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Cold Plasma – An emerging Seed treatment technology



Good quality seed has a significant potential of increasing productivity and enhancing food security. Seed treatments play a substantial role in improving plant health by inducing early germination and preventing seed borne pathogens and pests. Both chemical and biological seed treatments and coatings have the potential to overcome deleterious effects of biotic and abiotic stresses. Seed treatments are most effective when they are objective oriented and crop specific to ensure enhanced yields under changing climatic conditions. Significant research and development is being done by the industry in the field of seed treatments, and much of this technology is proprietary. Many biological seeds treatments are also being developed and marketed for pest management and as bio stimulants.

Innovation in seed treatment technology is crucial to combat the problem of climate change, develop resistance toward certain agrochemicals, and to stay ahead of competitors. Hence, seed industry is focusing towards developing and introducing new products through collaborations and innovations in new seed treatment technologies. There are number of pre-sowing treatments that are employed to enhance seed quality such as seed priming, coating and biological seed treatments, etc. Nonthermal plasma (NTP) or cold plasma, is an emerging eco-friendly technology to enhance seed germination, seedling vigor and to control seed borne pathogens and could be an alternative to chemical treatments. The development of lowtemperature plasma seed treatment technology can stimulate seed vitality, improve seed quality, and effectively enhance crop resistance to stress and plant growth, and thus increase crop yield. The cold plasma can be applied in two different ways i) Direct treatment of seeds and ii) indirectly treating the seeds with plasma activated water (PAW) or plasma acid. Glow discharge method is the most commonly used for generating plasma for seed treatment to improve seed quality, seed enhancement and to decontaminate pathogens from the surface of seed coat. It is based on non-

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Recent Advancements & Challenges in Agri Inputs

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Industry Speak (Dr. Manish Patel, Executive Director, Incotec)

News

ionizing low-level radiation, that can activate the seed vitality without causing gene mutations and is quite different from space breeding or mutation breeding. Seed exposure to plasma also causes changes in the enzymatic activity and cause sterilization of seed surface.

The NTP seed treatment technology opens a new way for the application of plasma in crops. This is a quick, economic, and pollution-free method to improve seed performance, plant growth, and plant production. Seed coating thickness is a critical factor that can influence seed germination and the seedling vigor. Therefore, specific seed coating formulations have to be developed and evaluated for effective utilization in any plant species and agronomic purpose.





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The technology has been demonstrated in various crops like wheat, beans, corn, barley etc and can improve all aspects of germination and plant growth efficiency by ensuring that each treated seed is in the best possible physical condition prior to sowing.

Various companies are offering solutions by developing equipment's for treating agricultural grains and providing plasma seeds and related services for the cultivation of high quality, ecologically and genetically safe agricultural products. Literature and <u>patents</u> related to seed treatment <u>devices</u>, seed germination and seed growth using low/medium/atmospheric pressure discuss the role of non-thermal plasma (NTP) in stimulating germination and growth in plant seeds. NTP technology is becoming gradually popular in agriculture, particularly for seed treatment. Plasma chemistry can be altered by using different feeding gases and can lead to an increase in variation of seed coating technology compared to traditional methods. Studies have shown a positive effect on seed sterilization, presenting an elegant solution in reducing the amount of chemical pesticides, to reduce the burden on the environment

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and protect human health. NTP technology can enhance seed germination rate and plant growth and thus increase crop yields and can yield significant benefits to the farmers. This promising technology provides an option to seed companies for offering tailor made solutions for seed surface treatments to maintain high quality seeds and ensure their competitive position in agricultural markets. These technologies may be incorporated into IPM programs too allowing in reduction of seed borne pathogens while enhancing seed quality in a fast and cost effective way.

Challenges and Opportunities for seed companies

Advancements in seed technologies have increased the agricultural productivity and have also helped to tackle the major challenges through hybridization, trait integration, trait stacking and were complemented by the other agri-input technologies such as micronutrients, efficient water management, integrated pest management practices etc. However, the emerging global challenges like climate change, pest resistance, herbicide tolerance, higher costs to R&D, and supply chain disruptions have made the seed industry facing challenging future. In recent years, the pace of innovation among the agri-input companies in seed sector has slowed noticeably posing a critical challenge not only for companies but also for farmers as well. More innovative approaches are required to feed the world's increasing population and also to meet the challenges of reducing arable land, increasing demand for more sustainably grown food, and the threat of climate change.

For agribusiness companies to remain competitive they need to move out of

the traditional innovation models and focus on attention to customer needs, dynamic R&D programs, rapid digitization, increased internal and external collaboration, and an innovation culture across the organization. The prolonged COVID-19 pandemic has provided both challenges and opportunities for seed companies to place more emphasis on sustainable innovative approaches for long-term profitability. Some of key technologies agribusiness companies need to invest in, either in-house or through collaborations, are discussed hereunder. Each of these technologies have the potential, however, they have their own challenges that need to be overcome through innovations.

• Genome editing technologies, primarily CRISPR/Cas methods, have the potential to deliver real breakthroughs in creating new traits in a variety of crops. However, they will not reach their full market potential unless regulations don't bracket them with popular notion about genetic modification (GM)



technologies that they have foreign genetic material in crops. For example, EU has already classified genome-edited crops as GMOs, and there is a risk that other regions might follow the EU's lead.

• *RNA interference* allows the suppression of specific genes in the target organism and provides the opportunity to overcome the challenges of weed and pest resistance and advance pest management. Despite the technology being available for some time now, no product using this technology has been truly successful in the market yet. This



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has put a dampener in use of this technology, but the technology has potential and need to be explored further and develop seeds with inherent capabilities of weed and pest tolerance or other traits like increasing shelf life, transportability, taste etc.

- Microbiome technologies such as the use of natural organisms like bacteria, yeasts, and fungi to strengthen plant and root systems, offer great promise. However, their use cases and successes are limited by nascent understanding of complex interaction of microbes in natural environment. It is expected that advancements in computing technology specifically the simulation of living systems might help generate further advances in this area and will make these technologies a commercially viable options both for companies as well as end consumers.
- There are a number of **technologies** beyond agriculture that have the potential to complement novel seeds for boosting productivity such as advances in automation, precision (sensors, UAVs, and spraying machines, new weeding and harvesting robots etc.), reducing the use of fertilizers, pesticides and optimizing the use of natural and human resources. Big Data Analytics can help gain new insights providing farmers precise information about soil, crop, and atmospheric conditions coupled with customized recommendations on correct planting, harvesting time and optimal use of inputs.

The challenges can be mitigated by adopting the following measures by private seed companies.

• Focus on Customer Problems: The seed companies need to be move away from a product-centric

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approach to product and services that can be tailored to customer's needs. The development of these solutions is more important now as the expectation of customers have been shifting towards growing there food more sustainably, using less of inputs for higher productivity. Therefore, the companies need develop products, services, and methods supporting sustainable farming, including seeds tolerant to biotic and abiotic stresses that can adopt to changing environmental conditions and new digitalfarming solutions further reducing the use of inputs.

- Focus on Highest-Value Opportunities: The seed companies need to prioritize their R&D efforts and allocate the resources to focus on highest-value opportunities. R&D resources should be oriented towards meeting the biggest challenges faced by growers.
- Increased collaboration: The seed companies cannot rely only on in-house R&D for the most promising innovations, especially in the areas outside their traditional purview. Instead, they need to enrich their innovation

pipelines by collaborating with digital startups and other specialized companies in biotech and AgriTech space on the lines of pharmaceutical industry. This will not only help in sharing the costs, and risks of innovation allowing them to leverage the expertise and innovation capabilities that they lack. These collaborative models can be codevelopment partnerships with equals, deals to help smaller companies fund their research in specific fields, and collaborations with universities, government institutions, and NGOs.

• Embrace Digital Opportunities: Digitization is the now the reality for the agriculture industry. If the seed companies need to meet the changing demands of farmers, regulators, and consumers, they need to focus on developing cross-functional capabilities in data, analytics, and digital technologies.

Major seed companies are facing challenging times ahead, with significant R&D challenges, increasingly restrictive regulatory environment, and an onslaught of competition from outside the traditional agriculture space. In this increasingly competitive business environment, winners will prevail on the basis of their ability to innovate and adopt quickly to changing digital space across their operations.

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Controlled release fertilizer driven sustainable agriculture systems

Fertilizers releasing nutrients in a controlled manner to improve nutrient uptake by a crop are called controlled release fertilizers (CRFs). CRFs are promising solutions for improving the nutrient supply, enhancing crop quality, and yield, and reducing application costs, plant toxicity and environment pollution. Conventional methods of releasing fertilizers not only lead to ~50% fertilizer wastage through seepage to the soil and water but also increases labour costs. CRFs is easier to use and it considerably delays or extends its availability for use after application and uptake by plants. CRFs have the potential to address two key aspects of plant nutrient supply by matching nutrient supply as per plant requirements and ensuring nutrient availability. The CRF products today can considerably shrink total fertilizer use (primarily nitrogen) by 20 -50%, leaching by \sim 55%, denitrification and volatilization by up to $\sim 40\%$ each. Majority of the CRF products are related to nitrogen fertilizers, to prevent atmospheric loss of N and resulting environmental emissions. Single application of CRF before sowing can satisfy crop nutrient requirements throughout the season. In addition to cost savings on application and labour, CRF application systems are independent of irrigation systems and need of sophisticated equipment for application.

CRFs are granular fertilizers, coated with materials that controls water penetration and enables gradual availability of nutrients to plants. The release process includes water diffusion, nutrient dissolution, and nutrient release. The factors affecting the efficient release process of the nutrients depends on the *thickness of the coating, shape, and size of the fertilizer, soil, and air temperature*. Fully coated CRF are the most efficient ones in enhancing nitrogen use efficiency (NUE), reducing nutrient losses and environmental pollution.

Technological advancements in the coating materials over the last decade has improved the efficiency of the release process and created more economical products. Primarily bioinhibitors, sulphur and biocomposite based coatings have been used for efficient controlled release systems. Innovations are being made in the nutrient release pattern depending on the changing requirement of crops. Developments through polymer-based coatings/ formulations for CRF is a green solution that enable to predict average release rate under ambient temperature and moisture condition. These not only help to alter nitrogen release dynamics but also reduce nitrogen losses caused by volatilization and leaching. Recent trends in the development of CRF include a combination of more than a single method (e.g.: sulphur + polymer). However, the key limitations for CRF's include lack of flexibility, locked in rate and storage limitations.

Recent advancements in CRF products coated with nanomaterials have proven that these have potential to further boost NUE (as compared to other regular coatings) by improving solubility and dispersion of insoluble nutrients into soil and release nutrients as per plant requirements. The use of nanoparticles in CRF products can further enhance absorption of photosynthetically active radiation, reduce soil absorption and fixation, lower wastage of nutrients and thus increase bioavailability. Researchers and industry players are still working on standardizing formulations of nanomaterials and evaluating efficiency



through large scale field and greenhouse evaluations before the industry adopts such products widely. However, the prospect of nano material based CRFs for sustainable cropping and its adequate adoption would depend on effective regulations, novel formulations, and associated risk management (nano toxicity).

With the growing demand of shifting to sustainable agricultural practices, the CRF market is increasing rapidly and is expected to grow at a CAGR of 6.37% globally and reach USD 3.86 billion in 2026 from USD 2.3 billion in 2017. The increased occurrence of nutrient deficient crop diseases is further expected to boost the demand for CRF's. The increasing investment in research activities and technological advancements through development of affordable and/or low-cost polymer coating for manufacturing encapsulated or coated CRFs is further driving the growth in the industry. The industry has a fragmented landscape of players with large number of companies operating in the developing economies. Nutrien, Yara International, Eurochem Agro Gmbh, Haifa Group, Kingenta International and HIF Tech Marketing Sdn Bhd., among others are the key players in



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CRF market. Regionally dominant players like SQM, ICL and Pursell are driving innovation standards by development of cost-effective solutions. The industry lately has been witnessing several strategic partnerships between key players such as Kingenta, Haifa Chemicals and Agrium engaged in M&A activities to expand their portfolio. Kingenta acquired 2 speciality fertilizer companies like Ekompany and COMPO GmbH for increased research activities on efficiency enhanced fertilizer. Turf, ornamental, and plantation crops is the leading application segment for CRFs globally.

The key challenges related to wide scale adoption of CRFs is the price gap between CRF and conventional fertilizer products. This has hindered extensive usage of CRF in horticultural and agricultural crops. Large scale production constraints, non-availability in local markets and farmer's limited understanding about CRFs have further hindered popularization of the segment. Sometimes slower release of nutrients to meet requirements, poor performance owing to improper soil and temperature conditions and presence of harmful chemical in coating material have further stalled wider adoption of these products.

CRFs are yet to make any considerable footprint in Indian fertilizer markets. Even though CRFs are available in the form of coated and encapsulated products, condensation products of aldehydes and urea, slow-release products and N-stabilizers, no major players are dealing with them for use in regular cropping systems of local markets. Local suppliers import CRFs from global giants and market locally primarily for use in ornamental, fruits, and plantation crops. Increasing demand of high efficiency fertilizers suitable for meeting the nutrient requirements and enhancing nutrient uptake are expected to be the

key growth drivers for the market. Several studies have indicated that NUE with CRFs in rice fields to be 50 - 100% higher than conventional urea (fertilizer savings of up to 30%) and similar results for vegetable crops.

Leading players are now aiming at building strong supply base and strategic partnerships in large agricultural economies like India, China and Malaysia to boost sales of CRF products. The adoption of CRF products in developing countries have been limited due to lack of major players promoting the product, higher prices, lack of efficient regulatory guidelines for CRF and associated subsidies. However, the growth of CRF products in developing economies is expected to be driven by encouraging government support for boosting adoption of variety of fertilizers to enhance production and ensure food and environmental safety.



Seed Enhancement

Seed enhancement is a range of treatments of seeds that improves their performance after harvesting and conditioned, but before they are sown.

What We Do

Incotec is a seed enhancement specialist. We have been specialising in seed treatment since 1968. The aim is to improve seed quality. We select, protect and improve. We work with seed for field crops and vegetables. Getting the utmost out of seed is what makes us proud. The seed enhancement work we do, contributes significantly to the development of sustainable agriculture. Our solutions support the huge efforts of seed companies, breeders, growers and farmers. Our headquarters are in Enkhuizen in the Netherlands and we have research and production facilities all around the world.

Innovative Technologies

Incotec has various innovative technologies that improve the resilience and performance of seeds. These range from cleaning, upgrading and priming



Dr. Manish Patel Executive Director Incotec

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(pre-germination) to pelleting, film coating and encrusting. We have a great deal of knowledge not only in the field of biology and physiology (the seed), but in technique and formulations too. That is what makes us the experts in combining the living seed with different coatings and other products such as plant protection products and nutrients.

About Technologies

Incotec's Seed Technology Range

In India, we have a huge range of

products and technologies - each designed to meet your specific needs. From facilities in India Incotec serves local solutions that help growers get the best out of their crop. How? With bespoke solutions designed to overcome specific challenges and that are following 7 Technology.



7 INCOTEC technologies

- **Upgrading**: Removing seeds of lower quality raises the overall quality of the seed lot using different technology platforms of seed separations.
- **Priming**: Under controlled conditions germination is triggered and then brought to a standstill at just the right stage. It is known as pregerminated seed technology as well where Seeds after priming are capable to grow in any given unfavorable climatic condition at almost double speed of emergence and doubled Vigor to grow.
- Seed Hygiene: Treatments that reduce or eliminate micro-organisms (e.g. fungi, bacteria) in/on the seed to

give birth to healthy seedlings and least mortality.

- Film Coating: Application of a very thin layer of polymer, possibly mixed with an active or additive, with virtually no change in size or weight in order to add real value on each and every seed.
- Encrusting and Pelleting: Adapting the shape of seeds by putting a layer of coating material on it. More uniform shape and size of the seeds to facilitate precision sowing and to increase seed space to add more actives ingredients per seed.
- Actives and Additives: Application of actives and additives integrated in the seed coating. Incotec is expert in

applied seed technology to deliver any given molecules / biological etc in precise way to each and every seed without affecting basic seed quality and in most efficient manner.

• Analytical and R&D services: NABL Accredited Seed Testing Service Provider and Provide R&D Services to support customers Seed technological need.

Summary

With an ever-growing population and the yield per seed and per square meter becoming increasingly important, Incotec's products offer the basis for the most efficient and effective way of growing seeds with added value in most sustainable way.



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Ion Beam breeding technology helps to alleviate varieties of glutinous rice

Ion beam technology promotes molecular breeding by application of ion beam mutagenesis in crops. This technology has been successful applied for the breeding of improved varieties of glutinous rice having early maturity, strong resistance, and high nitrogen fertilizer utilization efficiency. This new technology is now being applied to other crops and varieties including rice, wheat and corn.

6 desi and 4 kabuli varieties of Chickpea released in 2020

In collaboration with National Agricultural Research Systems in Africa and Asia, ICRISAT has released 10 new chickpea varieties which have contributed to 73% of the global chickpea production. Machine harvestable chickpea released in India were larger in size and could be quickly harvested saving the crops from unseasonal rains.

Read more

Read more

Precision agriculture introduced to farmers for sowing to increase farming efficiency

Under the guidance of Institute of Agricultural Sciences, Banaras Hindu University, farmers from Khutahan village were introduced to usage of drones for sowing. This will enable the farmers to sow in the wet areas where tilling by tractors is difficult. The time for sowing reduced and the precision in sowing increased, increasing the overall efficiency.

Read more

Ban on onion export lifted

Trade ban on onions excised in September this year will be now lifted from January 1st as announced by Directorate General of Foreign Trade. In September, due to spurt in its prices and in anticipation of supply crunch the Government had halted trade exercise.

Read more

Telangana government may stop the practice of regulated cropping system

Telangana government seems to have decided to stop the practice of issuing guidelines on what crops should the farmers grow. The Government's decision to enforce a regulated cropping system had come in for sharp criticism from the farmers' unions as such regulations would lead to monocropping and reduce the area of some minor crops.

Read more

Mosaic, BioConsortia collaborate to develop nitrogen-fixing microbial products

Mosaic, a fertiliser company, and BioConsortia have collaborated for the development of nitrogen-fixing microbial products for corn, wheat and other major non-legume row crops. The collaboration aims to develop beneficial microbial products designed to reduce the amount of conventional nitrogen fertilizer application, while increasing crop yields and grower revenue.

Read more

ICAR receives prestigious 'International King Bhumibol World Soil Day Award"

Indian Council of Agricultural Research (ICAR) has received the esteemed global award from the United Nation's Food and Agriculture Organization (FAO) for raising awareness about importance of soil health among all stakeholders on the occasion of World Soil Day, celebrated on December 5.

Read more

NCDC and Nabard to help form 8000 FPOs across India

FPOs will be formed and promoted through Cluster Based Business Organizations (CBBOs) engaged at the State/Cluster level by implementing agencies. Adequate training and handholding will be provided to FPOs by the NCDC. Through formation of FPOs, farmers will have better access to quality input, technology, credit and better marketing access.

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Sathguru Services

Our sectoral expertise and multi-disciplinary team aids in holistic assessment of the target company in supporting your investment decision



Agritech opportunities in India can broadly be segmented – Biotech companies, Precision Agriculture, Agribusiness companies, Market Linkages, Farming-As-A-Service, Big Data & ERP solutions etc

Case Studies



Strategic Blueprint & Detailed Project Report for the Bio 360 Life Sciences Park



Process design and optimization helps a logistics infrastructure company to kick-start operations in trading of high-value perishables commodities



India market entry strategy, customized product portfolio & operational roadmap for a global food company India market entry strategy, customized product portfolio & operational

Reach us at agribusiness@sathguru.com or vijayp@sathguru.com

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