



# CSIR-Central Salt & Marine Chemicals Research Institute, Bhavnagar

CSIR-CSMCRI



Seaweed cultivation



*Kappaphycus* seaweed



Seaweed sap extraction plant (Aquagri)



Seaweed biostimulant



Foliar spray of biostimulant

## CSIR-CSMCRI'S National award winning *Kappaphycus alvarezii* seaweed based organic plant biostimulant for raising agricultural crop productivity

### Seaweed biostimulant-related activities

Central Salt & Marine Chemicals Research Institute (CSIR-CSMCRI), Bhavnagar devised raft method of seaweed cultivation and has also invented (US Patent No. 6,893,479) a technology for production of sap of the seaweed, *Kappaphycus alvarezii*, along with a residue that yields kappa carrageenan. The sap derived from fresh *Kappaphycus alvarezii* is an effective biostimulant. It is inexpensive which makes it suitable for broad acre crops; and its price point makes it affordable and within the means of a small and marginal farmer. The usage level 2-15% and increase in crop yield production range from 12 to 35% across crops. Preliminary studies at CSIR-CSMCRI showed that the foliar application of sap in dilute form resulted in yield improvement in number of crops. Limited trials carried out by Pepsico India (2005-2007) using this sap showed substantial improvement in yields of sugarcane (18-33%) and several vegetables like Potato (26%), Okra (13%), Tomato (23.2%), Brinjal (22.1%), Chilli (14.6%) and Capsicum (19.1%) [Data courtesy: Aquagri Processing Pvt Ltd.).



Subsequently, during 2011-2017, CSIR-CSMCRI further perfected the sap application protocol in varied agro-ecological situations on a Pan-India scale and validated the performance of *Kappaphycus* sap on agricultural crops through extensive optimization and multi-locational multi-crop demonstration trials undertaken in farm and farmer's field at more than 40 locations across 20 states of India in collaboration with State Agricultural Universities and ICAR Institutes.

Studies at molecular level indicated that the seaweed biostimulant is capable of ameliorating soil moisture stress and can reduce the diminution in crop yield under drought stress. It has also been shown to stimulate soil microbes which may play a vital role in mineral cycling of soil nutrients making them more available to plants. A recent study by ICAR-IISR, Lucknow has shown it to be effective in reducing the usage of chemical fertilizers by 25% in sugarcane.

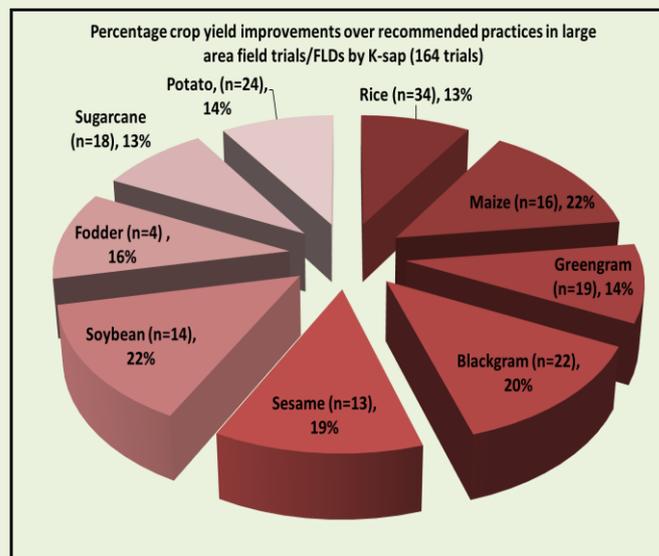
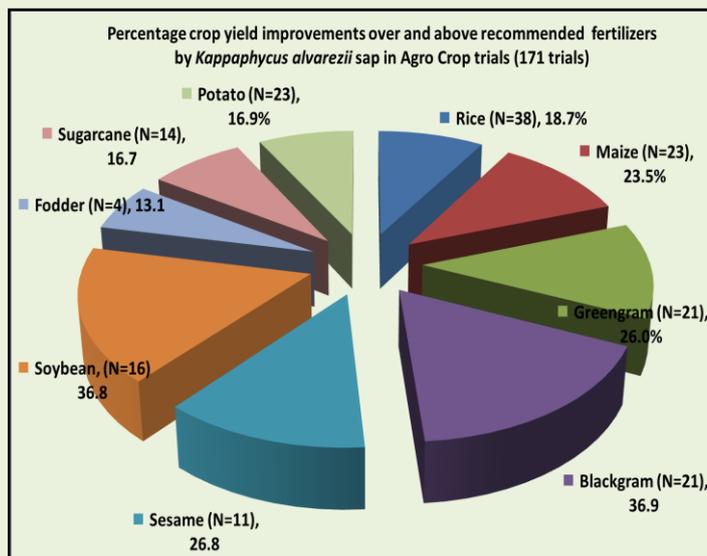
The sap, which is now commercially produced in large volumes, contains major and minor nutrients, besides phytohormones like indole-acetic acid, cytokinins and gibberellins. It also contains quaternary ammonium compounds like glycine betaine, choline chloride which confers the ability of the plants to withstand abiotic stress like drought. The sap was also found to enhance the maize crop yield in moisture stress condition even when it was applied only once during the grain filling stage, thus fitting into technology for climate resilient agriculture.

K-sap Constituents	Amount (mg L <sup>-1</sup> )
Na <sup>+</sup>	198
K <sup>+</sup>	33654
Ca <sup>2+</sup>	321
Mg <sup>2+</sup>	1112
Zn <sup>2+</sup>	4.7
Mn <sup>2+</sup>	2.1
Fe <sup>2+</sup>	86
Cr <sup>3+</sup>	32
Cu <sup>2+</sup>	0.65
Ni <sup>3+</sup>	3.5
P <sup>3+</sup>	17

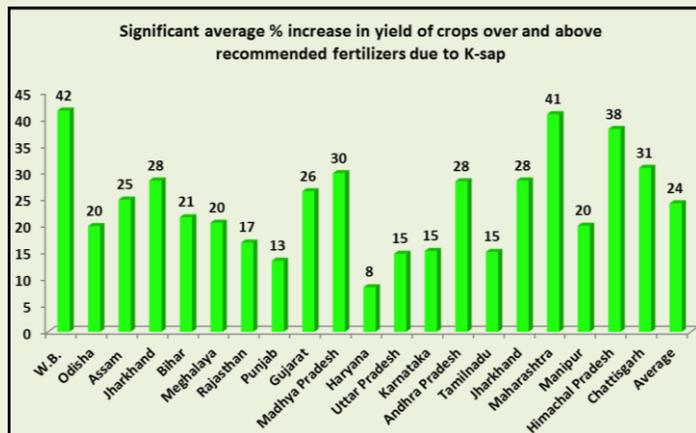
Constituents of Formulation of K sap	Chemical Structure	Concentration in mgL <sup>-1</sup>
IAA	<chem>CC(=O)Oc1ccc2c(c1)ncn2</chem>	21.11
GA3	<chem>CC1(O)C(O)C(O)C(O)C1O</chem>	25.72
Kinetin	<chem>Cc1ccc2ncnc2n1</chem>	9.21
Zeatin	<chem>Cc1nc2c(ncn2C)nc1</chem>	18.62
Choline	<chem>CN(C)CCO</chem>	60.71
Glycine betaine	<chem>CN(C)CC(=O)N</chem>	78.47

Key findings from the extensive Pan-India on-farm agro trials revealed that the average yield improvements over control by *Kappaphycus* sap for rice, maize, blackgram, greengram, soybean, sesame, potato, sugarcane and

fodder were 18.7, 23.5, 36.9, 26.0, 36.8, 26.8, 16.9, 16.7, and 13.1 %, respectively (See pie chart below based on 171 crop trials having statistically significant yield differences). In addition, 164 large area field trials/FLDs (1 acre area) were conducted, many of which were in farmer's fields and the results were found very encouraging (See pie chart below). In all cases, normal fertilizers were applied, i.e., the yield improvement was over and above the yield obtained with recommended doses of standard fertilizers. Carbohydrate content in grains was improved by application of seaweed sap in different crops.



CSIR-CSMCRI's extensive 335 trials carried out Pan-India affirmed that *Kappaphycus* biostimulant is an excellent means to improve the yield of several crops including pulses and oilseeds. The blackgram yields were increased by 20-37% in agro & demonstration trials, thus it can raise Pulse production in India. Results on floriculture and vegetable crops have also indicated a positive response. Based on the crop trial data, apparently, the states can reap yield increase by an average 24%.



**SAGARIKA**  
100% Natural Seaweed Extract  
Complete Plant Food

**Application:**  
• Spray in early morning hours after the dew has evaporated.  
• Suitable for all field and plantation crops.  
• First Spray - Plant establishment stage / Sowing stage  
• Second Spray - The Flowering stage  
• Third Spray - Post Flowering stage  
• Root dip (soak dip) at 3% solution.  
• Keep in a cool and dry place and out of reach of children.  
• Shake well before use.

**Recommended:**  
Dosage: 250ml/acre/ha  
Directions for Use: Shake the bottle well before use. Mix desired quantity of Sagarika in a small quantity of water and use with it. Add this mixture to quantity of water necessary for achieving full foliar coverage of the canopy.

**100% प्राकृतिक समृद्धि उत्पाद**  
समुद्री फसल खाद  
Complete Plant Food

The integrated technology has already been commercialized and one of our licensee viz., M/s Aquagri Processing Pvt. Ltd., which has set up processing plants for sap (15000 LPH capacity), has been marketing the product itself under the brand Aquasap and through many large fertiliser companies, both for Export and Domestic markets. Aquasap is approved for sale in South Africa, Nigeria, Zimbabwe and is OMRI listed and CDFA approved in USA. IFFCO which started by marketing the product in their brand name Sagarika has now taken 50% equity in Aquagri and are working on making this affordable product available to the Indian farmers on a pan India basis. The life cycle assessment of *Kappaphycus* sap production revealed a very favourable carbon foot print (118.6 kg CO<sub>2</sub> equivalent per kilo litre) rendering it as a potent green organic biostimulant. With its use, the soil microbes in moisture stress conditions was found to be maintained at par with that in normal irrigated condition.

CSIR National Award for S&T Innovations for the Rural Development (2012) was bestowed jointly to CSIR-CSMCRI, Bhavnagar and Aquagri Processing Pvt Ltd for the significant rural impact created by cultivation of red seaweed *Kappaphycus alvarezii* and co-production of bio-nutrients (sap) & carrageenan from fresh seaweed.

**For enquiries please contact** Dr. Amitava Das, Director, CSIR-CSMCRI, e-mail: [a.das@csmcri.res.in](mailto:a.das@csmcri.res.in) Web: [www.csmcni.org](http://www.csmcni.org)

