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Water Hyacinth in a Different Realm: The Case of Bora Woreda, East Shewa Zone, Ethiopia

Biruk Gobena* and Mohammed Berhanu

Ethiopian Environment and Forest Research Institute, Environmental Pollution Management Research Directorate, Ethiopia

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***Corresponding author:** Biruk Gobena, Ethiopian Environment and Forest Research Institute, Environmental Pollution Management Research Directorate, Ethiopia

Abstract

The utilization of water hyacinth, which is among world's aquatic weed that infests rivers, dams, lakes, wetlands, irrigation channels is getting great concern in different countries, despite its known negative impacts like loss of biodiversity through competing for nutrients, loss of water due to evaporation and so on. A cross-sectional study was done to quantify the role of utilizing water hyacinth as mulch at Bora woreda, in May 2018. Data was collected using the observational checklist and questioner and analyzed using Microsoft Excel Version 2010. The Bora Woreda farmers are harvesting more than six hectares of water hyacinth annually from Lake Koka and meanwhile, they are saving about 6400.00 ETB per one hectare of onion cultivation land per year upon using water hyacinth as mulch. The local farmers become a source of alternative solution to control water hyacinth attacking Koka Lake as they are benefiting economically and improving their onion mulching efficiency.

Keywords: Water hyacinth; Mulch; Germination

Background

Water hyacinth (Eichhornia crassipes) is an erect, free-floating macrophyte, live at the air-water interface and form two distinct canopies: leaf canopies comprising above-water structures and root canopies comprising below water [1]. The plants are up to 1 meter high although 40cm is the more usual height [2]. It grows at an extremely rapid pace; the number of water hyacinth plants doubled every 5 to 15 days with an annual minimum productivity of 2 tons of biomass per hectare [3] and standard densities of 300 to 442 tons per hectare [4]. It is becoming a great threat due to its extremely rapid proliferation and congests growth, presenting serious challenges in navigation, irrigation, and power generation [5]. It is aggravating losses of biodiversity through competing for nutrient and feed with native species and habitat along with altering the physical environment, specifically the water reservoirs [6].

Water hyacinth control efforts are incurring high cost. A lot of expensive unsuccessful control measures have been tried in many countries. For example, In the US alone, 700 000 hectares of waterways are occupied by this invasive aquatic weed, costing the states of Texas, Louisiana, and Florida over $1 1 million a year in control measures [7]. For the similar purpose, the Belgian Congo spent 1.5 million dollars on an eradication program in 1957 while Sudan has spent approximately 2.5 million dollars annually since 1962. In favor of these efforts, different studies which mainly focused on mechanical and manual harvesting, biological and chemical control mechanisms were also employed [8]. Despite all efforts, the water hyacinth persists today in these countries and continues to be the number one aquatic weed problem [7,9,10]. Lake Tana, Lake Shala and Lake Koka, Aba-Samuel dam reservoir, and Koka dam reservoir are some of Ethiopia major lakes attacked by Water hyacinth. Over one hundred hectares of Wonji Shewa Sugar Factory's irrigation water reservoirs and its secondary and tertiary irrigation water supplies together with its border and central drains were invaded by this weed. The weed inflicted versatile troubles such as annual excess loss of water estimated about 65,610 to 490,860m^3 which incur up to 2,482.83 USD annually for management options [11]. Similarly, the problem is serious in Lake Koka and thirty seven percent of the lake is covered by water hyacinth. Ironically, many people in different countries are working to find new uses of water hyacinth taking its existence as an opportunity rather than as a challenge. Among its possible application, using it as soil amendments, compost, mulch, phytoremediation, biofuel(biogas and bio-ethanol, waste water treatment (nutrient removal), ornamental value, animal fodder, raw material in the production of paper and mat production, charcoal briquetting, pellet and fish feed were mentioned [5,12,13]. In favor of this effort Bora woreda farmers, living around Koka Lake, which are largely rely on the cultivation of onion, are using water hyacinth as mulch in the process of onion

germination for the last four years. Hence this study is aimed at examining the use of water hyacinth mulch as substitute for "Fila" and to determine its contribution in water hyacinth expansion control and economic benefits of the farmers.

Materials and Methods

A cross-sectional study was conducted to quantify the contribution of utilizing water hyacinth as mulch in water hyacinth expansion control and economic benefits of the Bora woreda onion farming farmers. Bora woreda is located in East Showa zone, which is 160Km from Addis Ababa, the capital city of Ethiopia. One of major Ethiopian lake, Koka lake, is found mainly in the Dodo-wodera and Malima kebeles of Bora woreda. The lake is widely attacked by water hyacinth (locally called boche). An estimated total farm land of 1950 hectare of the woreda is cultivated with onion annually as the local officials reported. Data was collected by interviewing seven local farmers purposively and field visit using checklist and camera. Only one farmer was interviewed for one smallholder onion farming household by random selection. The objectives of this study were communicated to the owner of the land and verbal consents of owners and participants were obtained. Data was compiled and analyzed using Microsoft excels version 10 and presented using table, text and figures (Figure 1).

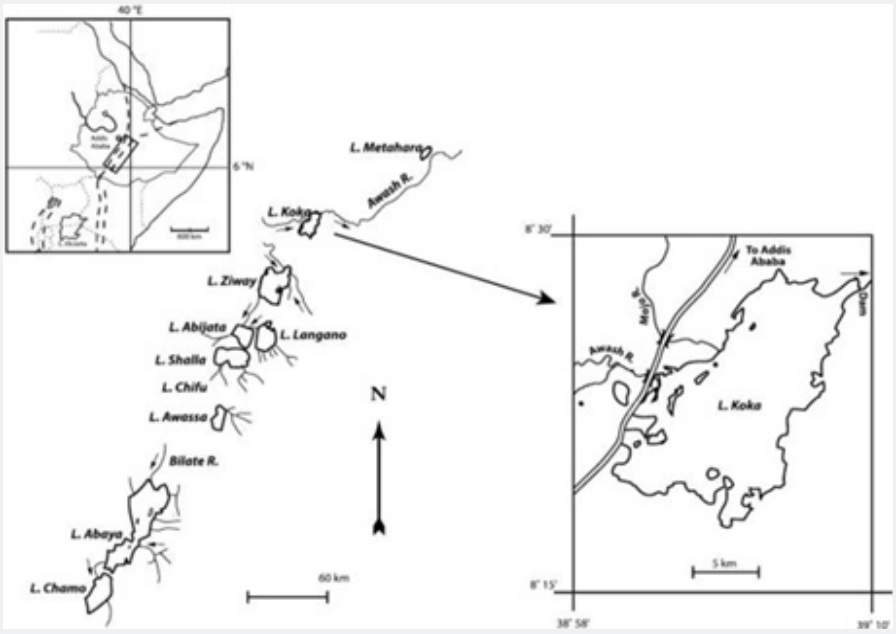

Figure 1: Map showing Lake Koka [14].

To determine the area of the lake cleansed and mass of water hyacinth harvested, simple equations (equation 1 and 2) below were employed.

$$V = A / H \quad \Rightarrow \quad V = A / H \qquad Eq(1)$$

Where,

V= Volume of water hyacinth collected

A= area of the lake cleansed

H= Average height of water hyacinth

$$\rho A = m / A \quad \Rightarrow \quad m = \rho A \times A) \qquad Eq(2)$$

Where,

ρA = average area density

m = total mass of the water hyacinth harvested

A = total area of the lake cleansed from water hyacinth

Results and Discussion

Onion is one of the crops widely cultivated around Lake koka. In the area common onion cultivation frequency is two up to three times per year. The input for the cultivation is germinated onion on a plot land. One eighth of a hectare is equivalent to 0.5 Qart (the local measurement unit). Germination to be effective and timely, seedling area conditions like temperature and moisture must be favorable. In onion seed germination process temperature plays an active role. While typically germination occurs within 7-10 days, soil temperature affects this process. For instance, the cooler the soil temperature, the longer it will take for onion seeds to germinate – up to two weeks. Warm soil temperatures, on the other hand, can trigger onion seed germination in as little as four days [15]. For germination activity, farmers have been using the plant locally called "Fila" for the mulching purpose before the infestation of water hyacinth (boche) on Lake Koka. For 0.125-hectare germination or seedling area 40 bundles of Fila were used. However, to replace it the farmers are now

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using 12.73m^3 of water hyacinth. While doing so, harvesting and transporting water hyacinth has been conducted manually (Figure 2). They need to collect approximately 6.37m^3 of water hyacinth to cultivate one hectare of onion. Its' cover (Figure 2a) helps the germination process by keeping heat and moisture at the optimum level.

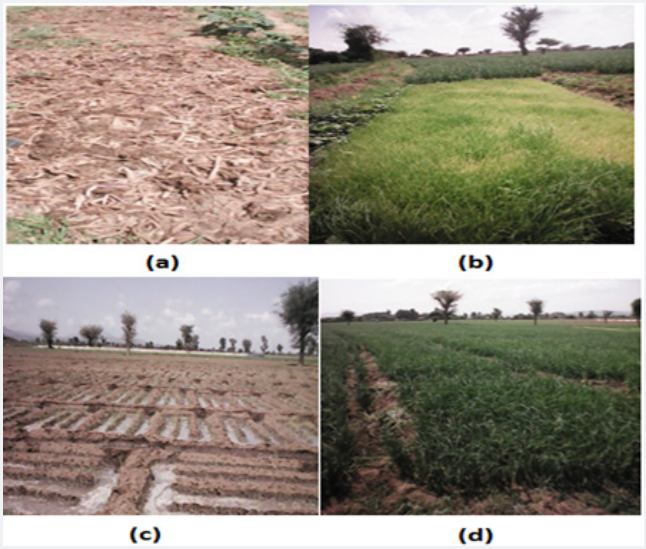

Figure 2: Images showing different stages of onion growth using water hyacinth mulching. (a) Onion seed covered by water hyacinth mulch. (b) Prepared onion seedling after 6 to 8 days of mulching. (c) Planted onion seedling on large cultivation land. (d) Growth of planted onion o after one month.

Background data of water hyacinth and "Fila" utilization

The survey has tried to collect some important information's that are important to calculate the contribution of water hyacinth use as mulch. About, 12.73 cubic meter of water hyacinth was used per 0.125 hectare of small farm land which later (after 6-8 days) transplanted on two hectares of cultivation land.. To prepare onion seedling on 0.125-hectare small farm land, 40 bundles of Fila were used while each bundle "Fila" Costs 20 to 30 ETB. The local cultivation frequency onion was two up to three times per year which is facilitated by Koka lake (Table 1).

Table 1: Background data.

S. No	Description	Unit Measurement
1	Proportion of Water hyacinth mulch to seedling area	101.84m^3/hectare
2	Ratio of onion seedling area to cultivation area	0.0625
3	Onion cultivation frequency	2 to 3 term/year
4	Proportion of Fila mulch to seedling area	320 bundles of Fila mulch /hectare
5	Cost of Fila mulch	20 to 30 ETB/bundle of Fila mulch
6	Onion cultivated land in the study area	1950 hectare
7	Average Fila mulch transportation cost per bundle	2.34 ETB
8	Average harvesting and transportation cost per cubic meter of water hyacinth mulch	10.02 ETB

Quantification of water hyacinth use practice Contribution

To estimate how much of a certain water hyacinth can be used as mulch, it is necessary to make approximations of how much biomass can be harvested. Hence, this study has tried to estimate water hyacinth spread control and economic contribution based major assumptions.

Water hyacinth spread control Contribution

Assumptions

Assume all Bora woreda farmers cultivating onion will use water hyacinth (Boche) for onion germination initiation.

Assume the local farmers are cultivating in two terms per year.

Assume the average height of water hyacinth is 40cm= 0.4m [2], we can determine an area of Lake Koka cleansed from water hyacinth annually.

From data shown in Table 1, 12.73m^3 of water hyacinth will be used to cultivate 2 hectares of onion. Therefore, now we can calculate the volume of water hyacinth collected for this purpose for 1950-hectare onion cultivated farm land in the woreda:

a) Estimated volume of water hyacinth collected each term

1. = (12.73m^3 *1950 hectare)/2hectare = 12411.75m^3

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b) Taking two terms as an average cultivation frequency,

2. = 12411.75m^3 * 2 = 24823.5m^3

3. A= V/H= 24823.5m^3/0.4m = 62058.75m^2 = 249m * 249m ~ 6.21 hectares of Koka lake water hyacinth will be cleansed each year.

c) Taking water hyacinth standard density of 300 to 442 tons per hectare into consideration, $m = \rho A \times A$ = 300 to 442 tons per hectares * 6.21 hectares = 1863 to 2745 tons of water hyacinth can be cleansed from lake Koka annually.

Economic contribution of Water hyacinth

Assumptions

a) Assume all Bora woreda farmers cultivating onion will use water hyacinth for onion germination initiation as a substitute for Fila.

b) Assume the local farmers are cultivating in two terms per year.

c) One bundle of Fila costs 20-30 birr (evidence) let's use 20birr for our case.

From data shown in Table 1, 40 bundles of Fila were used for 0.125-hectare (0.5 Qart) germination area, which is equivalent to 12.73m^3 water hyacinth mulch. Therefore, cost of required Fila per 0.125-hectare germination area = 40 *20 = 800 ETB. However, 0.125-hectare germination area= 2-hectare cultivation land:

a) Estimated cost saved per one-hectare onion cultivation land

= (800birr)/ (0.125 *2 hec)

= 3200birr per one-hectare onion cultivation land

b) Taking two terms as an average cultivation frequency

= 3200birr × 2 = 6400 ETB.

Regardless of money otherwise spent in transporting and disposing of these yard waste materials at least 6400 ETB will be saved per one-hectare onion cultivation land per year. However, the cost for harvesting and transporting water hyacinth was (1020 ETB) and cost of transportation of "Fila" is (750 ETB). Taking the above expenses in to consideration, the economic benefit of water hyacinth for mulching use was displayed in Figure 3.

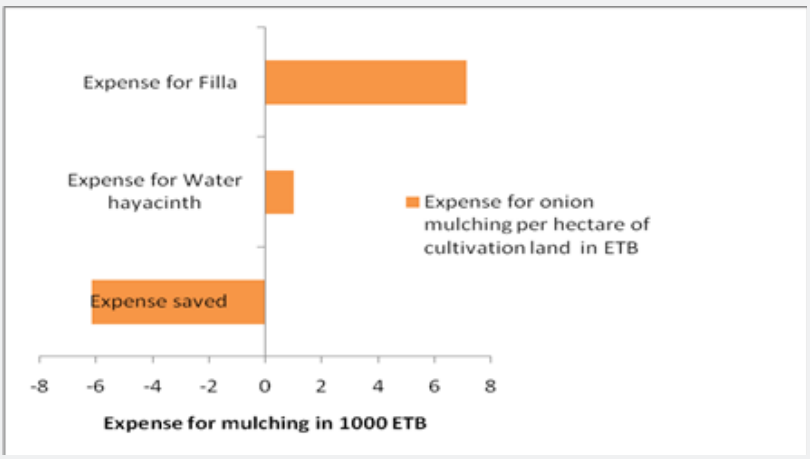

Figure 3: Estimated expenses saved due to water hyacinth use as onion mulching.

According to the Bora woreda farmer's response, utilizing water hyacinth mulch has showed better advantage as compared to using "Fila" as onion cover to prepare seedling. The estimated average expense (purchase, transport) for "Fila" to prepare onion seedling on 0.125 hectares of small farm land is 7,150ETB. Whereas, estimated average expense (harvesting, transport) for water hyacinth to prepare onion seedling on similar area of small farm land is 1,020 ETB. Accordingly, the utilization of water hyacinth has showed a saving of about 6,130 ETB per one hectare of onion farm land as presented in Figure 3. The locality which is known for its onion production has a yearly water hyacinth cleansing potential of about 6.21 hectares from Lake Koka. This calculated potential is resulted incurring the considerations that all Bora woreda farmers cultivating onion will use water hyacinth (locally named as "Boche" or "enboch") for onion germination initiation with an average of two term annual farming frequency. An estimated volume of 12.73m^3 water hyacinth mulch is used for one smallholder seedling area which is used as an input for 2 hectares of onion cultivating farm land. The onion cultivation farm land in the woreda is 1950 hectares. For this amount of farmland 12411.75m^3 of water hyacinth is applicable per a term. So, considering the total two terms of the yearly cultivation frequency, standard densities of 300 to 442 tons per hectare [4] and 40cm average height of water hyacinth [2] annually 1863 to 2745 tons of water hyacinth is cleansed from lake Koka. Keeping the above consideration of two term cultivation frequency, water hyacinth has economic profit over Fila. The minimum cost for a bundle of Fila according to a survey performed is 20 ETB. For 0.125-hectare (0.5Qart) germination area 40 bundles of Fila were required, which is equivalent to 12.73m^3 water hyacinth used

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for mulch. Hence using water hyacinth instead will benefit 6400 ETB regardless of harvesting and transportation cost. The other advantage of water hyacinth over "Fila", is after germination was initiated, (typically after 6-8 days), water hyacinth mulch will be collected and reused again two up to three times for this same mulching activity. Then the germinated onion will be transplanted on the prepared farm land. Finally, the repetitively used water hyacinth mulch will be discarded to decompose. According to a study done by Balasubramanian and his colleagues water hyacinth compost has a potential as organic substrate stimulating growth of diverse microbial population in agricultural soil [16].

Conclusion and Recommendation

It is very obvious that attempts to control the weed caused high cost and labor requirements, leading to nothing but temporary removal of the water hyacinth. In this research article, it was tried to show the potential use of water hyacinth in onion production process as seedling mulch. The local practice of the Bora woreda farmers could be an alternative management technique of water hyacinth invasion. The authors recommend that the experience should be taken as best practice by other farmers as they become source of alternative solution to control water hyacinth colonizing Koka Lake. In addition, concerned bodies should give attention to such local management options which are emerging from the hosting local communities. Moreover, research institutes should take responsibility to upgrade this indigenous knowledge with in-depth scientific experiments and extension. Based on the labor need and limited access to technology, using partially dried water hyacinth as mulch is feasible alternative. Furthermore, used water hyacinth mulch on onion germination can be used further for soil amendment rather than disposing it.

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