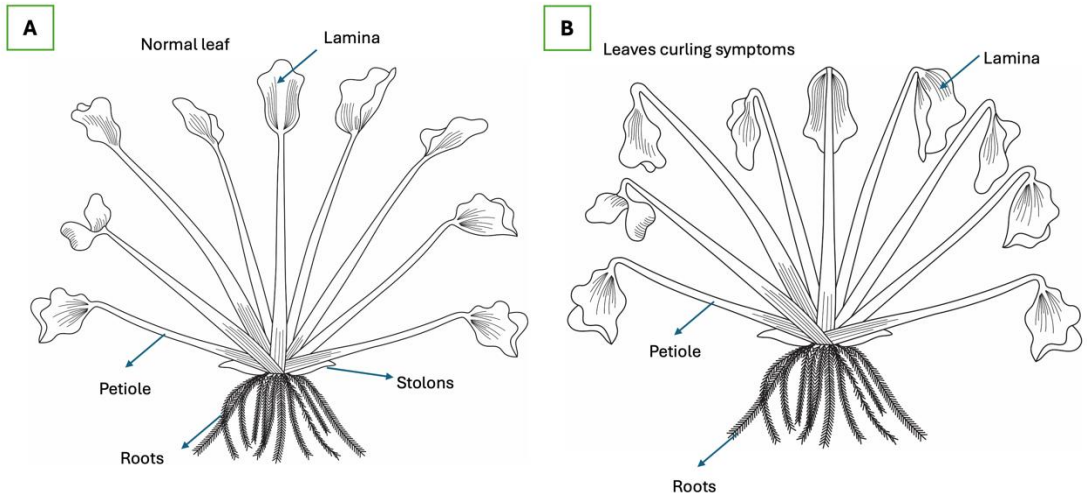

Figure 3. Morphology of *Eichhornia crassipes*
a) Normal Petiole (No Herbicide) b) Herbicide Treated Petiole (Petiole becomes more exposed and loses balance)

CONCLUSION

Florpyrauxifen-benzyl herbicide at a dose of 500 ml/ha to 1500 ml/ha can suppress the amount of water hyacinth weed biomass in freshwater ecosystems up to 12 WAA at Cirata Reservoir. Florpyrauxifen-benzyl herbicide with the tested dose range of 500 ml/ha - 1500 ml/ha had a percentage value of weed damage that reached 100% up to 12 WAA at Cirata Reservoir. In freshwater environments, one alternate strategy for managing water hyacinth weeds is to use floripyrauxifen-benzyl.

CONFLICT OF INTEREST

The researchers do not declare any divergent viewpoints, or competing interests in relation to the subject matter.

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