

Kaolin- A potential Particle Film in Stress Management of Fruit Crops

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SUMMARY

Fruits are nature's marvelous gift to human kind. These are life enhancing medicines packed with vitamins, minerals, anti-oxidants and phytonutrients. With increasing awareness on these benefits, there is tremendous demand for fruits in market. But as consumers, we tend to look for fruits that are having good shape, look brighter in colour and flavor, free from blemishes and spots and preferably organic. In the present scenario of global climate change, the combined effect of drought, heat, salinity and higher incidence of solar radiation are getting intensified. This climate change has an adverse effect on plant growth and development at different scales causing biotic and abiotic stress (Brito et al., 2019). In this context, several innovative technologies have been developed by agricultural scientists, one among them is Kaolin based particle film technology.

INTRODUCTION

Kaolin is a naturally occurring inorganic clay mineral, which is a white, non-porous, non-swelling, low abrasive and fine grained alumino silicate mineral. The name kaolin is derived from the Chinese term "Kauling" meaning high ridge, it is named after a hill in China where this material was mined centuries ago for preparation of ceramics. It is also referred to as China clay or hydrous kaolin. It is a secondary mineral extracted from the primary mineral called kaolinite after sedimentation.

- Chemically kaolin is a Hydrous aluminium silicate ($\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4$), it consists of alumina octahedral sheets and silica tetrahedral sheets stacked alternatively.
- It has a platy structure, and pseudo-hexagonal shape which helps in excellent coverage and uniform retention of the formulation on the crop plant. (Prasad *et al.*, 1991).

Composition: Alumina - 39.8 %

Silica - 46.3 %

Water - 13.9 %

Processing Of Kaolin (Prasad *et al.*, 1991)

Crude ore blending

○ In the first step the crude ore which is collected from different sources are mixed and are allowed to dry for some time, so that it can be pulverized well.

Crude ore crushing

○ After blending the crude clay is allowed to enter the storage shed, where it is shredded or crushed to relatively small pieces.

Crude ore drying

○ After crushing the crude at this stage contains 20 – 25 per cent moisture which is removed in rotary drier.

Pulverization

○ The kaolin is pulverized in a roller mill and is fed into the grinding section of the mill, here the plows lift the clay into the area where the rollers grind it against the grinding ring.

Air flotation

○ The finely ground product is lifted through the top of the machine to the outlet duct. In the outlet duct the particles travel up through whizzer which separates particles by size.

○ The light weight particles travel up through the whizzer and are collected separately. The course particles which lack the speed to escape the whizzer are rejected through the ports on the side of the mill. This product is subjected to further grinding to recover the additional amounts of previously unliberated clay.

Shipping

- After the complete processing is over shipping is done.

Ideal characters of a kaolin particle film

- Chemically inert over a wider range of pH.
- Diameter should be below 2 μm , because finer the particle size more will be the quality.
- Transmit photosynthetically active radiation (PAR) but exclude harmful radiation such as Infrared and ultra-violet radiation.
- Easily removable from the harvested produce by washing.
- Hydrophilic and disperses easily in water.
- Relatively low in cost, and it costs about 15 to 20 rupees per kg, which can be easily affordable for the farmers.
- Should not interfere with the gas exchange from the leaf by blocking the stomata.
- Alter insect or pathogen behaviour by reducing its oviposition as well as multiplication by forming a physical barrier on the surface.

Mechanism of kaolin action on plant performance

When kaolin is applied on the surface of the plants it acts as a protective film. It increases the reflection of excessive harmful infrared and ultra-violet radiations and increases redistribution and scattering of photosynthetically active radiation (PAR) within the crop canopy. Thus, by reducing the incidence of infrared and UV radiation it reduces the heat load accumulation in the crop canopy, which in turn reduces the plant oxidation stress as well as transpiration rate by improving the vapour pressure gradient between leaf and bulk air, and thus improved water use efficiency and plant water status. The improved plant water status will help in mitigating summer stress and reduces energy investment in leaf sclerophyll, respiration and secondary metabolism. With all these reduction in secondary metabolism and carbon consumption and increased plant photosynthetic capacity it will have a positive impact on increasing growth, yield and harvest quality of the produce. (Brito *et al.*, 2019).

Uses of kaolin

Kaolin is an extremely useful natural clay mineral, mainly because of its properties like white colour, softness, small particle size and chemical inertness, which make it suitable for several industrial application. (Prasad *et al.*, 1991).

Industrial application

• Paper

Paper industry is the largest single user of kaolin, as it uses about 40 per cent of the total kaolin production. It is mainly used for paper filling and paper coating.

• Ceramics

It is the second highest user of kaolin. Kaolin clay is an essential raw material for ceramics preparation because of its good moulding properties and smooth finish.

Agriculture

• Water use efficiency

Especially, in hot and arid regions where water stress is a major problem, Particle film technology appears as a valid tool to increase sustainability and limit irrigation use.

It will reduce the transpiration rate by improving the vapour pressure gradient between the leaf and the bulk air, also reduces leaf temperature and improve water use efficiency (Sharma *et al.*, 2015).

• Pest control

In agriculture kaolin was mainly used for controlling the pest, mainly because of its property of host camouflaging, which makes the plants unrecognizable by pests. It acts as a barrier by restricting the movement and also reduces oviposition and feeding. Kaolin particle acts as irritant and repellent for the insects and thus, reduces the insect population in microclimate of plant (Sharma *et al.*, 2015). It also acts as an environment friendly

alternative to the conventional broad-spectrum insecticide especially organophosphates and carbamates and thus, fits the goal of integrated pest management.

• Disease control

Kaolin particle film will envelope the leaf & fruit surface and acts as a physical barrier to prevent disease by separating the inoculum from the plant surface. Fungal & bacterial plant pathogens require liquid film for germination of its propagule. Kaolin Prevents adhesion of fungal spores and thus, reduces infection. Kaolin based particle film is effective in controlling the fabrea leaf spot of pear and also scab and powdery mildew disease in case of apple when sprayed in combination with lime and wettable sulphur. (Sharma *et al.*, 2015).

• Fruit quality

Consumers usually prefer fruit of good attractive shape and colour. But many fruits lack marketable value due its poor external appearance caused by sunburn, cracking, and many disorders. Kaolin film reduces the incidence of UV and infrared rays and causes redistribution and scattering of photosynthetically active radiation which lead to improved colour development. It causes improved red colour and blush development in Apple, improved fruit weight and oil content in walnut.

• Sunburn

Sunlight up to certain level is beneficiary but beyond optimum it will lead to many physiological disorder and sunburn is one among them.

Sunburn is the interaction of high solar radiation and temperature. Solar injury, mainly on fruit surfaces, reduces the commercial value of plant products and also makes them vulnerable to decay due to secondary infection by microorganisms. 20 - 40 per cent yield loss due to sunburn every year.

Applications of Kaolin in Fruit crops

Pomegranate

Pre-harvest sprays of Surround WP® reduced the sunburn and fruit cracking in 'Kandhari' pomegranate by 47 per cent and 46 per cent, respectively, and the incidence of both fruit borer and bacterial blight by 50.3 per cent and 40.2 per cent, respectively (Sharma *et al.*, 2018).

Grapes

Foliar application of kaolin reduced the sunburn in Thompson Seedless grapevine. The sunburn on the berries and leaves was lower (0.2 % and 0 % respectively) reported by Hosseinabad and Khadivi (2019).

Balady mandarin

Spraying of kaolin at 3 per cent and 4 per cent three times in summer months had positive effect on preventing sunburn damage (6.2 %) and improving yield (59.9 Kg) and fruit quality (Ennab *et al.*, 2017).

Demerits

- Inhaling kaolin on long term may cause lung diseases.
- Prolonged application is harmful for some beneficiary insects.

CONCLUSION

The particle film technology is a boon to the farmers/growers who wish to transform from conventional agricultural techniques to organic cultivation practices and/or integrated management practices. Kaolin particle film is a multi-functional and environment-friendly material, which has proved effective to mitigate biotic and abiotic stresses and contributes to the production of high-quality fruits. It also reduces the use of conventional chemical pesticides and ensures a safer food supply for the consumers.

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