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Nanasaheb Mahadik College of Engineering, Peth "Study on effect of Ammonium Nonanoate on Water Hyacinth"

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ABSTRACT
Water hyacinth (Eichhornia crassipes) is a floating aquatic weed and native of Amazon River. Water hyacinth is one of the fastest growing plants they primarily reproduce from runners or stolons. Each plant of E. crassipes can produce thousands of seeds each year and these seeds can remain viable for more than 28 years. Water hyacinth caused water loss through evapotranspiration which is more significant than indigenous weeds. Water hyacinth caused many problems in canals, ponds, lakes, rivers likes they are blocking of canals and causing floods, reduction of water quality, oxygen depletion, increased evapotranspiration rate, fish production problems, the beauty of ponds and effects on human health. Controlling methods of water hyacinth includes physical, chemical and biological but the biological method is effective and environment friendly. Neochetina bruchi, N. eichhorniae, and water hyacinth borer (Sameodes albiguttalis) are found effective biological control on water hyacinth. These weevils are feed on water hyacinth and reducing the size of water hyacinth, its vegetative propagation, and seed production. Semi-aquatic grasshopper Cornops aquaticum is also found effective control on water hyacinth.

KEYWORDS
Water hyacinth, Characteristics, Physical, Chemical and Biological control.

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I. INTRODUCTION

Water hyacinth is a type of invasive floating plant found in water bodies across the world. These invasive species block the sunlight reaching and oxygen level in water systems, which results in damaging water quality and serious affecting various lifeforms in the ecosystem. Pontederia crassipes (formerly Eichhornia crassipes), commonly known as common water hyacinth and by its Bengali name "kochuripana," is an aquatic plant native to South America, naturalized throughout the world, and often invasive outside its native range. It is the sole species of the subgenus oshunae within the genus Pontederia. Anecdotally, it is known as the "terror of Bengal" due to its invasive growth tendencies Water hyacinth is a free floating perennial aquatic plant (or hydrophyte) native to tropical and subtropical South America. With broad, thick, glossy, ovate leaves, water hyacinth may rise above the surface of the water as much as 1 meter (3 feet) in height.

The leaves are 10–20 cm (4–8 inches) across on a stem which is floating by means of buoyant bulb like nodules at its base above the water surface. They have long, spongy and bulbous stalks. The feathery, freely hanging roots are purple- black. An erect stalk supports a single spike of 8–15 conspicuously attractive flowers, mostly lavender to pink in color with six petals. When not in bloom, water hyacinth may be mistaken for frog's-bit (Limnobium spongiaor Amazon frogbit (Limnobium laevigatum).

Water hyacinth is a free-floating and flowering invasive aquatic plant originated from Amazon Basin, South America. It has spread mainly to the tropics and subtropics since the 1800s. Water hyacinth has been considered as an invasive aquatic plant in the United States since 1984, in Africa since early 1900s, in Asia since 1902, and in Europe since 1930s. The reproduction systems of water hyacinth are both sexual and asexual reproduction. The sexual reproduction is by producing seeds through flowers whereas the asexual reproduction is by budding through vegetative reproduction systems.

The invasive plant doubles itself within 5–15 days. The most favorable conditions for the optimum growth of water hyacinth are nutrient-rich water, temperature ranges from 28°C to 30°C, pH value between 6.5 and 8.5, salinity < 2%, 20 mg/L N, 3 mg/L P, and 53 mg/L K. Water hyacinth is a type of invasive floating plant found in water bodies across the world.

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damaging water quality and serious affecting various lifeforms in the ecosystem. Pontederia crassipes (formerly Eichhornia crassipes), commonly known as common water hyacinth and by its Bengali name "kochuripana," is an aquatic plant native to South America, naturalized throughout the world, and often invasive outside its native range.[1]

Figure 1-Water Hyacinth

Water hyacinth (*Eichhornia crassipes* (Mart.) Solms.) is a floating aquatic weed which is the most invasive species in the world.

Water hyacinth is a native of Amazon River where it's become an extremely serious weed. Water hyacinth has a rapid propagation and morphological characteristics that makes well adaptation of this weed in rapid distance dispersal and successful colonization in a short time (Obeid, 1984). Water hyacinth is also known as one of the fastest growing plants they primarily reproduces from way of runners or stolons, which eventually form daughter plants. Each plant can produce thousands of seeds each year, and these seeds can remain viable for more than 28 years (Sullivan, 2012).

Some species of water hyacinth are found to grow between 2 to 5 meters (7 and 16 feet) in a day in some sites of Southeast Asia (Gopal, 1987). A scientist reported that the nature of common water hyacinth (*Eichhornia crassipes*) are vigorous growers and they double their mat size within one to two weeks (Dickinson, 2014). *E. crassipes* caused water loss through evapotranspiration which is higher than indigenous weeds. In Sudan total annual loss caused by *E. crassipes* was calculated to be 7 milliards m^3,taking the total area infested by *E. crassipes* in the country to be 3000 km^2 (Desougi and Obeid, 1978).

Water hyacinth has significant negative impacts on ecosystem services limiting cultural service that people obtain from an ecosystem. It significantly affects the lakeWater hyacinth is a type of invasive floating plant found in water bodies across the world. These invasive species block the sunlight reaching and oxygen level in water systems, which results in damaging water quality and serious affecting various lifeforms in the ecosystem.

Water hyacinth decreased the productivity of the river by blocking the light from penetrating the river water, which changes in the flora and fauna underneath, decrease fish production and caused eutrophication under growing mats therefore water quality is also affected. It also helps increasing health hazards that is incidence of malaria and schistosomiasis (Navarro and George Phiri 2000). Water hyacinth creates many problems in canals, ponds, lakes, rivers likes they are blocking of canals and causing floods, creates problems for water transport, reduction of biodiversity, reduction of water quality, oxygen depletion, creates breeding grounds for insects and vectors, increased evapotranspiration rate, fish production problems and effects on human health.

II. LITRATURE REVIEW

P. Janaki have studied that Review On Ammonium Nonanoate for water Green Aquatic Plant Management.Aquatic vegetation plays an important role in the health of the aquatic ecosystem. Green Aquatic Plant (Eichornia crassipes) is important invasive vegetation causing significant ecological and economic impact

on precious aquatic and wetlands systems. It affects water movement, sedimentation, and water quality. Today's greatest challenges for the public and government is the management of this exotic plants that degrade water quality, human health, fisheries, water-bird habitat recreation, aesthetics and property values. Among the different herbicides available for its control and management, Ammonium Nonanoate is particularly useful as it is inexpensive and highly selective for Green Aquatic Plant when used at the recommended rate. Ammonium Nonanoate is the dominant herbicide used across the globe and in India which is commercialized as salt, amine and ester formulations and has post-emergence action. Due to its high solubility in water, it is easily transferred to the groundwater and might contaminate the water sources (Primel et al., 2005). Hence, the residues of active compound Ammonium Nonanoate acid from different Ammonium Nonanoate formulations in the aquatic ecosystem was studied to evaluate the risk to the environment.

Kulkarni B.V. Ranade S.V. and Wasif A.I., "Phytoremediation of Textile Process Effluent by using Water Hyacinth- a polishing treatment". In a present investigation phytoremediation of textile process effluent by using water hyacinth has been carried out in the KIT's College of Engineering Campus, for studying reduction of COD and metals from textile process effluent. It has been observed that there is a reduction of 80% in COD and about 25 to 45% reduction in metals after 18 days period.

Vasanthy Muthunarayanan, Santhiya. M, Swabna. V, Geetha. A," Phytodegradation of textile dyes by Water Hyacinth (Eichhornia Crassipes) from aqueous dye solutions"

In this study, the removal of textile dyes, namely Red RB and Black B from their respective aqueous solutions have been studied using the Water Hyacinth (Eichhornia crassipes). Batch type experiments were done using the hydrophytes and its dye removal capacity was observed. The used plant material after the experiment was subjected to GCMS analysis for determining the phytochemical components. The remaining waste material was subjected for composting and the compost produced was characterized in terms of Total Kjeldahl Nitrogen, Total carbon, Total Phosphorus, pH, EC and C:N ratio. The above mentioned experiments have proved the efficiency of Eichhornia crassipes to remove the colour and degrade the dye by about 95% with Red RB and 99.5% with black B. The phytochemical component analysis indicates the increased production of Hexadecenoic acid, which March be a promising result, but the reduction in phytol content records a significant reduction in the chlorophyll content.

Sanmuga Priya, P.Senthamil Selvan." Water hyacinth (Eichhlornia crassipes)- An efficient and economic adsorbent for textile effluent treatment"

Phytoremediation through aquatic macrophytes treatment system (AMATS) for the removal of pollutants and contaminants from various natural sources is a well established environ- mental protection technique. Water hyacinth (Eichhornia crassipes), a worst invasive aquatic weed has been utilised for various research activities over the last few decades. The biosorption capacity of the water hyacinth in minimising various contaminants present in the industrial wastewater is well studied. The present review quotes the literatures related to the biosorption capacity of the water hyacinth in reducing the concentration of dyestuffs, heavy metals and minimising certain other physiochemical parameters like TSS (total suspended solids), TDS (total dissolved solids), COD (chemical oxygen demand) and BOD (biological oxygen demand) in textile wastewater. Sorp- tion kinetics through various models, factors influencing the biosorption capacity, and role of phys- ical and chemical modifications in the water hyacinth are also discussed.

Er. Nilesh B. Deshmukh, Dr. M. V. Jadhav, Er. Vikas R. Rahane, "Use Of Phytoremediation for Treatment of Dairy Industry Waste Water for Analysis of COD and BOD"

Dairy industries have shown tremendous growth in size and number in most countries of the world. These industries discharge wastewater which is characterized by high chemical oxygen demand, biological oxygen demand, nutrients, and organic and inorganic contents. Such wastewaters, if discharged without proper treatment, severely pollute receiving water bodies. In this article stress is given on the lowest cost of the best possible treatment. The consumption of large volumes of water and the generation of organic compounds as liquid effluents are major environmental problems in milk processing industry. By which the pH, BOD, COD and the significant reduction in the parameters were observed and hence found more useful. In the study we found that initially the waste water sample was too alkaline but after the treatment the pH was observed near the Neutral also the BOD and COD removal efficiency 85% and 75% of and respectively was observed.

Bhavsar Swati R., Pujari Vedavati R., Dr.Diwan V.V. "Potential of Phytoremediation for dairy wastewater treatment."

Dairy industry is considered to be largest source of food processing wastewater in many countries. Huge amount of water is used during processing of milk, this result in generation of high volume of effluent containing dissolved sugars, proteins, fats etc. which are mainly organic in nature. Thus, dairy effluent is characterized by high concentration of organic matter, high BOD. Effluent with such characteristics cannot be used for land irrigation purpose and cannot be discharged into public sewer /surface water. Thus, proper treatment of dairy wastewater is necessary before disposal. Disposal problem of biological sludge (i.e.,

hazardous waste) etc. Hence there is need for developing low-cost technique for dairy wastewater treatment. Phytoremediation is one of such techniques which is defined as use of plant, microorganisms to remove harmless pollutants from contaminated water. In this study an attempt is be made to assess efficiency, suitability of aquatic plants like water hyacinth, duckweed to treat dairy wastewater. Aquatic plants have drawn attention because of rapid growth, High biomass production and capability to remove varieties of pollutants from domestic and industrial effluents. They have the ability to remove even nutrients and other chemical elements from sewage and industrial effluents.

Dhal G.C, Singh W.R, Kalamdhad A.S"Agitated Pile Composting of Water Hyacinth"

The water hyacinth (Eichhornia crassipes) is a free-floating aquatic weed originated in the 23.15% wetland area of north east region of India. Due to its fast growth and the robustness of its seeds, the water hyacinth has since then caused major problems in the whole area. However, the composting has the advantage of producing a product that is easy to work into the soil compared with dried water hyacinths, because of the decomposed structure. Therefore, the aim of this study was to investigate the evolution of some physico-chemical parameters during agitated pile composting of water hyacinth in combination with cattle manure and saw dust as a bulking agent (Trial 1, 2 and 3). Results suggested that the optimal degradation of water hyacinth can be possible in the presence of large amount of cattle manure; and rice straw could be a better option as a bulking agent in comparison with saw dust.

Das Ayan, Kalamdhad Ajay S. "Evaluation of Water Hyacinth Compost Stability Using Respirometric Techniques"

Composting is one of the alternative methods to convert water hyacinth into useful product. Because of its decomposed structure it easily transforms into stable compost. Stability is an important compost quality characteristic, but also one that is difficult to measure. Simple respirometric techniques i.e., CO 2 evolution and oxygen uptake rate (OUR) for the assessment of compost stability were performed for six waste combinations (trial 1, 2, 3, 4, 5 and 6) of water hyacinth, cattle manure, rice straw and sawdust in the agitated piles. Trial 3 achieved higher temperature (59.4 C) and entered into thermophilic phase after 1 day. Consequently, trial 3 and 4 showed higher loss of

organic matter and lower final OUR and CO 2 evolution, considered as very mature compost.

Aman Kumar Gupta, Dipak Yadav, "Biological control of water hyacinth"

In this paper,Water hyacinth decreased the productivity of the river by blocking the light from penetrating the river water, which changes in the flora and fauna underneath, decrease fish production and caused eutrophication under growing mats therefore water quality is also affected. It also helps increasing health hazards that is incidence of malaria and schistosomiasis (Navarro and George Phiri 2000). Water hyacinth creates many problems in canals, ponds, lakes, rivers likes they are blocking of canals and causing floods, creates problems for water transport, reduction of biodiversity, reduction of water quality, oxygen depletion, creates breeding grounds for insects and vectors, increased evapotranspiration rate, fish production problems and effects on human health.

M. Ojeifo," A Review Of The Utilisation Of Water Hyacinth: Alternative And Sustainable Control Measures For A Noxious Weed"

In study of The global concern on the problem of the infestation of water bodies by water hyacinth (Eichhornia crassipes) has provided the impetus for researchers and other conceited bodies to exploit ways of controlling its spread. Generally, efforts in this regard have been directed at the complete elimination of this weed from our water bodies. It is believed that water hyacinth is potentially beneficial to man, hence, this review was undertaken to highlight its possible application in aqua-culture, bio-gas production, livestock feed, bin-fertilizer, waste water treatment and as raw material for industries. It is suggested that cottage industries be established in the affected conmiunities to translate these possibilities into income earning sources. Thus, with institutional support from government and non-governmental organisations, the water hyacinth menace could be transformed from nuisance to wealth generation, employment and poverty alleviation.

Franck E. Dayan & Stephen O. Duke have studied that Natural Products For Weed Management In Organic Farming In The USA.there is a great need for more effective and more economical products for weed management in organic farming. While the certification of new natural products for use in organic farming can often be 'fast-tracked' if these products fall under the generally recognized as safe (GRAS) designation, and the inert ingredients used in the final formulation are exempt from tolerance, it limits the breadth of the natural compounds that can be used. In many ways, organic farmers are not interested in 'input substitutions' and they have devised a system that makes it very difficult to certify natural herbicides that would have higher selectivity, specific target sites, and/or more systemic mechanisms of action. Therefore, many alternative natural herbicides with scientifically good rational for use in organic farming are philosophically incompatible with the worldview of this farming community. Therefore, it is likely that such 'greener' herbicidal natural products may have their largest impact on conventional agriculture, which in the long run, may ultimately result in significant

environmental benefits.

3. CHARACTERISTICS AND GEOGRAPHICAL DISTRIBUTION OF WATER HYACINTH

According to (Gopal, 1987) water hyacinth has the following systematic, developmental, morphological, ecological and biological characteristics (Gopal, 1987). A) The average size of water hyacinth is 40 cm but it can reach up to 1 m in height and it has a high rate of multiplication and vegetative reproduction. B) The seeds remain viable for long periods up to 15 years and no known natural enemies for seeds. C) The stems and leaves of water hyacinth contain air-filled which gives to the plant. D) It grows in mats up to 2 m thick and double its plants population in 15-18 days by asexual vegetative reproduction. E) Each mother plants of water hyacinth produces 4 daughter plants that are capable for reproduction after 2 weeks. F) When the plant of water hyacinth is matured it consists of pendants roots, stolons, rhizomes, inflorescences and fruit clusters. Water hyacinth is found all parts of the tropical and subtropical regions of the world. It is initially originated from the Amazon Basin in tropical South America. Due to human and animals' activities it's enter in Africa, Asia, India, Australia, Central America North America (California and southern states) and New Zealand (Dagno, 2012).

In 1879, water hyacinth was first recorded in Egypt and later found in Incomati River in Mozambique in 1946 then Zambezi River and some rivers in Ethiopia in 1956. Introduction and spread of water hyacinth have been affected in many parts of Africa. In Zimbabwe the weed was first observed in 1937 in water bodies around Harare (Chenje, 1998; Mujingni, 2012). Climate change is a significant problem for distribution of water hyacinth. The pH requires for plant growth is neutral but it can tolerate4 to 10 pH values. It requires 28-30^0 C water temperature and 21-30^0 C air temperature for growth. The water temperature between 27-33^0 C can doubles the plant population in two weeks (Center, 2002). The limiting factor for undisturbed growth of water hyacinth is low air humidity from 15% to 40%. Water hyacinth is tolerates drought because it can survive in moist sediments up to several months (Center, 2002). In coastal areas, salinity is the main obstacle for growth of water hyacinth (Evans, 1963; De Groote, 2003).

a. Control methods

The control method of water hyacinth includes various options but in this paper physical, chemical and biological control methods are described.

3.1.1 Chemical control of water Hyacinth

The application of herbicides for controlling water hyacinth has been carried out for many years. The common herbicides are 2,4-d, Diquat and Glysophate. It has been found that there is a good success rate when dealing with small infestations but less success with larger areas. Application can be from the ground or from the air and requires skilled operators. As mentioned earlier the main concern when using herbicides is the environmental and health related effects, especially where people collect water for drinking and washing.Chemical control is the least used out of the three controls of water hyacinth, because of its long-term effects on the environment and human health. The use of herbicides requires strict approval from governmental protection agencies of skilled technician to handle and spray the affected areas. The use of chemical herbicides is only used in case of severe infiltration of water hyacinth.] However, the most successful use of herbicides is when it is used for smaller areas of infestation of water hyacinth. This is because in larger areas, more mats of water hyacinths are likely to survive the herbicides and can fragment to further propagate a large area of water hyacinth mats. In addition, it is more cost-effective and less laborious than mechanical control. Yet, it can lead to environmental effects as it can penetrate into the ground water system and can affect not only the hydrological cycle within an ecosystem but also negatively affect the local water system and human health. It is also notable that the use of herbicides is not strictly selective of water hyacinths; keystone species and vital organisms such as microalgae can perish from the toxins and can disrupt fragile food webs.[101]

The chemical regulation of water hyacinths can be done using common herbicides such as 2,4-D, glyphosate, and diquat. The herbicides are sprayed on the water hyacinth leaves and leads to direct changes to the physiology of the plant. The use of the herbicide known as 2,4-D leads to the death of water hyacinth through inhibition of cell growth of new tissue and cellular apoptosis. It can take almost a two-week period before mats of water hyacinth are destroyed with 2, 4-D. Between 75,000 and 150,000 acres (30,000 and 61,000 ha) of water hyacinth and alligator weed are treated annually in Louisiana.

The herbicide known as diquat is a liquid bromide salt that can rapidly penetrate the leaves of the water hyacinth and lead to immediate inactivity of plant cells and cellular processes. For the herbicide glyphosate, it has a lower toxicity than the other herbicides; therefore, it takes longer for the water hyacinth mats to be destroyed (about three weeks). The symptoms include steady wilting of the plants and a yellow discoloration of the plant leaves that eventually leads to plant decay

- **Herbicide Control Options**

Always read the product label for directions and precautions, as the label is the law. Click on the name of the product to see the label. Read the label for specific water use restrictions.
The active ingredients that have been successful in treating Water Hyacinth include:

- Bispyribac (Rated: Excellent)
- Diquat (Rated: Excellent)
- Glyphosate (Rated: Good)
- Imazamox (Rated: Excellent)
- Imazapyr (Rated: Excellent)
- Penoxsulam (Rated: Excellent)
- Triclopyr (Rated: Excellent)
- 2,4-D (Rated: Excellent)
- Florpyrauxifen-benzyl

These rating are based upon the U.S. Army Corps of Engineers aquatic herbicide trials.

b. Biological control of water Hyacinth

Figure2-Megamelus scutellaris

The biological control method is environmentally safe solution, cost- effective, beneficial for the aquatic animals and plants. In 1970, three species of weevil were released by USDA (United States Department of Agriculture) researcher in United States. These species are *Neochetina bruchi*, *N. eichhorniae*, and water hyacinth borer *Sameodes albiguttalis* and they feed on water hyacinth. These weevil species were introduced into the Gulf Coast states, such as Louisiana, Texas, and Florida, where thousands of acres area was infested by water hyacinth. In 1980, it was found that 33% of water hyacinth mats are decreased. The main limitation on the use of biological predation on water hyacinth is life cycle of the weevils. The life cycle of weevils is ninety days (Sanders, 2014). These weevils are regulating water hyacinth by limiting size of water hyacinth, its vegetative propagation, and seed production and they are also carrying microorganisms that can be pathological

to the water hyacinth. These weevils feed on stem tissue of the water hyacinth, which results in a loss of buoyancy for the plant, which will eventually sink (Jiménez, 2014).

The adults of these weevil's attack on water hyacinth and feed on the leaf pseudolamina and petioles by removing tissues and the larvae tunnel inside the petioles and the crown. The optimum temperature required for feeding and development of both species is 25° C. The progeny of *N. bruchi* and *N. eichhorniae* are reared separately for a period of 61 days (one generation period) on 41 hyacinth plants then results found that they reduced their population growth by 25.4% and 12.7% respectively. According to a report of Sudan 1979, found that the growth of the plants reduced by 22.5% when progeny of *N. bruchi* and *N. eichhorniae* are mixed cultured and control the population of the plants is increased by 136.6%. Stocking of hyacinth plants with adults and larvae of both species separately found that *N. bruchi* is more efficient from *N. eichhorniae* in checking the growth of the plant (Bashir, 1984).

Semi-aquatic grasshopper *Cornops aquaticum* is also considered as a biological control agent. Grasshopper has been introduced into South Africa in controlled trials and this insect is specific to the water hyacinth and its family. This insect feed on the water hyacinth and it introduces a secondary pathogenic infestation (Amédégnato, 2008). A researcher considered biological agents into 3 groups in his research work according the priority of these agents (Cordo, 2016). He considered first priority for screening agents, second priority for recently release or under testing agents and third priority for poorly known agents. He considered *N. eichhorniae*, *N. bruchi*, *N. albiguttalis* and *O. terebrantis* in first priority, *E. catarinensis*, *X. infusella*, *C. aquaticum*, *B. densa*, *P. tenuis* and *Thrypticus* spp. in second priority and *Brachinus* sp,

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