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Phytotoxicity of 2, 4-D and Glyphosate Herbicide at Different Concentrations as Chemical Control of Water Hyacinth (*Eichhornia Crassipes* (Mart.) Solms) in Lake Lanao, Philippines

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ABSTRACT:- The study aimed to evaluate the effectiveness of two herbicides, 2,4-D and glyphosate, at varying concentrations for controlling water hyacinth in Lake Lanao, Philippines. Offshoots with spoon-sized leaves were collected and acclimatized in a basin for one week before being transferred into buckets containing equal volumes of water. The experiment followed a completely randomized design (CRD) with a 2 × 4 factorial arrangement, replicated three times. Treatments included five concentration levels: control (0%), 10%, 20%, 30%, and 40% herbicide solutions prepared with distilled water. After eight weeks of plant growth, herbicides were applied through foliar treatment. Effectiveness was measured using a phytotoxicity rating scale. Results showed that 2,4-D was significantly more effective than glyphosate in controlling water hyacinth. At 30% and 40% concentrations, 2,4-D achieved a phytotoxicity rating of 9, indicating complete plant death. In contrast, glyphosate produced only moderate effects, with phytotoxicity ratings ranging from 4 to 5, and failed to cause lasting tissue damage even at higher concentrations. Notably, even the lowest concentration of 2,4-D (10%) was more effective than the highest concentration of glyphosate (40%). Overall, 2,4-D demonstrated superior potential as a chemical control for water hyacinth.

Keywords:, 2,4-D herbicide, glyphosate, foliar application, plant death, water hyacinth offshoots

I. INTRODUCTION

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms) is recognized as one of the most harmful free-floating aquatic plant species and is listed among the ten most detrimental weeds worldwide (Pieterse, 1990). It originated from the Amazon Basin in Brazil, South America (Cronk and Fennessy, 2001). It was later introduced to several subtropical and temperate countries by early aquarists due to its ornamental value (Gopal, 1987). Its remarkable adaptability has caused widespread ecological and economic problems in many countries, including the Philippines. Water hyacinth has significantly impacted lakes and waterways globally (Little, 1969) and remains one of the most difficult aquatic weeds to manage despite numerous control strategies (Heard and Winterton, 2000). In the Philippines, *E. crassipes* was introduced in 1912 by Spanish friars for decorative purposes (Gopal, 1987). Since then, it has rapidly proliferated, heavily infesting major water bodies. Its fast rate of multiplication threatens aquatic ecosystems by blocking sunlight penetration, which disrupts photosynthesis and reduces oxygen levels, thereby affecting the survival of aquatic organisms. Moreover, dense mats of water hyacinth obstruct waterways, causing serious problems in fishing, irrigation, and transportation, particularly in major water systems such as the Pasig River and Laguna de Bay. During the rainy season, these obstructions can lead to flooding and increased water pollution.

In Mindanao, water hyacinth infestation has been a persistent problem, especially in Cotabato City. It clogs the Rio Grande de Mindanao originating from Liguasan Marsh during rainy months. Similarly, in Lake Lanao, dense mats of the weed impede water flow and interfere with the turbines of the Agus II Hydroelectric Power Plant operated by the National Power Corporation (NPC). Continuous efforts are required to prevent the weed from entering turbines, as this can cause power interruptions and demand significant time and resources for removal. Various control methods for water hyacinth have been developed, including biological, mechanical, and manual removal. However, these approaches have generally proven ineffective or insufficient (Charudattan et al., 1995). As a result, chemical control using herbicides has been adopted as an alternative management strategy (Adekoya, 2000). Although the environmental impact of herbicides remains a concern, they are often considered a last resort for mitigating the adverse effects of invasive aquatic weeds (Agidie et al., 2018; Akinyemiju and Imevbore, 1990).

Phytotoxicity refers to the harmful effects of substances on plant growth, such as delayed seed germination, inhibited growth, or visible damage caused by chemicals like herbicides (REAL CCS, 2014). These effects are typically expressed through symptoms such as leaf burn, yellowing, reddening, vein clearing, necrosis, and wilting. Such damage is often assessed using standardized rating scales (e.g., 1–5 or 1–10). While herbicide-induced phytotoxicity is commonly observed in weeds, it has not been widely reported in agricultural crops when properly applied (Nagar et al., 2012).

Herbicides such as 2,4-D (2,4-dichlorophenoxyacetic acid) and glyphosate are widely used to control unwanted vegetation. These chemicals are classified as either selective or non-selective. Selective herbicides target specific weed species while minimizing harm to crops, while the non-selective herbicides eliminate all plant material they contact and are often used in non-agricultural settings such as industrial areas and railway tracks (EPA, 2011). Herbicides can also be classified based on their mode of action, timing of application, and chemical composition. Compared to other pesticides, such as insecticides and fungicides, many herbicides are applied at relatively lower dosage.

In chemical research, it is possible to identify certain substances that may pose risks to plant growth. However, it is impractical to test for all potentially harmful compounds. Therefore, plant response tests are commonly used to assess the presence of phytotoxic substances. Although these tests do not provide definitive conclusions—since plant responses vary among species but it offers valuable insights into the suitability of materials for plant growth.

Phytotoxic effects of herbicides are influenced by the concentration and mode of action. In some cases, plant response tests are conducted using diluted materials to evaluate their effects under realistic conditions. Such tests are particularly useful when unusually high concentrations of certain substances are detected or when plant growth problems occur without a known cause. Cropping tests may also help identify issues related to specific compounds, such as phenolics in bark (Machrafi et al., 2006). Standardized methods for assessing plant response are available, including ISO 11269:2012 and CEN protocols.

1.1 Objectives of the Study

This study aimed to evaluate the effectiveness of 2,4-D and glyphosate herbicides at varying concentrations in inducing phytotoxicity for the control of mature water hyacinth in Lake Lanao. Specifically, it sought to determine the efficiency of these herbicides and identify the concentrations that produce significant deleterious effects on the plant.

1.2 Scope and Delimitations of the Study

The study focused solely on the plant responses of mature water hyacinth following the application of herbicides at different concentrations. Phytotoxicity was assessed based on visible physical changes, including the onset and progression of injury symptoms.

II. MATERIALS AND METHODS

The study was conducted at the experimental area of the College of Agriculture, Mindanao State University–Main Campus, Marawi City, over a period of eight (8) months. The experiment began with the growth characterization of water hyacinth (*Eichhornia crassipes*) offshoots collected from Lake Lanao, followed by the evaluation of the phytotoxic effects of 2,4-D and glyphosate herbicides at various concentrations. Water hyacinth plants with small leaves (approximately teaspoon to tablespoon size) were carefully collected from Lake Lanao. Offshoots were separated from the mother plants using a sharp knife. The collected planting materials were temporarily placed in a basin filled with water. After a two-week acclimatization period in their new growing environment, the offshoots were individually transferred into medium-sized containers (buckets with a diameter of 12 inches) filled with tap water and maintained for up to ten (10) weeks.

The transplanted offshoots set-up were transferred in the open field to ensure adequate exposure to sunlight for optimal growth and development. Each bucket was filled with approximately two (2) gallons of tap water which contained a single water hyacinth offshoot. Daily monitoring was conducted to maintain the water level and observe plant growth. The herbicide phytotoxicity experiment was laid out in a 2 × 4 factorial design using a Completely Randomized Design (CRD) with three (3) replications. The two herbicides—2,4-D (2,4-

dichlorophenoxyacetic acid) and glyphosate—served as Factor A, while the different concentrations served as Factor B. The treatment combinations were as follows:

T0 – Tap water (control)
T1 – 10% 2,4-D + 90% water
T2 – 20% 2,4-D + 80% water
T3 – 30% 2,4-D + 70% water
T4 – 40% 2,4-D + 60% water
T5 – 10% glyphosate + 90% water
T6 – 20% glyphosate + 80% water
T7 – 30% glyphosate + 70% water
T8 – 40% glyphosate + 60% water

Herbicides were applied when the water hyacinth started to flower (reproductive stage) and produced 2-3 offshoots. Phytotoxicity, or herbicide injury, was evaluated 24 hours after the application of 2,4-D and glyphosate at the different concentrations. The assessment followed the procedure described by Nelson et al. (2001), using a rating scale ranging from 1 to 9, where 1 indicates no visible injury and 9 indicates complete plant destruction (Table 1). Each rating category describes common visual symptoms such as chlorosis (yellowing), necrosis (tissue death), and the estimated percentage of affected plant tissue. The phytotoxicity rating scale was used to express the level of herbicide effectiveness in terms of percentage of visual control.

TABLE 1. Phytotoxicity rating scale used to assess herbicide injury in water hyacinth.
Adapted from Nelson et al. (2001)

Rating	Description
1	No visible effect; green, healthy tissues; no herbicide damage; identical to check (control)
2	Very mild symptoms; slight color change (mild yellowing or browning); plants will recover
3	Mild symptoms; off-color plant tissues; more severe discoloration than no. 2 rating
4	Clear symptoms; probably won't result in plant death
5	Clear symptoms; possible permanent damage to plant tissues; will result in decrease biomass
6	Distinct damage on 25 % of plant tissues (but less than 50 %)
7	Severe damage on 50 % of plant tissues (but less than 75 %)
8	Very severe damage: 75 % of tissues affected (but less than 100 %)
9	Necrotic, collapsing tissues; damage on 100 % of plants; total destruction of plant stand

2.1 Statistical Analysis

Data on Phytotoxicity rating scale of herbicides were collected and tabulated for statistical analysis. Analysis of variance was done following Completely Randomized Design (CRD) and treatment means with significant differences were analyzed following the Tukey's Honestly Significant Difference (HSD) Test.

III. RESULTS AND DISCUSSION

The phytotoxic effects of 2,4-D and glyphosate applied as foliar sprays on water hyacinth (*Eichhornia crassipes*) at varying concentrations are presented in Table 2 and Figure 1. Phytotoxicity was assessed through visual evaluation using the rating scale developed by Nelson et al. (2001), conducted 24 hours after herbicide application. Results showed that water hyacinth treated with 30% 2,4-D (T3) and 40% 2,4-D (T4) exhibited the highest phytotoxicity rating of 9. All treated plants displayed complete necrosis, with leaves turning brown, indicating 100% tissue damage (Table 2 and Figure 1). Plants treated with the lowest concentration of 2,4-D (10%, T1) recorded a phytotoxicity rating of 7.67, indicating severe injury, with approximately 50% of plant tissues showed necrosis. Similarly, plants treated with 20% 2,4-D (T2) had a phytotoxicity rating of 8, corresponding to very severe damage, where about 75% of the plant tissues were affected and most leaves turned brown (Table 2 and Figure 2). These findings indicate that increasing concentrations of 2,4-D significantly enhance its phytotoxic effects on *Eichhornia crassipes*, resulting in greater tissue damage and faster plant deterioration.

TABLE 2. Average phytotoxicity or herbicide injury rating on the water hyacinth (*Eichhornia crassipes)* applied with 2,4-D and glyphosate herbicides at various concentrations.

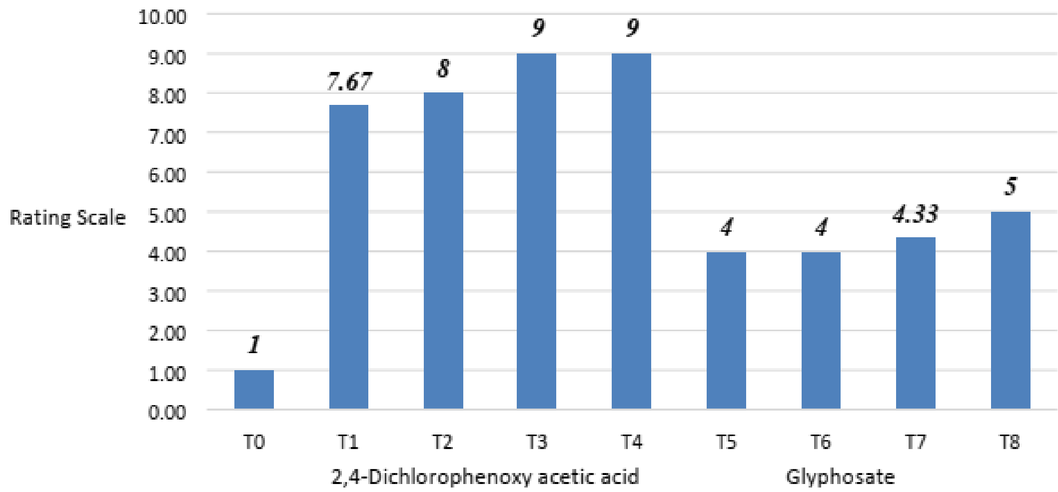
Treatment	Treatment Mean
T0 (no control)	1_e
T1 (10% 2,4-D + 90% H20)	7.67^b
T2 (20% 2,4-D + 80% H20)	8_b
T3 (30% 2,4-D + 70% H20)	9_a
T4 (40% 2,4-D + 60% H20)	9_a
T5 (10% glyphosate + 90% H20)	4_d
T6 (20% glyphosate + 80% H20)	4_d
T7 (30% glyphosate + 70% H20)	4.33_{cd}
T8 (40% glyphosate + 60% H20)	5_c

**All means within column of the same letter/s do not differ significantly at 1% level by HSD test.*

Note:

Rating	*Description*
1-	*No visible effect; green, healthy tissues; no herbicide damage; identical to check (control)*
2-	*Very mild symptoms; slight color change (mild yellowing or browning); plants will recover*
3-	*Mild symptoms; off-color plant tissues; more severe discoloration than no. 2 rating*
4-	*Clear symptoms; probably won't result in plant death*
5-	*Clear symptoms; possible permanent damage to plant tissues; will result in decrease biomass*
6-	*Distinct damage on 25 % of plant tissues (but less than 50 %)*
7-	*Severe damage on 50 % of plant tissues (but less than 75 %)*
8-	*Very severe damage; 75 % of tissues affected (but less than 100 %)*
9-	*Necrotic, collapsing tissues; damage on 100 % of plants; total destruction of plant stand*

Figure 1. Phytotoxicity rating of 2,4-D and glyphosate herbicides after 24-hour application. in water hyacinth (E. crassippes) at various concentrations.



Before 2,4-D and glyphosate spraying **After 2,4-D and glyphosate spraying**

Figure 2. Water hyacinth (*E. crassipes*) before and after spraying with 2,4-D and glyphosate herbicides at varying concentrations showed damaged appearance.

The phytotoxic effects of glyphosate, a non-selective herbicide, on water hyacinth (*Eichhornia crassipes*) at varying concentrations are also presented in Table 2 and Figure 1. Results showed glyphosate application at 10%, 20%, and 30% concentrations did not significantly affect the plants with a phytotoxicity rating of 4 (no plant death). Also, there was no differences among treatments, which indicates minimal injury and no likelihood of plant loss. However, water hyacinth treated with 40% glyphosate (T8) exhibited a slightly higher rating of 5, suggesting moderate injury with possible permanent damage (Table 2 and Figure 1). These findings indicate that glyphosate has a lower phytotoxic effect on *Eichhornia crassipes* compared to 2,4-D. This result supports the established effectiveness of 2,4-D in controlling broadleaf plants, particularly in aquatic environments such as lowland rice fields. Several studies have demonstrated that 2,4-D is highly efficient in managing broadleaf weeds due to its rapid phytotoxic action.

Similar findings were reported by Datta et al. (2017) which compared five herbicides for controlling water hyacinth. Based on the effectiveness, the herbicides were ranked as follows: 2,4-D ester > 2,4-D amine salt > 2,4-D sodium salt > glyphosate > chlorimuron. Among the herbicides evaluated in the present study, 2,4-D exhibited significantly higher efficacy than glyphosate. Previous studies on water hyacinth management have commonly relied on herbicides such as diquat (Langeland et al., 2002), glyphosate (Van et al., 1986), and 2,4-D (Joyce and Haller, 1984) to reduce biomass and limit the spread of the weed. Diquat has been reported to rapidly reduce plant tissues within three days, achieving more than 85% control (Langeland et al., 2002). Similarly, glyphosate and 2,4-D can reduce water hyacinth populations to non-problematic levels, with over 85% control achieved within 14 days or less (Joyce and Haller, 1984; Van et al., 1986; Deivasigamani, 2013).

Modern herbicides are generally considered more environmentally acceptable due to their biodegradable nature or rapid conversion into biologically inactive forms. Herbicidal control is therefore regarded as an effective and fast-acting option for managing aquatic weeds (Uka and Chukwuka, 2008). Although herbicide residues in water may initially be high following application, they typically decline rapidly and often become undetectable within days or weeks. Residue levels in aquatic organisms generally reflect the concentrations present in the water, and most herbicides do not bioaccumulate in fish or shellfish. Aquatic organisms are able to eliminate herbicide residues once these compounds dissipate from the environment. Despite ongoing concerns, herbicide use remains a common management strategy until more efficient and environmentally sustainable alternatives are developed (Frank, 1972).

IV. SUMMARY AND CONCLUSION

The study was conducted at the experimental area of the College of Agriculture, MSU–Marawi City, Lanao del Sur, BARMM, Philippines, for eight months to evaluate the response of water hyacinth to 2,4-D and glyphosate herbicides. Specifically, it aimed to determine the phytotoxic effects of these herbicides at varying concentrations. A total of nine (9) treatments were used, consisting of 10%, 20%, 30%, and 40% concentrations of both 2,4-D and glyphosate, along with a control treatment. The experiment was arranged in a Completely Randomized Design (CRD) with three (3) replications. Phytotoxicity assessment was conducted after 10 weeks of water hyacinth offshoot growth. The herbicides were applied to the sample plants, and visual observations were recorded 24 hours after application to evaluate plant injury as the basis for Phytotoxicity.

Results showed that water hyacinth treated with 2,4-D at 30% and 40% concentrations exhibited the highest Phytotoxicity rating of 9, indicating complete (100%) plant damage. In contrast, 2,4-D at 10% and 20% concentrations resulted in Phytotoxicity ratings of 7.67 and 8, corresponding to approximately 50% and 75% tissue damage, respectively. On the other hand, glyphosate-treated plants at 10%, 20%, and 30% concentrations showed no significant differences, all with a Phytotoxicity rating of 4, indicating minimal damage insufficient to cause plant death. At 40% concentration, glyphosate produced a slightly higher Phytotoxicity rating of 5, indicating minor damage and a possible reduction in plant biomass.

The study reveals that 2,4-D is more effective than glyphosate in inducing Phytotoxicity in water hyacinth across all tested concentrations. Even at lower concentrations, 2,4-D caused substantial damage to plant tissues, while higher concentrations resulted in complete plant destruction. In contrast, glyphosate exhibited relatively low phytotoxic effects on water hyacinth, even at higher concentrations. This suggests that glyphosate may be less effective for controlling water hyacinth under aquatic conditions. Its effectiveness may be more pronounced in non-aquatic or dryland environments, where conditions are more favorable for herbicide absorption and activity.

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LITERATURE CITED

[1]. "2,4-D Benefits." (2015). *The Industry Task Force II on 2,4-D Research Data*. Retrieved February 10, 2019.

[2]. Adekoya, B. B. (2000). Chemical control of water hyacinth (*Eichhornia crassipes*) at Ere, Ogun State, Nigeria: Implications for aquatic and terrestrial biodiversity conservation. Paper presented at the *International Conference on Water Hyacinth*, New Bussa, Nigeria.

[3]. Agidie, A., Sahle, S., Admas, A., & Alebachew, M. (2018). Controlling water hyacinth, *Eichhornia crassipes* (Mart.) Solms using selected eco-friendly chemicals. *Journal of Aquaculture Research & Development, 9*, 521. https://doi.org/10.4172/2155-9546.1000521

[4]. Akinyemiju, O. A., & Imevbore, A. M. A. (1990). *Herbicidal control of water hyacinth: A field pilot demonstration at Kofawei Creek, Igbokoda, Ondo State, Nigeria* (Final report). Submitted to the Presidency Special Services, Tafawa Balewa Square, Lagos.

[5]. Charudattan, R., Labrada, R., Center, T. D., & Kelly-Begazo, C. (1995). Strategies for water hyacinth control. *Aquatic Plant Control Research Laboratory*, Fort Lauderdale, Florida, USA.

[6]. Center, T. D., & Spencer, N. R. (1981). The phenology and growth of water hyacinth (*Eichhornia crassipes*) in a eutrophic north-central Florida lake. *Aquatic Botany, 10*, 1–32.

[7]. Cronk, J. K., & Fennessy, M. S. (2001). *Wetland plants: Biology and ecology*. CRC Press.

[8]. Datta, M. K., Kundu, C. K., Singharoy, S., & Sarkar, S. K. (2017). Effectiveness of 2,4-D ethyl ester 80% EC in controlling weeds in kharif rice. *Journal of Crop and Weed, 13*(1), 196–199.

[9]. Deivasigamani, S. (2013). Influence of certain herbicides for the control of water hyacinth (*Eichhornia crassipes*) and its impact on fish mortality. *Journal of Biofertilizers & Biopesticides, 4*, 138. https://doi.org/10.4172/2155-6202.1000138

[10]. Environmental Protection Agency (EPA). (2011). *Pesticides industry sales and usage: 2006 and 2007 market estimates*.

[11]. European Food Safety Authority (EFSA). (2011). Review of existing maximum residue levels (MRLs) for 2,4-D according to Regulation (EC) No. 396/2005. *EFSA Journal, 9*(11), 2431. https://doi.org/10.2903/j.efsa.2011.2431

[12]. Frank, P. A. (1972). Fate of organic pesticides in the aquatic environment (pp. 135–148).
[13]. Findlay, J. B. R., & Jones, D. (1996). Integrated control of water hyacinth (*Eichhornia crassipes*) in Africa using Roundup® herbicide treatments. In V. C. Moran & J. H. Hoffmann (Eds.), *Proceedings of the 9th International Symposium on Biological Control of Weeds* (pp. 435–440). Stellenbosch, South Africa.
[14]. Gettys, L. A., Haller, W. T., & Petty, D. G. (2014). *Aquatic plant management: Best management practices in support of fish and wildlife habitat* (3rd ed.). Aquatic Ecosystem Restoration Foundation.
[15]. Global Invasive Species Database. (2008). *Eichhornia crassipes*. Retrieved June 12, 2008, from http://www.issg.org/database/species/ecology.asp?si=70
[16]. Gomez, K. A., & Gomez, A. A. (1984). *Statistical procedures for agricultural research*. IRRI, Los Baños, Laguna, Philippines.
[17]. Gopal, B. (1987). *Water hyacinth*. Elsevier.
[18]. Harley, K. L. S., Julien, M. H., & Wright, A. D. (1996). Water hyacinth: A global problem and control methods. In *Second International Weed Control Congress*, Copenhagen, Denmark.
[19]. Heard, T. A., & Winterton, S. L. (2000). Interaction between nutrient status and weevil herbivory in biological control of water hyacinth. *Journal of Applied Ecology, 37*, 117–127.
[20]. Hill, G., Waage, J., & Phiri, G. (1997). The water hyacinth problem in tropical Africa. *International Water Hyacinth Consortium*, Washington, D.C.
[21]. Hill, M. P., & Cilliers, C. J. (1999). Review of arthropod natural enemies for biological control of water hyacinth. In T. Olckers & M. P. Hill (Eds.), *Biological control of weeds in South Africa* (pp. 103–112). Agricultural Research Council.
[22]. Hildebrand, E. M. (1946). Herbicidal action of 2,4-dichlorophenoxyacetic acid on water hyacinth. *Science, 103*, 477–479.
[23]. Joshi, R. C. (2006). Invasive alien species: Concerns and issues. ISSG.
[24]. Joyce, J. C., & Haller, W. T. (1984). Effect of 2,4-D and gibberellic acid on water hyacinth. *Journal of Aquatic Plant Management, 22*, 75–78.
[25]. Langeland, K. A., Hill, O. N., Koschnick, T. J., & Haller, W. T. (2002). Evaluation of Reward herbicide for aquatic weed control. *Journal of Aquatic Plant Management, 40*, 51–53.
[26]. Little, E. C. S. (1969). Aquatic plants. In *Man-made lakes and human health*. Academic Press.
[27]. Muramoto, S., Aoyama, I., & Oki, Y. (1991). Effect of salinity on element concentration in water hyacinth. *Journal of Environmental Science and Health, 26*, 205–215.
[28]. National Pesticide Information Center (NPIC). (n.d.). *2,4-D technical fact sheet*.
[29]. Nelson, L. S., Skogerboe, J. G., & Getsinger, K. D. (2001). Herbicide evaluation against giant salvinia. *Journal of Aquatic Plant Management, 39*, 48–53.
[30]. OEPP/EPPO. (2008). *Bulletin OEPP/EPPO Bulletin, 38*, 441–449.
[31]. Penfound, W. T., & Earle, T. T. (1948). The biology of water hyacinth. *Ecological Monographs, 18*, 448–473.
[32]. Penfound, W. T., & Maynard, V. (1947). Light intensity effects on 2,4-D in water hyacinth. *Botanical Gazette, 109*, 231–234.
[33]. Pieterse, A. H. (1990). Introduction of aquatic weeds. In A. H. Pieterse & K. J. Murphy (Eds.), *Aquatic weeds*. Oxford University Press.
[34]. Spencer, D., Tan, W., Liow, P. S., Ksander, G., Whitehand, L., Weaver, S., Olson, J., & Newhouser, M. (2008). Evaluation of glyphosate for managing giant reed. *Invasive Plant Science and Management, 1*. https://doi.org/10.1614/IPSM-07-051.1
[35]. Thompson, K. (1991). *Water hyacinth in Uganda: Ecology, distribution, and control strategies*. Proceedings of National Workshop, Kampala, Uganda.
[36]. Uka, U., & Chukwuka, K. (2008). Chemical control methods. *Zonas Áridas, 12*(1), 184–190.
[37]. United Nations Environment Programme (UNEP). (2008). *Africa atlas of our changing environment*. Nairobi.
[38]. U.S. Environmental Protection Agency (EPA). (2005). *2,4-D reregistration eligibility decision (RED)*.
[39]. Van, T. K., Vandiver, V. V., & Conant, R. D. (1986). Herbicide rate effects on glyphosate phytotoxicity. *Journal of Aquatic Plant Management, 24*, 66–69.
[40]. Willoughby, N. G., Watson, I. G., Lauer, S., & Grant, I. F. (1993). Effects of water hyacinth on biodiversity in Lake Victoria, Uganda. Natural Resources Institute.

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