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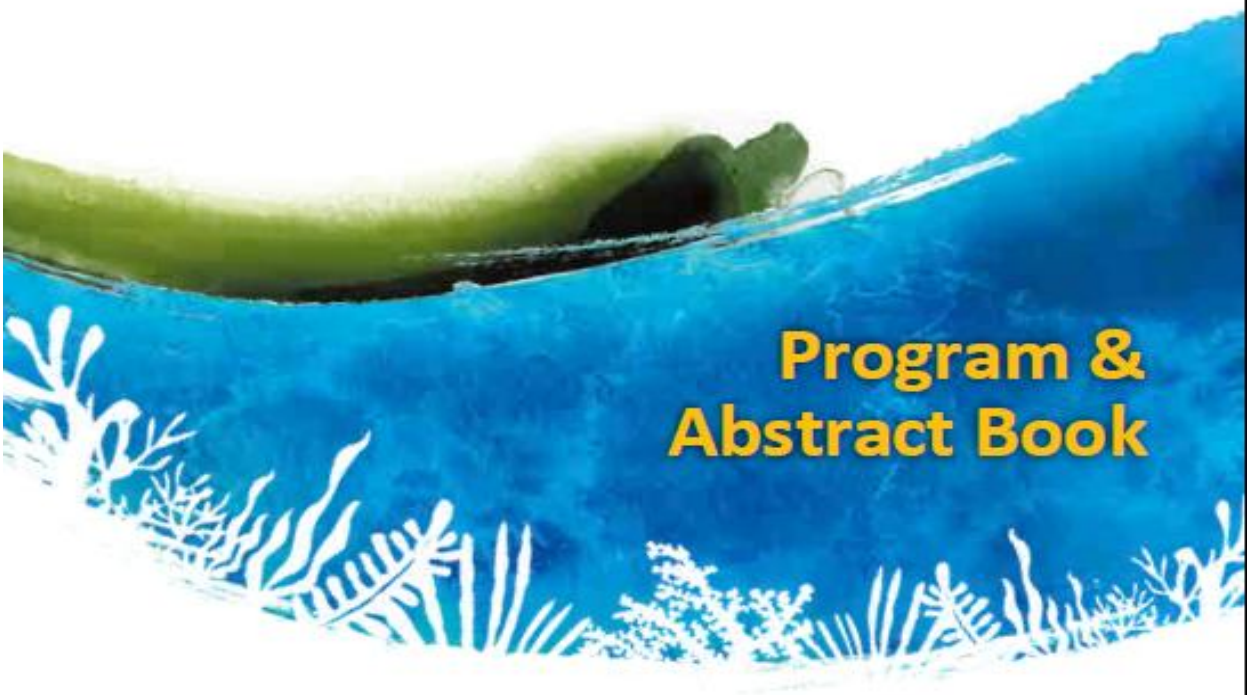

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Tropical seaweed extract based agro bio-stimulant 'SAGARIKA' for better crop health and higher crop production

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ABSTRACT

Seaweed extract based agricultural bio stimulant that are currently available in the market, are manufactured mainly from brown seaweeds of cold water origin. 'SAGARIKA' a seaweed extract based product of 'AquAgri – IFFCO Bazar' is a tropical seaweed based agricultural bio-stimulant manufactured from *Kappaphycus alvarezii* and *Sargassum* species. CSIR-CSMCRI, Bhavnagar, Gujarat has been the technology provider of this product and has also conducted seaweed sap efficacy trials in collaboration with 43 universities on different crops and agro-climatic conditions of India recording 11% -36 % higher crop yields. SAGARIKA is a repository of micro and macro-nutrients, plant growth regulators (PGR) such as Auxins, Cytokinins and Gibberellins. In addition, it is also a source of thermo-stable glycine, betaine and choline which help boost crop yields, through activation of its internal metabolic processes. Basal application of SAGARIKA granule (@25 Kg/ha) and foliar application of SAGARIKA liquid (@ 0.25 %) at critical crop growth stages has become an integral part of balanced soil- crop nutrition programme. It has resulted into yield enhancement to the tune of 9.5 to 36.0% in different crops. SAGARIKA has also led to improvement in crop immunity and its tolerance to various biotic - abiotic stresses. Present investigation on SAGARIKA summarizes its production, nutrient profiling and constituent details as well as its efficacy trial results in different crop geographies. Authors have also attempted to focus on its stress relieving properties and mechanism of action in plants.

Key Words: Tropical Seaweeds; SAGARIKA; IFFCO; Agro bio stimulants; Crop production; Crop health

to support the sustainability of selected, farmed carrageenophytes. Four strains of *Kappaphycus* spp. (viz. *K. alvarezii* (tambalang brown and green,) *K. malesianus* (aring-aring) and *K. striatus* (sacol green)) were used in the present study to optimize the use of *Ascophyllum* Marine Plant Extract Powder (AMPEP) as a culture medium ingredient acting as a biostimulant, applied with the addition of terrestrial plant growth regulators (PGRs). Data will be reported on the relative performances of the treated cultivars grown under the same conditions. The use of the brown seaweed-derived extract acting as a biostimulant and as the main ingredient of the culture medium for the micro-propagation of four strains of *Kappaphycus* was highly encouraging and one which may be promoted as a protocol for the economic and commercial mass production of new plantlets (asexual seedlings) which are an urgent requirement for Malaysian seaweed farming to meet its full potential.

OR 11-4

Red seaweed derived bioformulation, AgroGain, improves crop yields by enhancing photosynthesis, metabolism and nutrient uptake

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Increasing demand for food production, worldwide, requires technologies that can enhance agricultural productivity and its quality. Cultivated red seaweeds have conventionally been used till date only to produce the gelling agent, carrageenan. However, we have identified unique bio-active ingredients from red seaweeds which can be explored for improving plant growth and development. Freshly harvested red seaweeds are fractionated into distinct chemical components using proprietary processes and optimally blended to form the bioformulation, AgroGain. The active ingredients of the bioformulation are well characterized, and this enables manufacturing a consistent product. Several field trials were conducted in various agroclimatic zones across multiple geographies and seasons to evaluate the efficacy of the bioformulation. These trials were undertaken at the research facilities of Indian Council for Agriculture Research (ICAR) and by several agri-experts in other countries. In addition, to elucidate the mode of action of AgroGain, tomato (*Solanum lycopersicum*) and rice (*Oryza sativa*) plants were foliar-treated with the bioformulation and leaf transcriptomes were analysed at 24 and 48 hours post treatment by the RNA Seq method. Application of AgroGain at a dose of 500ml/hectare in vegetative and early reproductive phases resulted in yield increases of 10-30%. AgroGain also improved phenotypic characteristics such as root length and volume, plant height, leaf area and improved flowering. Transcriptome studies on tomato and rice plants indicate upregulation of several genes involved in photosynthesis, cell division, metabolism and nutrient uptake. We present a sustainable, scalable and consistent product formulation from cultivated red seaweeds for use in agriculture to improve crop yields

OR 11-5

Seaweed extracts for plant growth & nutrition

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For centuries seaweeds have been used for promoting plant growth and increasing crop yields. In the current context of world population increase, climate change and reduction of chemical inputs, agriculture can benefit from molecules developed by seaweeds to tackle agricultural challenges. CMI Roullier works on the development of innovative seaweeds extracts to offer tailored solutions to solve numerous agronomic issues. Our experimental approach can be summarized as follow: selection of seaweeds based on literature, production of crude extracts (CEs) under various conditions, CEs screening via agronomic trials, selection and characterization of the most promising CEs, extraction optimizations to selectively isolate the desired categories of molecules using appropriate conditions (duration, pH, temperature). Secondary trials on the fields are carried out for efficacy validation. The success of this methodology can be illustrated by extracts from *Ascophyllum nodosum* (AZAL'S) and *Fucus serratus* (Phéoflore), designed respectively for foliar and soil application, where aqueous extracts were produced from dried seaweeds in optimized conditions. AZAL'S contains minerals, polyphenols and phytohormones with high amounts of indoleacetic acid and abscisic acid. Even under water-stressed conditions, trials on wheat demonstrated that AZAL'S significantly increases the grain K uptake and leads to a +25 % yield with N supplementation. An enhancement of N, C and S assimilation has also been demonstrated on rapeseed. Another strategy is to stimulate plant growth by acting on the soil microbiome, for instance the addition of Phéoflore to mineral amendment increases the microbial population and promotes favorable microbes, leading to an improved soil fertility thanks to a better degradation of organic matter. On the basis of these conclusive results, we are continuing our screening of algae with agronomic potential and are also aiming at developing sustainable extraction processes to take full advantage of algae potential.

OR 11-6

Tropical seaweed extract based agro bio-stimulant 'SAGARIKA' for better crop health and higher crop production

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OR 12-1

Global climate change and *Macrocystis pyrifera* (Ochrophyta): does environmental history affect the ability to acclimate to future oceanic conditions?

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Global environmental changes such as warming and acidification of the oceans, OW and OA, respectively, are predicted to have wide-ranging effects on marine organisms. However, coastal marine ecosystems are highly variable. For example, along the Chilean coast, large fluctuations in pH/CO_2, temperature and nutrient regime have been well documented as a consequence of e.g., upwelling events. This has led to suggestions that organisms living in highly variable environments (upwelling zones) will be more tolerant to future global (i.e. OW and OA) and local changes (i.e. eutrophication) to those living in more stable environments. Therefore, the aim of this study was to determine the interactive effects of OA and OW on the physiological performance of juvenile sporophytes of *Macrocystis* from populations that are naturally exposed to high environmental variability due to upwelling events (Las Docas: 32°08´S, 71°42´W) v/s coastal areas with more stable conditions (El Tabo: 33°27´S, 71°66´W). To test this, juveniles from both populations, which were previously grown for 3 months in a common garden experiment, were incubated for 3 weeks under three temperatures (12, 16, 20°C) and two CO_2 treatments (ambient: 400uatm/pH 7.9, OA: 1200uatm/pH 7.5) with ambient nutrient concentrations. We found that growth rates of both populations were negatively affected by high temperature (20°C), regarding of the CO_2 treatment, but significant differences were found among populations (Las Docas > El Tabo). However, photosynthetic rates of both populations were neither affected by temperature nor CO_2. Nitrate reductase (NR) varied among populations (Las Docas > El Tabo) but was unaffected by the experimental treatments while carbonic anhydrase (CA) varied among populations (Las Docas < El Tabo) but was also affected by temperature. Our results showed that the environmental conditions to which organisms are naturally exposed will affect their physiological responses to future oceanic conditions, making some ecotypes more resilient than others.

OR 12-2

Diploneis serrate (Bacillariophyceae), a new diatom species from Kenting, Taiwan, and the structural mechanistic analysis of the striae pattern of its frustrule under shear, normal and uniform loading

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An understanding of the forces involved in silica cell wall deformation that may be encountered during stress from nutrient depletion and ocean acidification can also help explain the different modes of diatom existance, planktonic or benthic, the molecular and physical forces that have made the diatoms one of the most abundant phytoplanktonic organisms in all the earth's aquatic habitats, and the potential effects of a changing ocean habitat by contemporary global warming patterns. Phytoplanktonic microalgae-diatoms belonging to the genus *Diploneis* collected from a microcosm made of intertidal submerged benthic shore rocks from Kenting National Park, Taiwan were observed at the ultrastructural microscopic scale and classified both morphologically and resolved molecularly using 18s ribosomal DNA as a marker for cladistics. Furthermore, the naked diatom cells void of organic material (frustules of silica) were subjected *in vivo* to shear forces in order to study the proportion of stiffness and strength resistance to cell deformation and ultimate structural failure by fracture. It was observed that stiffness and strength were greatly magnified and improved by ultracellular silicone structures conforming to a triangular beam-like support shape towards the middle of the frustule as opposed to more rectangular beam-like support structures also found in the cell wall, but more towards the poles. When a uniform loading direction was applied, the ratio of stress and strain between the triangular vs. the rectangular shape showed very little improvements in test for maximum stress and maximum deflection suggesting that gains in stiffness and strength do not seem to benefit the strength of the frustule when a uniform loading stress is applied, for example during gliding or sliding on mucilaginous mats that are part of a benthic existance.

OR 12-3

Historical climate-driven range shifts shape latitudinal diversity gradients of the marine brown alga *Sargassum thunbergii* in the Northwest Pacific

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The centre-periphery hypothesis (CPH) is a 'classic' biogeographical paradigm used to explain genetic diversity patterns across a species' distributional range. However, this hypothesis has seldom been tested in the Northwestern Pacific, where coastal shorelines and hence spatial gradients in marine biodiversity have been sharply influenced by range shifts during the Last Glacial Maximum (LGM) due to thermal and sea level changes. Herein, we chose the brown alga *Sargassum thunbergii* (Mertens ex Roth) Kuntze as a model to explore whether historical factors contributed to latitudinal diversity patterns by linking present population genetic variation to geographical range shifts from the LGM to the present, predicted with species distribution modelling (SDM). We used 11 polymorphic microsatellites to estimate heterozygosity, allelic richness, private diversity, and population differentiation. We found strikingly rich diversity and diverged genetic lineages in the centre-north periphery, contradicting predictions based on the CPH. SDM showed the predominant roles of sea ice thickness, ocean and air temperatures in determining the distributions of *S. thunbergii*, and hindcasted regions of persistence and