Use of Biopolymers in Plant Health Management of Oilseed Crops

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Oilseeds, the raw material for vegetable oil, occupy a significant place in India's economy. Next to food grains, oilseeds account for 10 per cent of the cultivated area and value of all agricultural produce. Nearly 85 per cent of the oil and fat needs of the country is primarily met by vegetable oils. India is the third largest producer of oilseeds in the world. No other country has its range of perennial and annual oilseeds. In terms of area, India ranks first in groundnut, sesame, linseed, safflower, niger and castor. Although India has 20.8 per cent of the world's area under oilseeds, it accounts for less than 10 per cent of world's production. In terms of vegetable oils, India is the fourth largest oil economy in the world after the U.S, China and Brazil. Favourable agro-ecological conditions in the country have supported commercial cultivation of seven annual edible and two non-edible oilseed crops, besides a number of minor oilseeds of horticultural and forest origin, including in particular coconut and oil palm. With the growing population along with raising per capita income, the demand for vegetable oil is likely to grow unabated in the coming years. The impact of green revolution has made our country self-sufficient in the production of cereals. The situation so far as oilseeds are concerned is not very bright. Although India is one of the world's largest producer of oil seeds, the quantity of edible fat available falls far short of the country's requirement.

The increasing demand for oilseeds requires modern techniques for production, minimizing losses in the crops, transportation and storage. Among the main causes of losses there are biotic and abiotic stresses. Crop protection agent plays as an important control tool for maintaining quality of seed by plant health management. However, some collateral effects may be credited to their indiscriminate use such as environmental contamination, human poisoning, reduction in the number of natural enemies, insecticide resistance by insects, etc. In this scenario, polymers have been reaching a prominent position (Hubbard et al., 1983).

Highlighting present research trends like its impact on food safety and security and what the future holds, within the sciences the study of polymers has helped to foster the emergence of agricultural polymers. A polymer (Greek poly-, "many" + -mer, "parts") is a large molecule, or macromolecule composed of many repeated subunits.Polymers are used for various technical purposes, depending on their diversifying properties. A wide range of functional differences and behaviours has made them useful in a large variety of applications. The endless numbers of options for creating or modify polymers have made these materials attractive to researchers. Their successful utilizations are quite broad including a variety of fields, such as agriculture, pharmaceutical, medical, technological, drug delivery, aerospace etc.

Because of their broad range of properties, both synthetic and natural polymers play an essential and ubiquitous role in everyday life.Among synthetics a well-known examples areplastics, polystyrene, polyethylene and petroleum products.Moreover, the high price of petroleum-based polymers, their non-biodegradable nature, the significant amount of greenhouse gas emission and huge heat consumption during their processing, the scarcity of the raw materials, environmental legislations, and so on are also responsible for the search for biobased alternatives.

The history of biopolymer is not a long one. They are beginning to emerge as a result of needing to be more responsible in taking care of the world we live in. Various reasons are associated with the research and development of biopolymers. Natural biopolymers such as DNA and proteins are fundamental to biological structure and function. Biopolymers are chain-like molecules made up of repeating chemical blocks and can be very long in length. The prefix bio means that they are produced by living organisms and thus are biodegradable. The following substances are example-biopolymers for each group: cellulose (found in plants), myoglobin (muscle tissues), and DNA (genetic material of a given organism).

Polymers, both natural and synthetic, are created via polymerization of many small molecules, known as monomers which produces unique physical properties, including toughness, viscoelasticity, and a tendency to form glasses and semi crystalline structures rather than crystals.During the last few years, the science and technology by tailoring biopolymers have received considerable interest for the production of improved materials. They have found widespread applications and potential advantages due to characteristic properties of the molecules in biopolymer synthesis (Rudzinski et al., 2002).

Applications of biopolymers in oilseed crops

1) Controlled release formulations: Formulations liquid and solid commercially available are requires use of emulsifiers, hazardous solvents, drifting problems without any release pattern of pesticides. Due to this threating problem to environment for excess release of pesticides from carriers and their runoff to ground water table, evaporation losses of hazardous chemicals controlled release formulations (CRF) approach is of tremendous interest among the formulation chemists because of scope of manipulation of carrier properties to achieve zero order release kinetics.Polymeric materials have been popularly used as carriers for sustained release. Biopolymeric microspheres of sodium alginate and starch using $CaCl_2$ as a cross linker are used as carriers for the controlled release of the pesticides, nutrients and microbes (De Lucca et al.,1990).

Ex: CRF mostly useful for soil borne pathogen-pests and nematode management. To avoid nutrient losses, fertilizers can be supplied at required intervals and quantities. Pheromone traps can be combined with CRF leads to profitable.

2) Polymeric films: The leaf surface provides the first barrier that pathogen must overcome in order to gain access to the leaf, but it also provides chemical and physical cues required for the development of pathogen infection structures. Coating the leaf surface, for example by using film-forming polymers, can provide a physical barrier to penetration, and can also disguise the cues necessary for pathogen development on leaf surfaces. Leaf surface coatings have been shown to provide disease control under field

conditions, proving that the concept works in practice. Such materials must provide high levels of disease control with minimal environmental impact. If this can be achieved, they offer the prospect of disease control based on the use of a renewable resource. Polymers demonstrated significant disease control, and suggested that the polymer formed a physical barrier on the leaf surface, thereby disguising leaf surface characteristics, and it also induces resistance (Marin et al., 2016).

Ex: These kinds of materials will be used for foliar and aerial pathogens of oilseed crops i.e., damping off of sunflower, alternaria etc. Against insects like capsule borers, leaf eating caterpillars etc. Pesticides which needs applied aerially can be applied by this technique so that wash-out can be avoided.

3) Soil mulch: Plastic mulch films are widely used in agriculture to enhance crop production by suppressing weeds, conserving soil water and increasing soil temperature. The majority of plastic mulch films are however not biodegradable and are typically removed after each growing season. Recovery of these plastics from the soil is difficult and can affect successive crop yields while causing substantive cost to the environment and farmers. Due to increasingly stringent regulations regarding use of non-degradable plastic in agriculture they are likely to be phased out in the near future. In the past 10 years several classes of 'biodegradable' materials have been studied but most of these films are reported to be relatively weak in mechanical properties, not efficiently degradable and cost prohibitive. More recently, researchers have turned their attention to sprayable biodegradable polymer coatings for use on soils due to their easy application and versatility. The ability to mix natural additives, plasticizers and fillers to control and improve the mechanical and biodegradation properties of the core polymeric mulch film has been the driving force behind the development of these next generation sprayable polymeric mulch films (Sartore et al., 2013).

Ex: In some oilseed crops like groundnut mulching is very much essential for initiation of heat generation and other purposes. There these kind of sprayable polymer mulches are of need.

4) Seed coats: Seed being the basic input, production and supply of quality seeds to the farmers will go a long way to achieve the goal of self-sufficiency in oilseed crops.Seed quality comprises several physical, chemical and biological components. Seed being a biological or living entity,deterioration in its quality with time and biotic stresses are inevitable. Among them seed diseases and shelf life during storage contribute significantly to reduced seed germination and stand establishment resulting in an uneven crop density, increased weed density and reduced crop yield. The most common seed treatments with purely crop protection agents alleviate stresses by reducing the damage. Loss of these materials from the seed treatment is called dust-off and results in reduced crop performance and environmental contamination. Seed treatment techniques that contribute to pesticide dust-off are detrimental to non-target organisms including humans, wildlife and beneficial insects and neighbouring crops. Maximum germination and seedling establishment of seed treated with pesticides, growth regulators, biologicals or micro-nutrients relies on firm attachment of these products to the seed coat during packaging, handling, and planting.

Seed coating is the most applicable technique provides an opportunity to package effective quantities of materials such that they can influence micro environment of each seed. Seed coating with polymers is one such technique that can be used either singly or in combination with other pesticides as formulation to protect seeds against abiotic and abiotic stresses. The possibilities of using polymers along with other chemicals to ensure the keeping quality of seeds are reported (Schneider and Renault, 1997).

Ex: Soybean, sunflower against abiotic stresses during storage and castor, groundnut against biotic stresses requires seed coating (Chachalis and Smith, 2001).

5) Seed Pellets: Pelleting is the process of coating seeds with inert materials to make them uniform in size and shape. Whether direct seeded in the field or sown in flats for transplants, pelleted seed allows for greater accuracy and results in a more efficient seeding process. Because of its uniform size and shape, pelleted seed is less likely to become jammed or stuck in mechanical planters, allowing growers to accurately singulate and efficiently plant direct-seeded crops. Accurate seeding and seed spacing makes thinning stands easier or even unnecessary, leading to less seed waste and lower labor costs. Usage of inert materials may lead to dusting off and for binding binders/ stickers are needed which are of synthetic ones. So, here biodegradable polymers come into role which uses for binding inert materials and also less usage of it.

Ex: to provide site specific sowing incase of sesame and mustard pelleting is required.

6) Water use efficiency in dry land crops:One of the scientific approaches in the present context is the use of a special class of polymers referred to as superabsorbent polymers (SAPs), a specific category of hydrogels (Chandrika et al., 2014 and 2016).

Ex: All oilseeds are dry land crops WUE is very important aspect. To address this issue hydrophilic polymers for soil application and anti-transpirants for partial stomata closure to avoid water loss.

7) Soil conditioners: Soil amendments play an important role in the management of runoff and leaching losses of pesticides from agricultural fields due to their ability to alter the physicochemical properties of soils, which in turn influence their sorption behaviour towards soil applied pesticides. In modern agriculture, in order to enhance the per unit productivity of available water through overall improvement in the soil properties, polymers are increasingly being viewed as potential soil amendments to condition soil and to prevent soil erosion. Suitably designed polymers possess specific properties. Owing to their matrix properties these materials trap nutrients and are reported to exhibit significant saving of water and nutrients, improving crop yield, plant health and produce quality (Chandrika et al., 2014 and 2016).

Ex: To avoid losses of nutrients, fertilizers etc in all oilseed crops.

Conclusion:

In general, polymeric materials which are biocompatible and biodegradable should be prepared. This practice has the aim to avoid the emergence of new environmental and toxicological problems. The biopolymers are produced by microorganisms, synthesis or even petroleum derivate products. In common, when exposed to the environment they are easily destroyed by UV radiation and/or microorganism enzymes generating CO_2 and H_2O as final product. Processes such as swelling, hydrolysis, diffusion, erosion, etc., must be manipulated in a controlled way in order to obtain the desired characteristics of

application and biological activity for the formulated products. Based on applications involved with biopolymers a lot of scope for research required in oilseeds following by awareness to stakeholders for utilizing as and where required.

Future scope in oilseed crops:

- These materials can be explored as potential materials in biotic and abiotic stresses like anti-transpirants, for post-harvest losses, soil mulch, seed coats, barriers for different diseases and insects-pests, CRF.
- Materials used in preparation of polymers can be further explored from existing mandate crops as value added products
- There is better potential in exploring these polymers in controlled release formulations for pesticides as well as biocontrol agents

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