Technological Improvements in Commercial *Eucheuma* Cultivation (A Short Communication)

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ABSTRACT

Two new devices developed by FMC BioPolymer for attaching propagules of the commercial *Eucheumas Kappaphycus alvarezii* and *Eucheuma denticulatum* to farm lines (the Eclip and Made Loop) were tested against the conventional Tie-tie system based on growth rate, percent plant loss, seeding and stripping time, as well as cost. Compared to the Tie-tie system, growth rates and percent plant loss were not statistically different with the Eclip and Made Loop. Seeding time is four times faster with the Made Loop and twice as fast with the Eclip. Stripping the line took a similar amount of time with the Eclip, but is 30 times faster with the Made Loop. The material cost of the Made Loop is similar to Tie-tie, although the Eclip is over ten times more costly. The cost of the Tie-tie did not include the fact that the Made Loop will last two years while the Tie-tie lasts no more than three months and, subsequently labor must be expended at least eight times as often to replace them on the main farm line.

Key words: *Eucheuma Kappaphycus*, farming systems, Tie-tie method, seeding technique, seaweeds, carrageenan

INTRODUCTION

In the late 1960s, Marine Colloids (purchased by FMC Corporation in 1977) in cooperation with the University of Hawaii, introduced the cultivation of *cottonii* (*Kappaphycus alvarezii* a.k.a. *K. striatum, K. cottonii,* and *Eucheuma denticulatum* in the Philippines (Doty, 1973; Parker, 1974)) as a response to a shortage of material. Although successful—today over 150,000 mt/year are produced by over 70,000 families in 10 countries—the basic farm system (lines with plastic straw to tie vegetative propagules, or the Tie-tie system) that had evolved by the mid-1970s has not changed (Trono, 1992). The Tie-tie system requires a lot of farm labor which limits productivity. The plastic straw or

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tie-tie can end up with the dried *cottonii* and *spinosum* headed to the processing facilities causing increased processing costs through extra maintenance, downtime, additional machinery to remove the tie-tie, and repair and replacement of machinery (Ask & Azanza, 2002).

In 1996, FMC BioPolymer launched a program to develop a "no-tie" farm system to improve the quality of raw materials and increase the efficiency of the farm system. Initially, a tube-net system was developed based on a method that was tried in the early 1970s (BFAR, 1974), but using high-density polyethylene netting that was more affordable. This system, however, had distinctly lower growth rates than the tie-tie system. During a three-week, side-by-side grow out in Tanzania, 3 kg of *eucheumas* grew to 12 kg using the tie-tie system, while 3 kg in a tube net produced only 6 kg. At this point, the team decided to focus exclusively on systems that emulated the free movement allowed by the tie-tie system. The results were the Eclip and the Made (pronounced as "Maudie") Loop, which was named after its inventor Mr. Made Simbik of Nusa Dua, Bali, Indonesia.

A comparison of the three systems (i.e., tie-tie, Eclip, and Made loop) based on (a) speed to seed; (b) speed to strip lines; (c) cost of the system; (d) growth rates; and (e) percent plant loss is presented and discussed in this paper.

MATERIALS AND METHODS

Description of the Eclip and Made Loop farm systems

1. The Eclip is a solid plastic piece that inserts into the braided farm line with an arrow shaped extension (Fig. 1). It can be handled between the thumb and middle finger, while the index finger is used to open the circle to allow the insertion of a propagule or the removal of a harvest-sized plant. The name is derived from *Eucheuma* Clip.

2. The Made loop is made from a 1.0 mm nylon braided line or plastic straw and is inserted into the strand of the main braided farm line (Fig. 2a). When the main line is loose, the propagule can be inserted into the loop. The size of the loop (length of the initial 1.0 mm line) depends on the size of the thallus of the propagule. Enough space should be left to accommodate growth, but not so much that the propagule will fall out during heavy water motion.

Seeding the lines

For each farm system (i.e., tie-tie, Made loop, and Eclip), five 20 m long, 4 mm diameter nylon lines were prepared, with the seeds spaced at 20 cm intervals using propagules of around 100 gm. The seeded lines were planted on off-bottom farms in the reef flat of the East Coast of Nusa Dua, Bali, Indonesia.

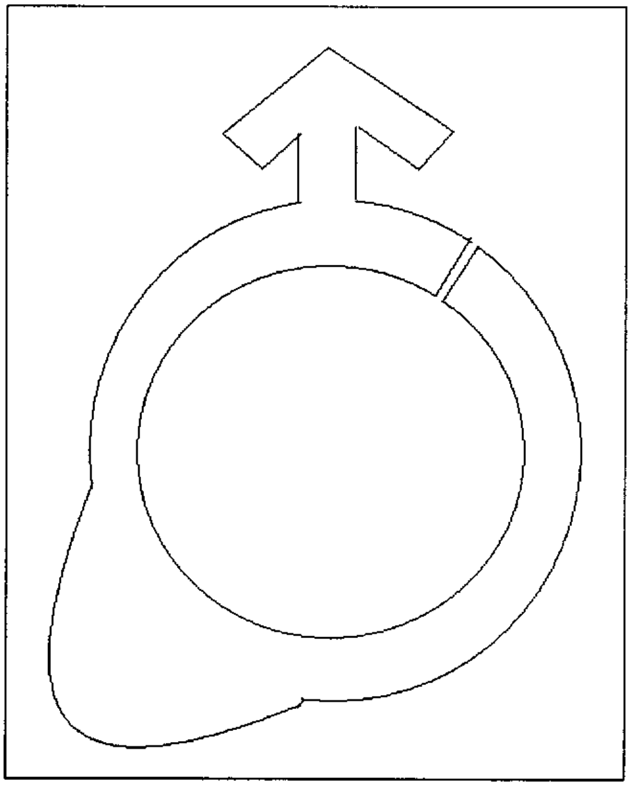

Fig. 1. The Eclip has an inside diameter of 2 cm, has a thumb/pointing finger tab, and is opened and closed with the middle finger. This leaves the other hand available to insert propagules. The "arrow head" is used to insert the Eclip into a braided farm line that is usually 3.5 to 4 mm.

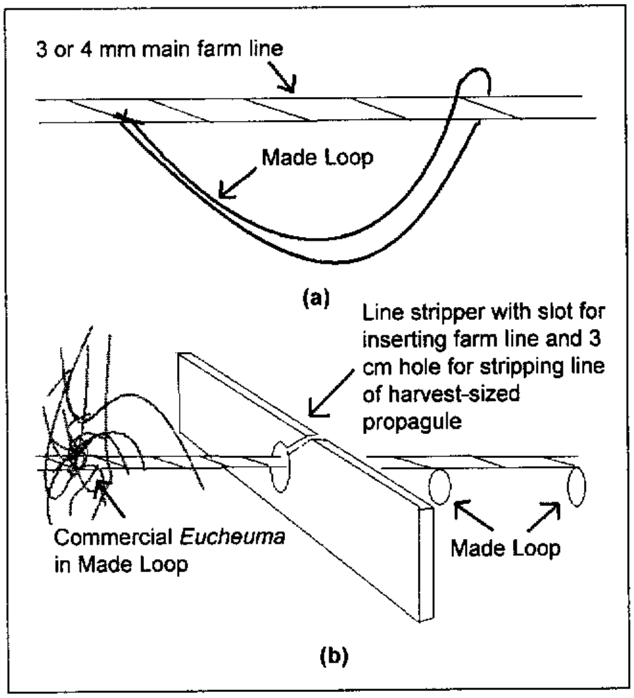

Fig. 2. (a) The Made loop is made from a piece of 1 mm braided line or tie-tie. It is inserted into the 3.5 to 4 mm braided main farm line. The propagules are inserted into the loop; (b) The Line stripper is made from a board with a hole and a slit in order to insert lines or accommodate attached float lines. When plants reach the hole, they brake off, leaving the loop and line to pass through.

Farmers were allowed to work with the Eclip and Made loop systems for a day to accustom themselves with seeding and stripping the lines.

Growth rates and percent plant loss

The 15 seeded lines were arranged/laid out with the 3 systems alternating each other. A farmer maintained the lines as he usually would—harvest after four weeks. After harvest, the number of propagules from each seeded line were counted and, after drip-drying for 30 seconds, the entire biomass of the seeded line was weighed using a Detecto 100 kg hanging spring scale with 500 gm increments. The same method was used to weigh the lines after the grow out period. The number of propagules were counted again to determine the percent plant loss and allow for the calculation of the growth rate on a per plant basis; broken portions were also accounted for.

Stripping the lines

The stripping of planted lines was done on the same lines. The tie-tie and Eclip systems entailed removing the plants individually, while the Made loop allowed the stripping of lines using a plank of wood with a hole drilled in it called a "line stripper" (Fig. 2b). The farmers were given a day to accustom themselves to the new systems.

RESULTS AND DISCUSSION

Growth rates and percent plant loss for all three systems were not significantly different at the 95% confidence level (Figs. 3 & 4), which indicates that the Made loop and the Eclip allow a high growth rate because they emulate the tie-tie system, with water flowing freely around the propagules. Glenn & Doty (1992) have emphasized the need to consider water movement in a farming system which facilitates nutrient availability to the crops.

The time it takes to seed a 20-m line containing propagules spaced 20 cm apart is two times faster with the Made loop system compared to the Eclip, and four times faster than the tie-tie system as shown in Fig. 5. Stripping time for the same line is extremely fast with

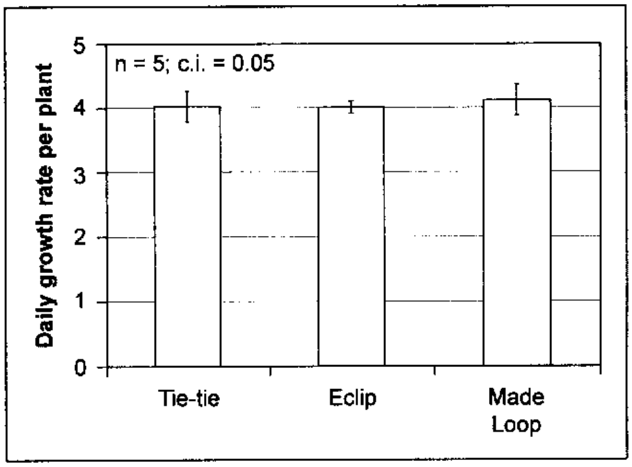

Fig. 3. Growth rates, on a per plant basis (five 20 m lines with the propagules spaced 20 cm apart) of *Kappaphycus alvarezii* were not statistically different at the 95% confidence level for all three systems.

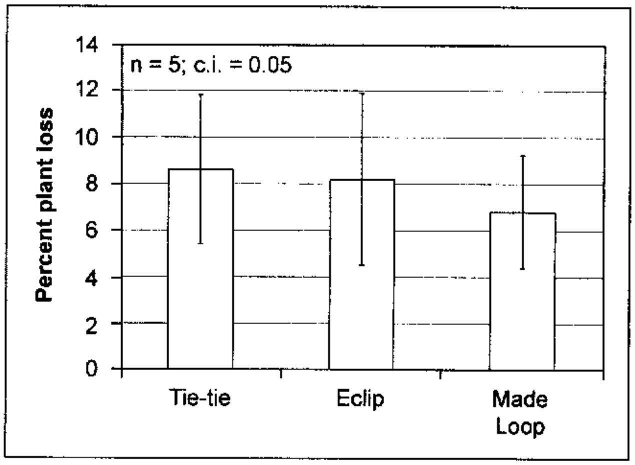

Fig. 4. Percent propagule loss (five 20 m lines with propagules spaced 20 cm apart) of *Kappaphycus alvarezii* were not statistically different at the 95% confidence level for all three systems.

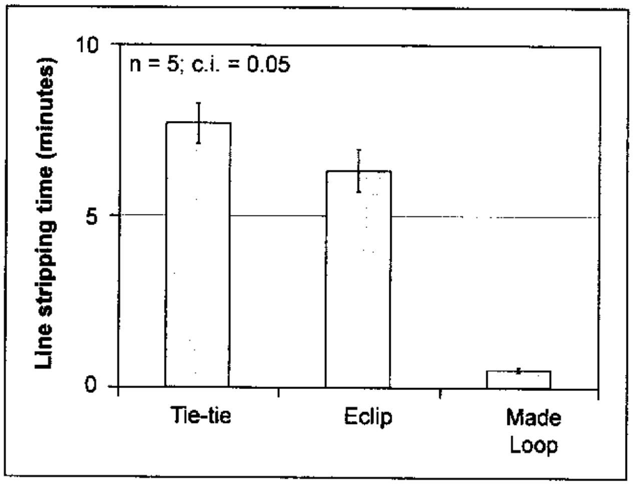

Fig. 6. Line stripping with the Made loop is 10 to 15 times faster than the Eclip and tie-tie systems, respectively (five 20-m lines with the propagules spaced 20 cm apart).

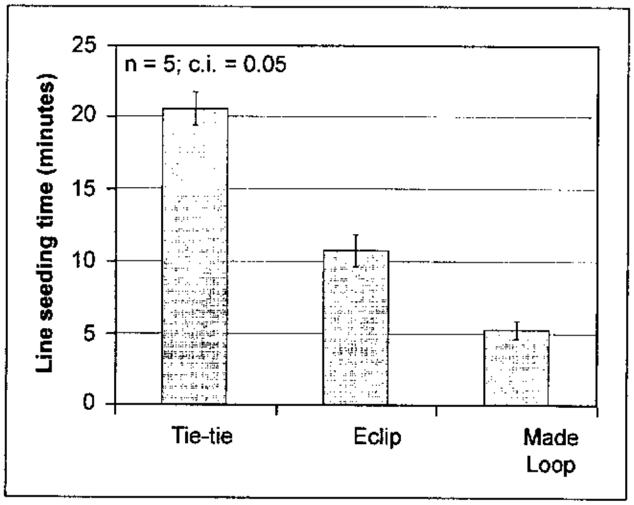

Fig. 5. Seeding the lines with *Kappaphycus alvarezii* propagules using tie-ties took twice as long as compared with the Eclip, and four times as long as compared with the Made loop (five 20-m lines with the propagules spaced 20 cm apart).

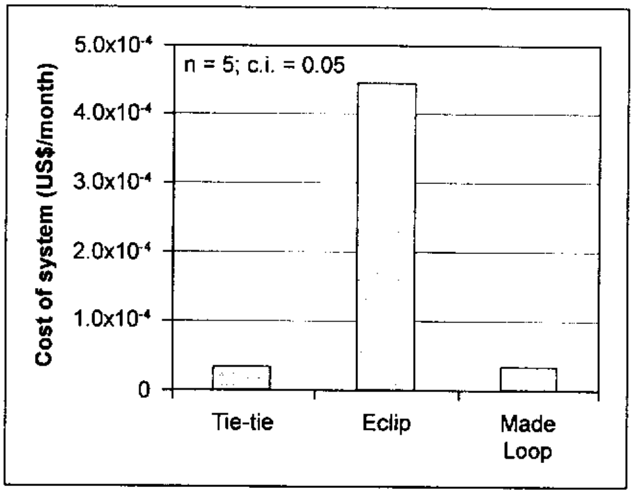

Fig. 7. The Made loop and tie-tie systems have similar costs—significantly (nearly 10X) cheaper than the Eclip on a per month basis. However, the tie-tie also requires replacement and re-attachment to the main farm line at least every three months, while the Made loop lasts two years. This is a labor cost not included in the calculation.

the Made loop compared with the other two systems (30 seconds versus 6 to 7.5 minutes; Fig. 6).

The useable life of a tie-tie is roughly three months, 18 months for an Eclip, and 24 months for a Made Loop. The cost of a tie-tie (30 cm of plastic raffia) is US$ 0.001, US$ 0.008 for an Eclip, and US$ 0.0008 for a Made loop. Fig. 7 compares the three systems on a cost per month basis. Eclips are substantially more expensive. Although the tie-tie and Made loop systems are comparable in terms of costs, it is important to note that the tie-tie system has an additional labor cost for replacing the tie-ties every three months, which requires tying the tie-ties to the main farm line. This is important because farms can exceed 6,000 m, which is equivalent to 30,000 tie-tie's that need to be attached every three months to the main farm line.

Another factor that is especially important when working with smallholder farmers is the appropriate technology aspect. Eclips would have to be manufactured in large quantities at some low-cost manufacturing location and shipped to most farm areas while Made loops can be made from 1.0 mm lines by the farmers themselves.

Based on the three factors (i.e., time to seed, time to strip lines, and cost), it is apparent that the Made loop system is by far the best alternative to the tie-tie system. One disadvantage is the difficulty encountered in replacing missing plants on short, tight farm lines (off bottom and rafts) without untying the farm line, which could cause slack to insert the propagule. The benefits of the Made loop system, however, far outweighs this problem. At present, FMC BioPolymer is quickly introducing the Made Loop technology to all its suppliers' farm sites throughout the Pacific and Indian Oceans.

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Date received: April 4, 2003
Date accepted: June 26, 2003