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SCREENING FOR HERBICIDAL AND GROWTH PROMOTOR ACTIVITIES IN MARINE BACTERIA

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ABSTRACT

Herbicides for practical use today are mostly synthetic compounds and they may be classified as follows on the basis of their mode of action, herbicides inhibiting photosynthetic electron transfer, herbicides affecting plant hormonal actions, herbicides interfering with nutritive metabolism, herbicides affecting cell division and microherbicides. Sooner or later weeds acquire resistance to the existing herbicide and thus the continued development of new and potent drugs for controlling them is required. This development of new herbicides must always take into consideration the problem of environmental pollution. Work regarding herbicidal activity relating to marine natural products is very limited. Screening for herbicidal activity was carried out using 250 marine bacterial strains by Lemna assay. Herbicidal activity was noted in 50 strains, out of which eight strains exhibited90% inhibition at a very low concentration of 5 ppm. Dwarfing and bleaching offronds were noticed as effects of various crude extracts. In the course of this study growth promoter activity was also noted in 75 strains.

KEYWORDS

herbicides, marine bacteria, Lemna assay, growth promoter

INTRODUCTION

The oceans represent a virtually untapped resource for the discovery of novel chemicals with potential as pharmaceuticals, nutritional supplements, cosmetics, agrochemicals, molecular probes, enzymes and fine chemicals. Each of these classes of marine bioproducts has a potential multi-billion dollar market value (Pomponi, 1999).

The farmland of the world includes about 150,000,000 hectares or 10% of *terra firma* and there are more than 200 families (6000 species including the analogs) of weeds that damage agricultural production. Before chemical herbicides appeared early in the 1950s, weeding was done by hand and by machinery requiring more than half the total hours of farming labour. Nowadays the appropriate application of herbicides has brought about a great reduction of labour and increase in crop yield to support the world population (Okuda, 1992).

Herbicides for practical use today are mostly synthetic compounds and they may be classified as follows on the basis of their mode of action, herbicides inhibiting photosynthetic electron transfer , herbicides affecting plant hormonal actions, herbicides interfering with nutritive metabolism, herbicides affecting cell division and microherbicides. Sooner or later weeds acquire resistance to the existing herbicide and thus the continued development of new and potent drugs for controlling them is required. This development of new herbicides must always take into consideration the problem of environmental pollution (Okuda, 1992).

Work regarding herbicidal activity relating to marine natural products is very limited. The major work carried out in this field was a collaborative study carried-out by Australian Institute of Marine Sciences and Department of Biochemistry and Molecular Biology, James Cook University, Australia. They have developed a rapid thorough put bimolecular screening for marine derived C4 plant specific herbicides (Burnell *et al.,* 2000). C4 plants utilize a 4-carbon molecule as the first stable compound after inorganic fixation. C3 plants Incorporate $C0_2$ into a 3-carboncompound. Most of the worlds grain crops are C3 plants (e.g. Wheat, rice barley and oats) and importantly though, 9 out of 10 of the world's worst weeds are C4 plants.

The enzymes involved in C4 acid cycle are essentially absent in C3 plants and therefore are suitable targets for C4 specific plant herbicides. The C4 specific plant herbicides have an estimated market value worth of 5 billion US dollars per year. The chemical diversity of the marine macro as well as microorganisms provides a vast unexplored resource relating to herbicides as well as plant growth promoters.

Food production in quantity and quality as well as for new plant commodities and products in developed and developing countries around the globe cannot rely solely on classical agriculture. Human survival *vis-a-vis* a continuous increase in agricultural productivity depends on the effective merging of classical breeding with modern plant biotechnology and the novel tools it provides.

The full realization of the agricultural biotechnology revolution depends on both continued successful and innovative research and development activities and on a favourable regulatory climate and public acceptance. Biotechnology is nowadays changing the agricultural and plant scene in major areas such as growth and development

control (vegetative, generative and reproductive propagation), protecting plants against the ever-increasing threats of abiotic and biotic stress and expanding the horizons by producing specialty foods, biochemcials and pharmaceuticals**.** Screening for growth promotors for agriculture usage is important in the context of increasing agriculture production to meet the demand of the increasing world population.

In this present study while screening for herbicidal activity of marine bacterial strains, many strains were found to promote growth and among which few were found potential.

MATERIALS AND METHODS

Preparation of crude extracts

An initial bacterial seed culture of 100ml was cultured in a rotary shaker (290 rpm) for 5-7 days in room temperature. Then 10 ml of this seed culture was added to five 250 ml conical flasks, each containing 200 ml of Zobell Marine broth and cultured in the shaker for 7 to 10 days at 290 rpm at room temperature. Extraction of the culture broth was carried out by liquid-liquid extraction method outlined by Gailliot, (1998) with slight modification. The cultures were pooled in a "1 –lit beaker and equal volume of ethyl acetate was added and the mixture was stirred for 30mins. using a magnetic stirrer. Then the broth and solvent phase (ethylaceate phase) were removed in a separating funnel, and the water phase discarded. The ethylaceate phase was filtered through a Whatman no. 1 filter paper and concentrated by evaporation and the residue obtained was weighed and used for the assay.

Lemna *bioassay*

Herbicidal activity was assayed following the method of McLaughlin *et al.* (1991). *Lemna minor* L. (duck weed) is a miniature aquatic monocot. *Lemna* plants consist of a central oval frond or mother frond with two attached daughter fronds and a filamentous root. Under normal conditions the plants reproduce exponentially with budding of daughter fronds from pouches on the sides of the mother fronds.

Aseptic Technique

The duckweeds were collected from a fresh water pond and were washed vigorously to remove algae and other plant growth. They were placed in the mineral medium of 0.2% sucrose and 6O0mg tryptone in 1 lit. distilled water to proliferate the growth of the bacterial spores attached on the fronds. After heavy bacterial growth was observed, the fronds were surface sterilized for 5 min in a 1/10 dilution of 0.5% hypochlorite solution. The stock cultures were grown in cotton stoppered 125 ml Erlenmeyer flasks with 50 ml medium and were stocked with 1 to 3 fronds transferred to E medium (E medium consisting of KH_2PO_4-680mg, $KN0_3$-1515 mg, Ca $(N0_3)_2$ 4 H_2O-1180 mg, $MgS0_4.7H_20$- 492 mg, H3BO3-286 mg, $MnCl_2$ $4H_20$-3.62 mg, $FeCl_2$ $6H_2O$-5.40mg, $ZnS0_4$ $7H_20$ -0.22mg, $CuS0_4$ $5H_20$ - 0.22mg, Na_2Mo0_4 $2H_20$ - 0.12mg and EDTA 11.2mg were prepared) by loop under aseptic conditions in a laminar flow hood. Rosettes were cultured at 29°C under constant light and the sterile fronds were used for further bioassay studies.

Vials per dose of 500, 50, 5 ppm and control were prepared. 15mg of crude extract was dissolved in 15 ml solvent and from that 1000, 100 and 10 uJ solution were transferred to vials for 500, 50 and 5 ppm and it was allowed to evaporate overnight. 2 ml of E medium was added and a single plant containing a rosette of 3 fronds were introduced to each vial. The vials were kept in glass chamber with about 2 cm water at bottom to maintain the moisture content of the chamber and sealed with glass plate. The fronds per vial were counted and recorded on 3rd and 7th days of experiment and symptoms of damage to the frond such as bleaching and dwarfing were also noted. The results were tabulated and the percentage inhibition was calculated using the formula B_c-B_t/B_CX100. Where, B_c - Final number of fronds

in control and B_t - Final number of fronds in each tested concentration. In case of growth promotion, the percentage promotion was also calculated.

RESULTS

Out of the 250 strains screened for herbicidal activity, 50 strains exhibited activity, which ranged from mild to pronounced effect. Eight strains exhibited 90% inhibition at a very low concentration of 5 ppm. The strains that exhibited 90% inhibitions were SB3, SC7, AB17, AF6, AK8, CC6, BFC12, ASB1 and SPE9. These strains were isolated from different marine sources such as SB3 and SC7 from sponges, AB17, AF6 and AK6 from seaweeds, CC6 from a crab, BFC from biofilm, ASB1 from ascidian and SPE9 from cephalopod eggs. Only one strain, SQ7, exhibited 100% inhibition at the low concentration of 5 ppm. The frond damage was also noted as dwarfing and bleaching. (Table 1).

Table 1
Herbicidal activity of marine bacteria

Strain	Days of Exposure	Control	No. of fronds, symptoms of damage and % inhibition		
			500 ppm	50 ppm	5ppm
SA2	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	5 (50%)	9(10%)	9(10%)
SA7	3	4	3 (25%)	3 (25%)	3 (25%)
	7	10	7 (30%)	8 (20%)	8 (20%)
SB3	3	4	0(D &B) (100%)	1 (D &B) (75%)	2 (D &B) (50%)
	7	10	0(D &B) (100%)	0(D&B) (100%)	1(D &B) (90%)
SB4	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	5 (50%)	8 (20%)	9(10%)
SC7	3	4	1 (75%)	2 (50%)	2 (50%)
	7	10	0(D &B) (100%)	0(D &B) (100%)	1(D &B) (90%)
SD1	3	4	3 (25%)	2 (50%)	1 (90%)
	7	10	7 (30%)	8 (20%)	8 (20%)
SE5	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	4 (60%)	5 (50%)	8 (20%)
SJ2	3	4	0(D &B) (100%)	1 (75%)	2 (50%)
	7	10	0(D &B) (100%)	0(D &BH100%)	1 (90%)
AA2	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	4 (60%)	8 (20%)	8 (20%)
AA12	3	4	1 (75%)	2 (50%)	2 (50%)
	7	10	5150%)	8 (20%)	9(10%)
AB12	3	4	2 (50%)	2 (50%)	3 (25%)
	7	10	4 (60%)	7 (30%)	8 (20%)
AB17	3	4	0(D &B) (100%)	1(D &B) (75%)	1(D &B) (75%)
	7	10	0(D &B) (100%)	0(D&B) (100%)	1(D &B)(90%)
AC2	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	4 (60%)	7 (30%)	9(10%)
AC4	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	0(D &B) (100%)	3(D &B)	5(D &B) (50%)
AD14	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	6 (40%)	8 (20%)	9(10%)
AD15	3	4	0(D&B)(100%)	1 (75%)	3 (25%)
	7	10	0(D &B) (100%)	3(D &B)	5(D &B) (50%)

AE5	3	4	2 (50%)	2 (50%)	3 (25%)
	7	10	4 (60%)	7 (30%)	8 (20%)
AE9	3	4	1 (75%)	3 (25%)	3 (25%)
	7	10	3 (70%)	5 (50%)	7 (30%)
AF1	3	4	0(D&B) (100%)	1 (75%)	1 (75%)
	7	10	0(D&B) (100%)	1(D &B) (90%)	3(D &B) (70%)
AF6	3	4	0(D &B) (100%)	1 (75%)	2 (50%)
	7	10	0(D &B) (100%)	0(D&B)	1(D &B) (90%)
AF18	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	3 (70%)	5 (50%)	7 (30%)
AG5	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	7 (30%)	8 (20%)	9(10%)
AH13	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	4 (60%)	5 (50%)	7 (30%)
AJ8	3	4	1 (75%)	3 (25%)	3 (25%)
	7	10	2 (50%)	4 (60%)	6 (40%)
AK8	3	4	0(D &B)(100%)	0(D &B)(100%)	1 (75%)
	7	10	0(D &B)(100%)	0(D &B)(100%)	1(D &B) (90%)
CB8	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	3 (70%)	5 (50%)	7 (30%)
CB13	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	6 (40%)	7 (30%)	9(10%)
CC6	3	4	0(D &B)(100%)	1 (75%)	3 (25%)
	7	10	0(D &B)(100%)	0(D &B)	1(D &B) (90%)
BFA1	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	3 (70%)	5 (50%)	6 (40%)
BFA2	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	5 (50%)	8 (20%)	9 (90%)
BFB5	3	4	2 (50%)	3 (25%)	4 (0%)
	7	10	6 (40%)	8 (20%)	9(10%)
BFC12	3	4	0(D &B) (100%)	1 (75%)	1 (75%)
	7	10	0(D &B)(100%)	0(D &B)(100%)	1(D&B) (90%)
SM8	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	3 (70%)	6 (40%)	8 (20%)
SM3	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	6 (40%)	8 (20%)	9(10%)
JF5	3	4	0(D &B)(100%)	1 (75%)	2 (50%)
	7	10	0(D &B)(100%)	4 (60%)	6 (40%)
GMA9	3	4	1 (75%)	3 (25%)	3 (25%)
	7	10	4 (60%)	6 (40%)	8 (20%)
GMC10	3	4	0(100%)	1 (75%)	2 (50%)
	7	10	1 (75%)	3 (70%)	5 (50%)
ASB1	3	4	0(D &B)(100%)	1 (75%)	1 (75%)
	7	10	0(D &B)(100%)	0(D &B) (100%)	1(D &B) (90%)
ASC1	3	4	2 (50%)	2 (50%)	3 (25%)
	7	10	5 (50%)	7(30%)	9(10%)
GE12	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	5 (50%)	7 (30%)	8 (20%)
STCL1	3	4	0(D &B)(100%)	1 (75%)	2 (50%)
	7	10	0(D &B)(100%)	3 (70%)	6 (40%)
OBSA10	3	4	0(100%)	1 (75%)	2 (50%)
	7	10	1 (90%)	3 (70%)	5(D &B) 100%)
OBSA18	3	4	2 (50%)	3 (25%)	3 (25%)
	7	10	4 (60%)	6 (40%)	8 (20%)

0BSA17	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	4 (60%)	5 (50%)	8 (20%)
0BSB1	3	4	0(100%)	1 (75%)	1 (75%)
	7	10	3 (70%)	5 (50%)	6 (40%)
0BSB8	3	4	0(100%)	2 (50%)	3 (25%)
	7	10	4 (60%)	7 (30%)	8 (20%)
SPE8	3	4	1 (75%)	2 (50%)	3 (25%)
	7	10	5 (50%)	6(40%)	8 (20%)
SPE9	3	4	0(D &B)(100%)	0(D &B)(100%)	1 (75%)
	7	10	0(D &B)(100%)	0(D&B)(100%)	1(D &B) (90%)
SQE6	3	4	0(100%)	2 (50%)	3 (25%)
	7	10	4 (60%)	6 (40%)	7 (30%)
	3	4	0(D &B)(100%)	1 (75%)	1 (75%)
owe /	7	10	0(D&B)(100%)	0(0 &B) (100%)	0(D &B)(100%)

The growth promotor activity was exhibited by different strains in higher percentage comparatively. The strains SB5, SC4, SG2, AI14, ASC4, CE11, STCL12 and OBSA22 exhibited 6% growth promotion at a higher ppm of 500. The strains SB5, SC4, SG2 were isolated from sponges, AM 4 from seaweed, ASC4 from ascidian, CE11 from crab egg, and STCL12 from coral and OBSA22 from Opisthobranch surface. The strains BFA20, CE15 and OBSB 10 exhibited 7% growth promotion at 500-ppm concentration of the crude extract. The strain BFA20 was isolated from biofilm, CE from crab egg and OBSB10 from Opisthobranch surface. The trains SI4, AC6 and SUR6, exhibiting 8% growth promotion, was isolated from a sponge, seaweeds and sea urchin respectively. The strain AL3, isolated from seaweed, exhibited 10% growth promotion at 500-ppm concentration and 5% growth promotion at 50-ppm concentration. The strain CC13, isolated from a crab, exhibited 12% growth promotion at 500 ppm and 5% at 50 ppm. The strain STCL18, isolated from a coral, exhibited 10% growth promotion at 500 ppm, 6% in50 ppm and 3% in 5 ppm. The Opisthobranch surface derived strain OBSA10 exhibited 11% growth promotion at 500 ppm, 5% growth promotion at 50 ppm and 2% in 5 ppm. The strain SQE 4, from squid egg, exhibited 13% growth promotion at 500 ppm, 6% at 50 ppm and 2% at 5-ppm concentration of the crude extract (Table 2).

Table 2
Growth promoter activity of marine bacteria

Strains	Days of exposure	Control	No. of fronds, % growth promotion		
			500 ppm	50 ppm	5 ppm
SA1	7	10	12 (2%)	10(0%)	10(0%)
SA3	7	10	13(3%)	10(0%)	10(0%)
SB1	7	10	15(5%)	13(3%)	11(1%)
SB5	7	10	16(6%)	12(2%)	10(0%)
SC4	7	10	16(6%)	12(2%)	10(0%)
SD7	7	10	11 (1%)	10(0%)	10(0%)
SE8	7	10	11 (1%)	10(0%)	10 (0%)
SG2	7	10	16(6%)	13(3%)	11 (1%)

SH5	7	10	12(2%)	10(0%)	10(0%)
SI4	7	10	18(8%)	15(5%)	12(2%)
AA10	7	10	11 (1%)	10(0%)	10(0%)
AA4	7	10	12 (2%)	10(0%)	10(0%)
AA14	7	10	11 (1%)	10(0%)	10(0%)
AB2	7	10	12 (2%)	10(0%)	10(0%)
AB12	7	10	15(5%)	12(2%)	10(0%)
AB15	7	10	13(3%)	10(0%)	10 (0%)
AC6	7	10	18(8%)	15(5%)	11 (1%)
AE10	7	10	11 (1%)	10(0%)	10(0%)
AF4	7	10	13<3%)	11 (10%)	10(0%)
AF7	7	10	16(6**%o)**	12(2%)	10(0%)
AH1	7	10	15(5%)	11 (1%)	10(0%)
AH5	7	10	11 (1%)	10(0%)	10(0%)
AH10	7	10	15(5%)	11 (1%)	10(0%)
AH16	7	10	12(2%)	10(0%)	10(0%)
AI7	7	10	12 (2%)	10(0%)	10(0%)
AIM	7	10	16(6%)	12(2%)	10(0%)
AI16	7	10	11 (1%)	10(0%)	10(0%)
AK17	7	10	12 (2%)	10(0%)	10(0%)
AL3	7	10	20 (10%)	15(5%)	12 (2%)
ALIO	7	10	13(3%)	11 (1%)	10(0%)
AL14	7	10	12 (2%)	10(0%)	10(0%)
CA2	7	10	15(5%)	12 (2%)	10(0%)
CA8	7	10	12(2%)	10(0%)	10(0%)
CC7	7	10	11(1%)	10(0%)	10(0%)
CC13	7	10	22(12%)	15(5%)	13(3%)
BFA10	7	10	13(3%)	11 (1%)	10(0%)
BFA18	7	10	11 (1%)	10(0%) '	10(0%)
BFA12	7	10	15(5%)	12(2%)	10(0%)
BFA20	7	10	12(2%)	10(0%)	10(0%)
BFC5	7	10	17(7%)	15(5%)	11 (10%)
BFC16	7	10	12(2%)	10(0%)	10(0%)
SM12	7	10	13(3%)	11 (1%)	10(0%)
SM18	7	10	11 (1%)	10(0%)	10(0%)
SCU5	7	10	13(3%)	11 (1%)	10 (0%)
SCU8	7	10	15(5%)	12(2%)	10(0%)
SUR6	7	10	18(8%)	15(5%)	12 (2%)
GMB1	7	10	13(3%)	11 (1%)	10(0%)
GMB5	7	10	15 (5%)	11 (1%)	10(0%)
GMC1	7	10	12(2%)	10(0%)	10(0%)
ASC4	7	10	16(6%)	12(2%)	10(0%)
CE2	7	10	12(2%)	10(0%)	10(0%)
CE11	7	10	16(6%)	13(3%)	11 (1%)
CE15	7	10	17(7%)	13(3%)	11 (1%)

GE1	7	10	19 (9%)	15(5%)	12 (2%)
BCL2	7	10	13(3%)	10(0%)	10(0%)
BCL7	7	10	12 (2%)	10(0%)	10(0%)
BCL13	7	10	11 (1%)	10(0%)	10(0%)
SCL17	7	10	15 (5%)	11 (1%)	10 (0%)
STCL12	7	10	16(6%)	12(2%)	10(0%)
STCL14	7	10	11 (1%)	10(0%)	10(0%)
STCL18	7	10	20 (10%)	16(6%)	13(3%)
STCL20	7	10	14(4%)	11 (1%)	10(0%)
OBSA3	7	10	15 (5%)	11 (1%)	10(0%)
OBSA10	7	10	21 (11%)	15(5%)	12 (2%)
0BSA12	7	10	12(2%)	10(0%o)	10(0%)
OBSA22	7	10	16(6%)	13(3%o)	10(0%o)
OBSB5	7	10	11 (1%)	10(0%>)	10 (0%)
OBSB10	7	10	17(7%)	13(3%)	11 (1%)
0BSB15	7	10	15(5%)	11 (1%)	10(0%)
SPE1	7	10	12 (2%)	10(0%)	10(0%)
SPE7	7	10	15(5%)	12 (2%)	10 (0%)
SPE10	7	10	12(2%)	10(0%o)	10(0%)
SQE4	7	10	23 (13%)	16(6%)	12 (2%)
SQE6	7	10	14(4%)	11 (1%)	10(0%)
SQE8	7	10	11 (1%)	10(0%)	10(0%)

In the genus level identification of the potential strains exhibiting herbicidal and growth promotor activities, genus like *Alteromonas sp., Flavobacterium sp., Pseudomonas sp., Vibrio sp., Streptomyces sp., Bacillus sp., Micrococcus sp., Alcaligenes sp.* and few unidentified species were encountered (Table 3 & 4).

Table 3
Genus level identification of strains exhibiting herbicidal activity

Strains	Genus
SB3	*Alteromonas sp.*
SC7	*Alteromonas sp.*
AB17	*Vibrio sp.*
AF6	*Pseudomonas sp.*
AK8	*Bacillus sp.*
CC6	*Streptomyces sp.*
BFC12	*Flavobacterium sp.*
ASB1	*Unidentified*
SPE9	*Streptomyces sp.*
SQE7	*Bacillus sp.*

Table 4
Genus level identification of potential strains exhibiting growth promoter activity

Strains	Genus
SB5	*Flavobacterium sp.*
SC4	*Vibrio sp.*
SG2	*Micrococcus sp.*
AI14	*Pseudomonas sp.*
ASC4	*Alteromonas sp.*
CE11	*Streptomyces sp.*
STCL12	*Alteromonas sp.*
OBSA22	*Vibrio sp.*
BFA20	*Streptomyces sp.*
CE15	*Unidentified*
OBSA10	Unidentified
SI4	*Flavobacterium sp.*
AC6	*Alteromonas sp.*
SUR6	*Vibrio sp.*
AL3	*Alcaligenes sp.*
CC13	*Unidentified*
STCL18	*Pseudomonas sp.*
OBSA10	*Vibrio sp.*
SQE4	*Pseudomonas sp.*

DISCUSSION

Works relating to screening and isolation of herbicidal compounds from marine sources is very limited. The shift towards marine natural products regarding herbicides is very recent. Burnell*et al.,* (2000), reported the development of rapid throughput biomolecular screening for marine derived C4 plant specific herbicides. They have further planned to screen the marine natural products resources of Australian Institute of Marine Science, which possesses 10,000 extracts of marine macroorganisms and 7000 cryopreserved marine microorganisms.

In the present study a vast number of marine bacterial strains were screened for herbicidal activity. Only 50 strains exhibited inhibitory activity and of which only 10 strains exhibited 90% activity in the lowest concentration of 10 ng/ml and 100% activity at 100 jig/ml concentration of the crude extract. There is no single report until now of works regarding isolation of herbicidal compounds from marine bacteria to the author's knowledge. Dobler *et al.* (2002) reports that Diketopiperazines are rather abundant in marine bacteria and inspite of the simple structures of these compounds some are reported to have herbicidal, chitinase inhibitory, phytotoxic and antifungal activity. In terrestrial side, selective and contact herbicidal activity A and B were reported in 1976 (Okuda, 1992). The majority of herbicidal compounds from microorganisms were reported from Japan by the Omura group (Omura *et al.,* 1979, Omura *et al.,* 1984a, Omura *et al.,* 1984b, Omura *et al.,* 1990). This is a first report on

screening of marine bacteria for herbicidal compounds and isolation and purification of the active compounds may result in the discovery of new novel herbicidal metabolites.

During the course of screening for herbicidal activity, many strains were found to promote the growth rate of *Lemna.* Growth promotor activity of seaweeds have been widely studied and reported by many researchers. In recent years, the uses of natural seaweed products as substitutes to the conventional synthetic fertilizers have assumed importance (Crouch & Staden, 1993). Studies on growth promotor activity of marine bacteria are lacking and this line of research may yield novel growth promoters from marine bacteria

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