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(RESEARCH ARTICLE)

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How to prevent early onset of Epiphytes and 'Ice-Ice' disease in cultivated seaweeds (*Kappaphycus*), Camarines Norte, Philippines

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Abstract

This brief research focused on the incidence of ice-ice diseases (IID) and epiphyte infestation (EI) in cultured seaweeds *(Kappaphycus spp.*), identifying a doable strategy to prevent early development and outbreaks. An assessment of the prevalence of IID and EI was carried out on 29 seaweed farms, taking notes on the stage of culture and current farming practice. The findings revealed that the onset of IID and EI occurs during the early stages of out-planting as a result of stressors acquired during the transplanting procedure. Because seedlings are lightweight after cutting and current flotation methods are inadequate, newly planted seaweeds are exposed to the surface and direct sunlight for an extended period during wave action, resulting in a high incidence of EI and IID. Therefore, a bamboo spacer (BS) is being proposed to be incorporated into floaters to prevent the early development of IID and EI in newly out-planted seaweeds. BS can aid in maintaining proper depth, improving seaweed line movement, preventing entanglement, and keeping seaweed from being exposed to the surface and direct sunlight.

Keywords: Seaweeds; Diseases; Incidence; Control; Float; Spacer

1. Introduction

In the past years, issues and concerns in seaweed farming have been focused on two major problems, epiphyte infestations (EI) and 'ice-ice disease' (IID). In the province of Camarines Norte which is the current leading seaweed producer in the Bicol region, epiphytes are locally called "hibo" or "balahibo" and are known to cause fitness loss, leading to IID. An outbreak of IID can lead to fragmentation or falling of broken seaweed thalli, a phenomenon that resembles "underwater snow," as described by seaweed farmers.

IID is primarily caused by unfavorable environmental conditions (temperature, salinity, and light intensity) [1, 6, 9]. While EI is a common phenomenon and has even become a major problem, affecting the productivity of seaweed [8, 2, 4, 16]. As observed in this study, both are associated with each other. A high occurrence of IID occurs during an outbreak of epiphytes or when seaweeds are infested by epiphytic algae due to fitness loss. Early studies have already debunked that IID is related to epiphyte incidence [14, 15], which has been suspected to induce IID development [7]. An outbreak of epiphyte and concomitant IID can decrease harvest by 25-75% or worse, with no harvest at all [4], and can also decrease the yield and quality of carrageenan [12, 17, 10].

Recent studies showed that factors that influence the onset of epiphytes are the intensity of sunlight, the movement of water and low currents [10], changes in water temperature, wind, and water movement [5], and the occurrence of irradiation and an increase in water temperature [11]. While, IID is caused by excessive UV exposure or desiccation and begins on the tips of growing plants, restricted to those areas of the thallus that are above the water's surface for

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extended periods [3]. Although there are already recent developments and specific efforts that have been made to overcome these specific problems, such as: maintaining a certain light intensity to reduce the epiphytic algae, changing the seasonal rhythms of seaweed cultivation to control epiphytism [13], and frequent shaking of the rope line [10]. However, EI and IID in seaweed farming remain a major threat to most seaweed farms in the country.

2. Material and methods

To possibly address problems specific to the incidence of EI and IID outbreaks brought on by UV exposure and light intensity, this study was conducted to develop possible techniques or farming strategies that can contribute to the improvement of existing seaweed farming practices. Twenty-nine (29) seaweed production areas in Camarines Norte were visited from April - September 2022 to record the occurrence of EI and IID, taking notes on the current farming method of seaweed farmers (Figure 1). The health condition of seaweed was monitored monthly by swimming along the seaweed areas using snorkeling gear to assess the current status. An underwater camera was used to document infected seaweed with IID and EI, taking notes on the stage of culture and floating system to propose appropriate responses and specific actions relative to the occurrence of EI and IID. A key informant interview was also conducted to obtain additional information from the actual experiences of seaweed farmers. The proposed method was discussed in this study using a graphical design, comparing the current state of seaweed farming with the proposed methods for future developments and applications as mitigation strategies in seaweed farms.

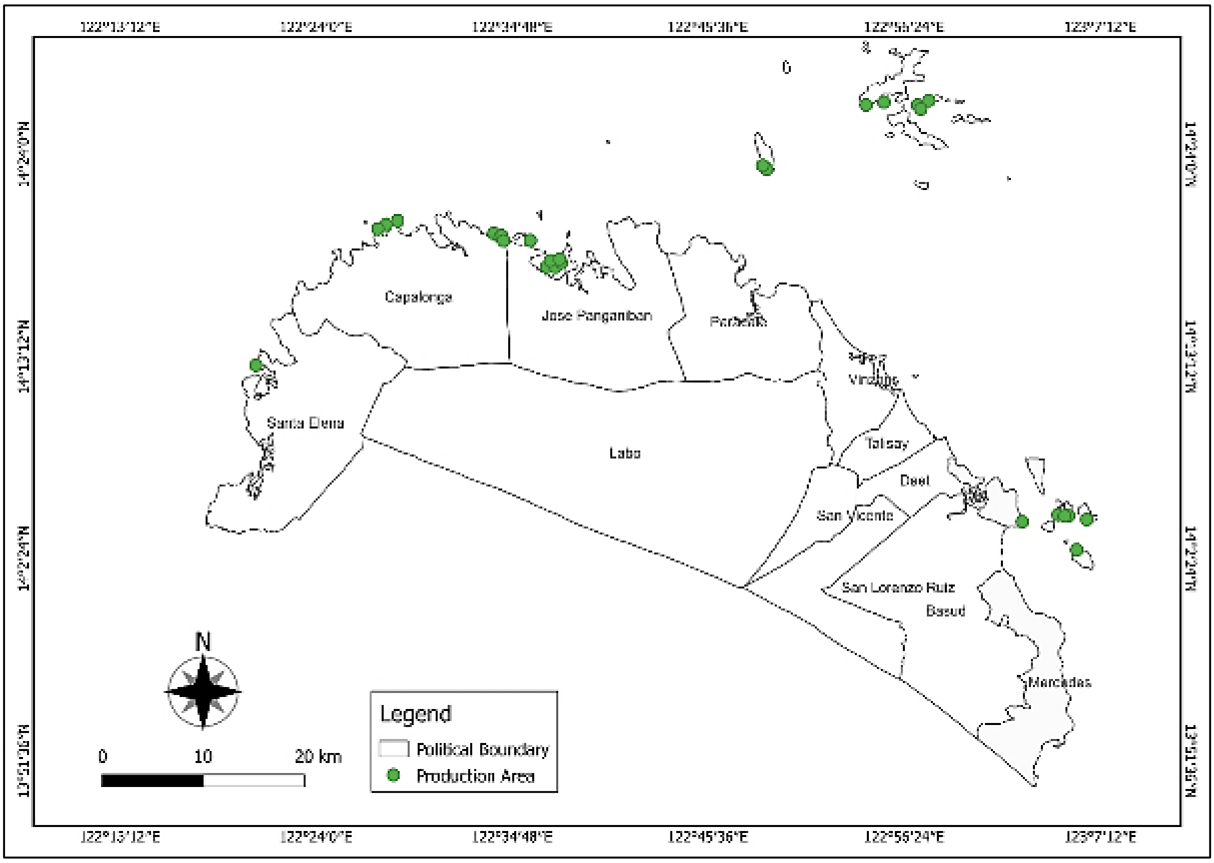

Figure 1 Coastal towns of Camarines Norte, Philippines, showing production areas of seaweeds

3. Results and discussion

3.1. Incidence of IID and EI

In this study, the onset of ice-ice disease (IID) and epiphyte infestation (EI) was observed to be higher during the early stage of culture compared with the grow-out stage. Because open wounds acquired after cutting and stressors received during the trans-planting process, such as long exposure to air and desiccations during harvesting, shipping, and individual tying, greatly increase the risk of ice-ice. Newly planted seedlings are also vulnerable to sudden weather and environmental changes because of their exposed wounds, and their growth is disrupted owing to the healing process.

Moreover, due to the seedling's lightweight after cutting and the unsuitable floating system employed by seaweed farmers, seedlings are usually exposed to air and intense sunlight. Therefore, epiphytic algae and other organisms adhere to and develop on seaweed thalli in the early stages due to light exposure and slow water movement. As a result of water movement and cyclic wave action, newly planted seaweed is exposed to the surface and direct sunlight, leading to the whitening of tips, bleaching of color, epiphyte infestation, and 'ice-ice' diseases (Figure 2). Previous research conducted in the same area (Vinzons) has also discovered this phenomenon, in which styrofoam floatation was nearly at the same level as the cultured seaweed, thereby exposing the crop [4]. Hence, in the latter stage, if the seedlings have survived, the float lines are extended downward owing to weight increase, acquiring adequate depth, and optimal sunlight, resulting in faster growth and greater resistance to "ice-ice" diseases and epiphyte infestation. Thus, due to the increasing weight of seaweed, more floats are also added.

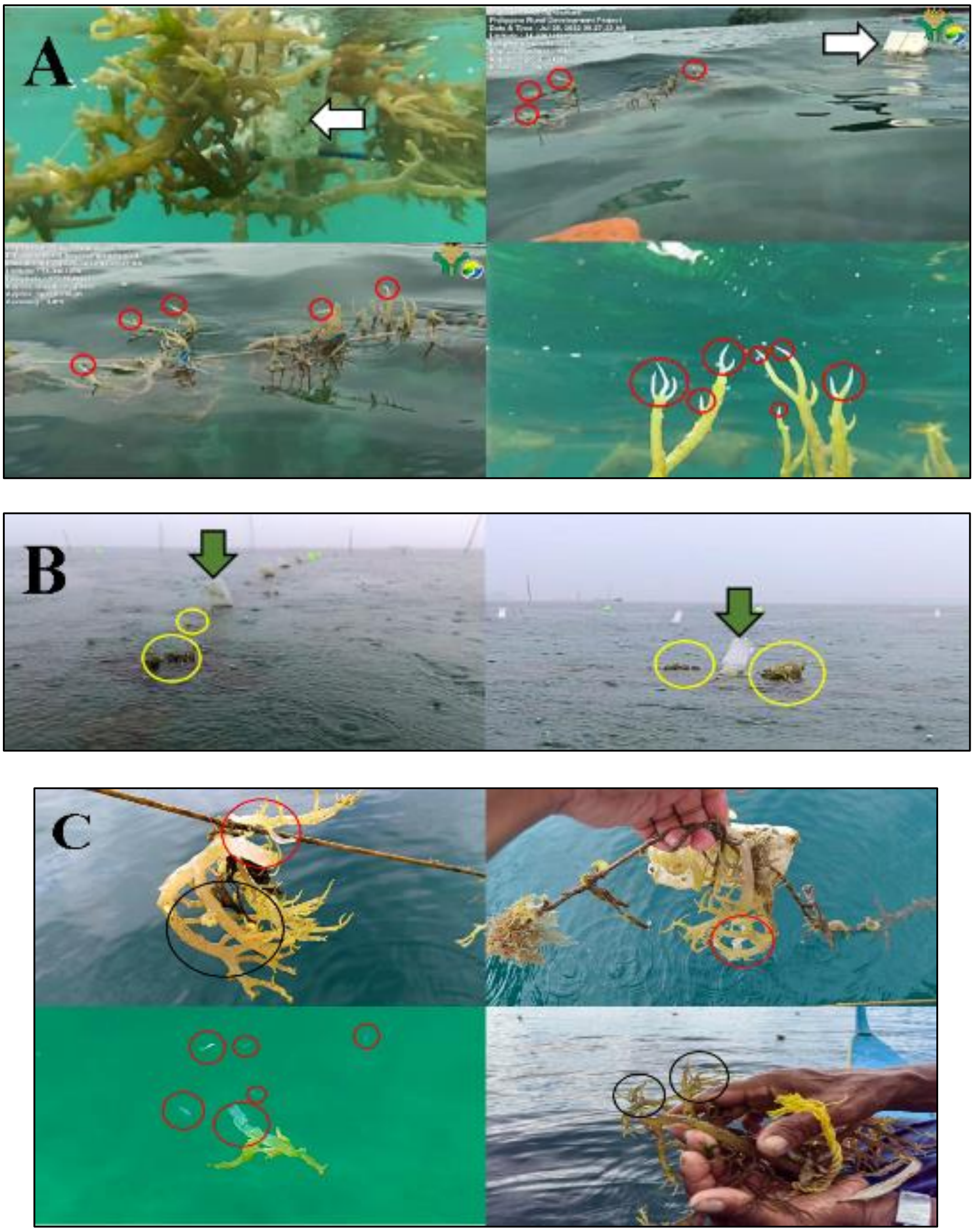

Figure 2 Current float lines of seaweed farms in Camarines Norte, showing a high incidence of 'ice-ice' diseases and epiphyte infestation in newly out-planted seaweed. (A) Entangled extruded polystyrene foam or styro float line (white arrow), showing emergent seaweed thalli during every wave cycle and whitening of tips (red circle). (B) Newly out-planted seaweed using plastic bottle floats (green arrows), showing exposed seaweed thalli at the surface (yellow circle). (C) Newly out-planted seaweed seedlings heavily infested by epiphytes (black circle) with 'ice-ice' disease, showing the event of thalli fragmentation or "underwater snow" (red circle)

3.2. Proposed planting method

To reduce the high prevalence of ice-ice diseases and epiphytes in newly transplanted seaweed caused by air exposure, direct sunlight, and low water motion, it is crucial to use the proper float line and tying method. A standard float line consisting solely of floats and rope coupled with a seaweed culture line has several drawbacks. Due to their low density, seedlings are prone to float and get entangled in float lines, exposing them to air and direct sunlight. Only by installing a spacer between floats and seaweed line can maintain the appropriate depth and prevent entanglement, hence limiting the incidence of ice-ice diseases and epiphyte infestation during the early stages. As a result, a spacer for float and culture lines is proposed as a mitigation strategy to prevent EI and IID outbreaks during the out-planting of seaweed. Different materials that can be used as spacers in float lines are PVC pipes and plastic hoses. Hence, to promote the use of indigenous materials, bamboo is recommended as a spacer instead of synthetic materials to avoid further water pollution. Bamboo is a low-cost and widely accessible material, especially in coastal areas. As demonstrated in Figure 3, a floating line (A) enclosed in a bamboo spacer is significantly successful in maintaining the proper depth and preventing entanglement. The use of spacers in seaweed float lines can increase water motion during water movement and cyclic wave action due to the floats and seaweed line solid connection. The standard size of a 12-inch spacer at a distance of 10-15 meters is advised for the efficient prevention of EI and IID outbreaks caused by surface exposure.

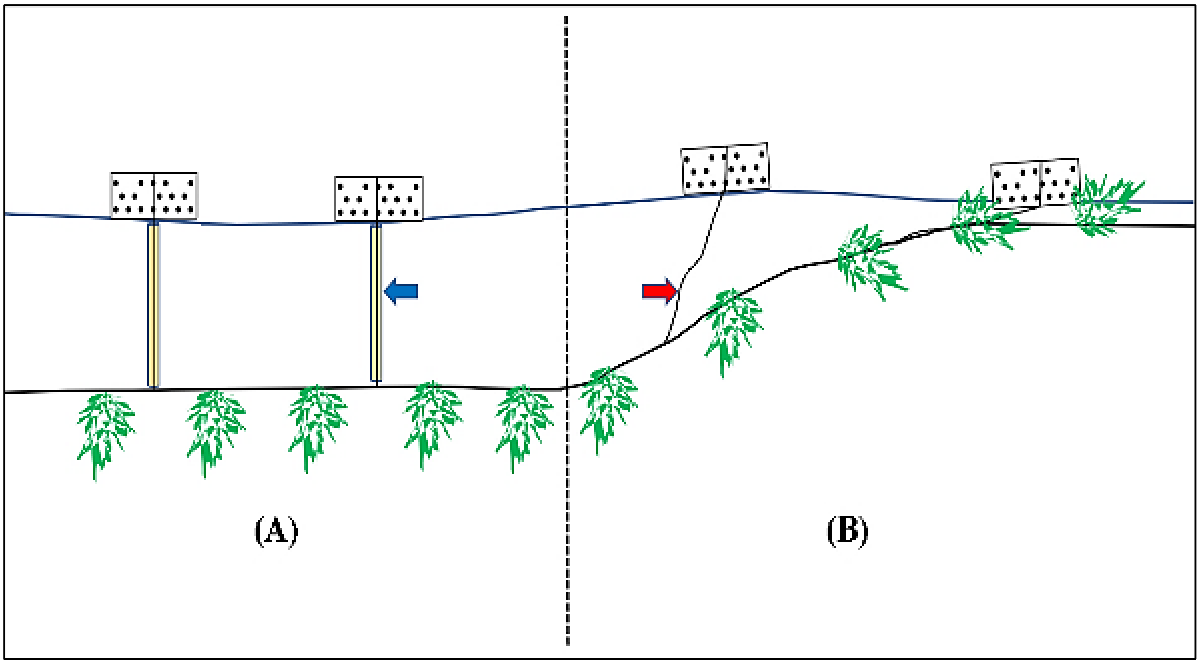

Figure 3 Proposed innovation of float lines (A), versus current practice (B) in seaweed farming using extruded polystyrene foam or “styro float”. Letter A represents a floating line encased with a bamboo spacer (blue arrow), showing an upright position and maintained depth and distance of seaweed propagules from the surface. While letter B represents a floating line (red arrow) without a bamboo spacer, showing entangled floats and seaweed lines, exposing seaweed propagules to the surface during wave action

3.3. Float position

Correct tying of floats is also needed to obtain higher buoyancy of float lines to achieve higher water motion and prevent attachment of epiphytes to seaweed thalli. The appropriate position of floaters can help increase the movement of seaweed lines to prevent the early development of epiphytes. The float position represented by the plastic bottle float should be tied in a horizontal position to utilize enough surface of the floats to achieve an upright position and up and down (vertical) motion during wave action as shown in Figure 4. Likewise, a bamboo spacer is necessary to maintain an appropriate depth and prevent surface exposure of seedlings. The horizontal position of floaters is recommended for areas with low water currents and wave actions to increase vertical movement, preventing the attachment of epiphytes and dirt to seaweed. While vertical/slant position of floats by tying to the plastic bottle’s neck is recommended in areas with high water current and wave action to prevent too much movement of ropes, preventing fall and fragmentation of seaweed seedlings.

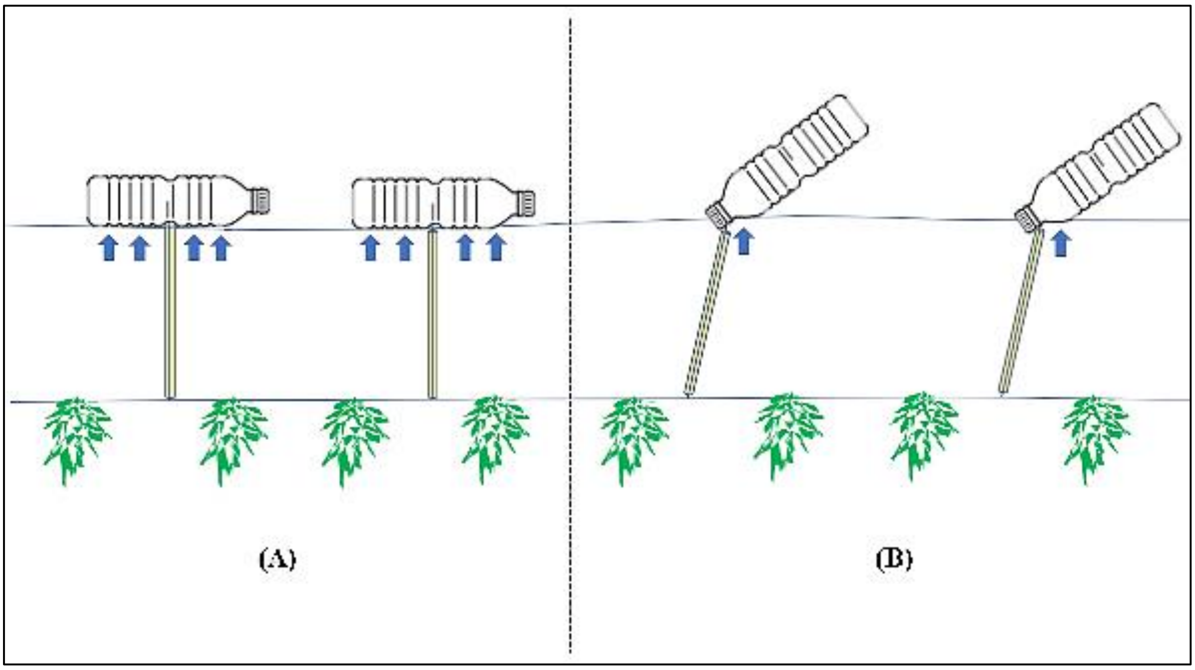

Figure 4 Proposed tying and position of a recycled plastic bottle or "plastic bottle float" encased with a bamboo spacer. Letter A represents enough surface for buoyancy and water motion (blue arrow), showing an upright position for up and down movement during wave action. While letter B represents a plastic bottle floating in a slant position with a smaller surface (blue arrow) for buoyancy and water motion during wave action

4. Conclusion

Based on the results and findings, the early onset of ice-ice diseases and epiphyte infestations is attributed to the unsuitable floatation employed by seaweed farmers. Newly transplanted seaweeds are vulnerable to ice-ice and epiphyte infestation due to stress accumulated during transplanting and weight loss, which leads to extended exposure to the surface. Therefore, the integration of spacers in existing floats to maintain the desired depth and avoid surface exposure of newly planted seaweed is recommended.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares that they have no conflict of interest.

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