Molten Shellac Resin Mix with Soil Could Be Useful in Crop Protection Modelled with Chickpea

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Abstract
Rural Society produce has great economic viability that needs to be explored to help improve their income. Plant and insect resins that form a major produce from rural background in India could be explored for further use that can increase their value. In this article we demonstrate the insect resin lac could be used in crop protection since addition of it to soil followed by water retention and plant injury protected Chick pea seedlings as compared to control. In this article we show it for the first time that molten hot shellac (1:25parts) mixed with organic manure used for seed germination conferred protection to seedlings against water logging and water deficit related decay, recovery from physical injury. The basis of protection could be lac altering the dielectric nature of soil, it altering the soil texture or directly inhibiting fungal mycelium responsible for root rot. In water logged condition or drought, root rot fungi could play a major role in destruction of crop. To observe the protection conferred by lac resin, non-pathogenic agaricus fungi was modelled for observing mycelial spread over tin metal plate.

Keywords: Lac, Soil, Agriculture, root rot, crop-protection

Introduction

Some major issues in a developing country include improving the income of rural people by finding value to their produce and other is protection against crop failure. This article addresses the use of a rural produce – lac resin for protection against crop failure. The plant modelled here is Chick pea which is of economic importance and our article shows that addition of lac resin to soil helped in survival of the seedling subjected to water logging stress, physical injury stress, drought stress. In another experiment we have shown that lac resin coated material inhibited the mycelial spread of *Agaricus.*

Lac resin is obtained from the insect *Kerria lacca* Kerr and the host plants are not economically important (1) like that of *Butea monosperma* (Vern. Palas), *Zizyphus spp* (vern. Ber), *Schleichera oleosa* (Vern. Kusum), *Acacia catechu* (Vern. Khair), *Acacia arabica* (Vern. Babul), *Acacia auriculiformis* (Vern. Akashmani), *Zizyphus xylopyrus* (Vern. Khatber- grown in part of M.P. & U.P.), *Shorea talura* (Vern. Sal grown in mysore), *Cajanus cajan* (Vern. Pigeon-pea or Arhar), *Grewia teliaefolia* (Vern. Dhaman preferred in Assam), *Albizzia lebbek* (Vern. Siris/Gulwang), *Flemingia macrophylla* (Vern. Bholia), *Ficus benghalensis* (Vern. Bargad), *Ficus religiosa* (Vern. Peepal).

The small-scale rural industries process the produce to shellac which can be used further in industrial applications like coating. Shellac is non-toxic natural resin and has its applications in variety of industries like that of paint, food coating, shoe polish, electrical industries (1). Further lac dye has been used in its converted form (treated with diazo methane) as a foliar spray to confer protection against phytopathogens (2).

In this article we show the use of shellac resin by using it as a soil additive in its molten form for protection of chick pea seedlings.

In Chick pea (Cicer arietinum), it has been shown that drought stress can cause necrotic infection by the fungus M*acrophomina phaseolina* (3). Similarly, water logging can also cause loss in the Chick pea crop (4).

Methodology

1. Method used to study lac resin in seedling protection

20grams of lac resin purchased from amazon.com was boiled in a pressure cooker with 100ml tap water and once in molten sticky stage, it was mixed with 500grams of organic manure. It was mixed well and after 2 days, it was used for planting of chickpea germinating seeds. The organic manure was placed in a plastic container with no bottom pores for water drainage to induce water logging. The set up was placed in full sunlight area and exposed to heavy rainfall to induce water logging and physical injury to the seedlings. The germination, survival was compared between the control and the lac resin added group.

2. Method of coating lac resin on metal surface to study *Agaricus mycelium* spread inhibition

a. Preparation of lac resin- Lac button resin was purchased online through Amazon.com and dissolved in 70% ethanol (one button resin in 50ml of 70% ethanol.
b. Coating of plate – 200ul of resin was used to coat the plate as shown in figure 1 and left to dry at room temperature for one day.
c. Growth of saprophytic fungi – *Agaricus inoculum* was purchased from Amazon.com that was in a base of barley seeds and was placed in an aluminium vessel with lid and a nozzle for gas exchange (basically a pressure cooker).
d. The coated plates were placed facing the mycelium and the vessel was kept tightly closed at room temperature. Pictures were taken once in two weeks
e. The metal plate pictured was analysed by image J and presented as 3-d graphics

3. Method adapted for checking the effect on seeds in water logged soil

The soil treated with molten shellac was filled in pot and then the chick pea seeds were sowed in that and covered with 5 cm soil and surface water of 1cm. After 2 weeks when the water had evaporated, the soil was uncovered to observe the decay of seeds.

Results

The results indicated that seedlings in lac -manure mix had better survival and stress tolerance as compared to that of control plants as shown in figure 1. Survival in water logged condition was almost double than that of without resin and similarly seedlings that got broken off in heavy rain had recovery capacity in the resin exposed. Further as indicated in figure 4, the lac treated organic manure had pores after water logging removal as compared to control. In Figure 5, the seeds in control water logged condition showed decay by mycelial growth but not in the soil treated with molten shellac.

In another experiment as shown in figure 2,3 spread of mycelium of *Agaricus* (modelled for a saprophytic fungi) was limited in case of tin surfaces, lac resin coated surface but not on aluminium or stainless-steel surfaces.

Discussion

The possible mechanism of lac treatment conferring protection to plant could be that the resin altering soil texture as seen in figure 4, furnishing plants with repair mechanisms and stress tolerance (unknown mechanisms), the resin inhibiting the soil rot fungi that could destroy plant root in water logged soil (surrogate model with *Agaricus* in Figure 2,3). Moreover, lac has the capacity to alter dielectric property (5) and hence mixing it with soil would have effect on it. Moisture is known to influence soil dielectric nature and it has been shown that mycorrhiza infection in black walnut seedlings is affected by soil moisture ().
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Although diazomethane treated lac dye has been shown to be antifungal in nature and used in plant foliar protection from pathogenic fungus (2), our research shows that melted lac resin mixed with the rhizosphere soil or tin metal surface coated with lac could confer protection. It could be possible that the organic manure having humus might have free methyl groups that binds to lac resin and acts as an antifungal agent.

Tin as a micronutrient additive to plant conferring protection to pea plant has been shown (7). But our study shows the use of a tin metal surface coated with resin that might prevent root rot in flooded condition. One possible way is to insert these metal surface in the plant rhizosphere that might prevent fungal spread as shown by us with *Agaricus* mycelial spread over metal surface (Figure 2,3) and in Figure 5 in real conditions of water logging in soil and the prevention of seed decay in treated soil.

Conclusion

Shellac lac resin treated soil could act as protectant for plants in stressful conditions.

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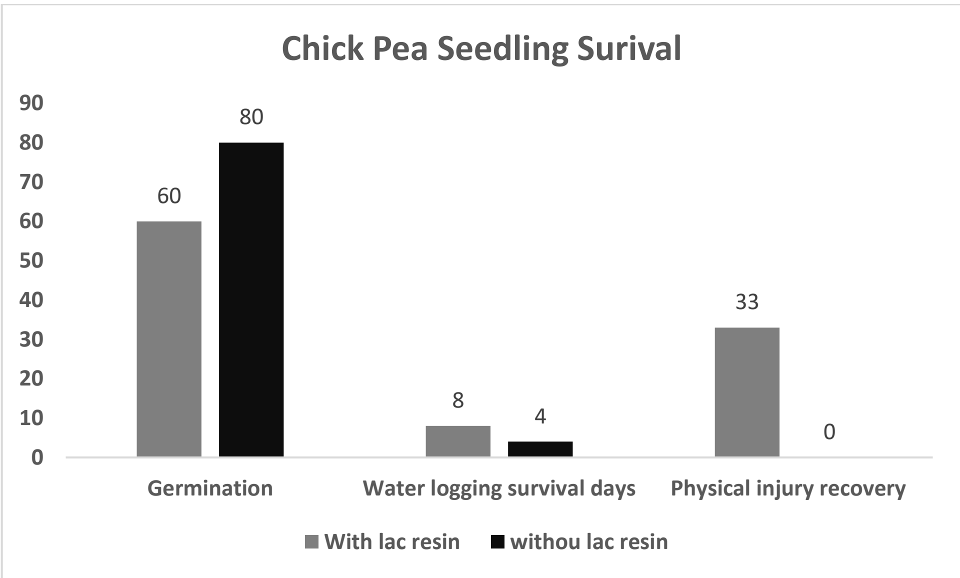


Figure 1

The results comparing control seedling (grown in organic manure without lac resin) and one in lac resin mixed (1:25 lac:organic manure mix)

Figure 2 Creating a model for resin coated metal plate to observe *Agaricus mycelial spread.* The plates were coated with lac resin in one side and moringa resin in another side

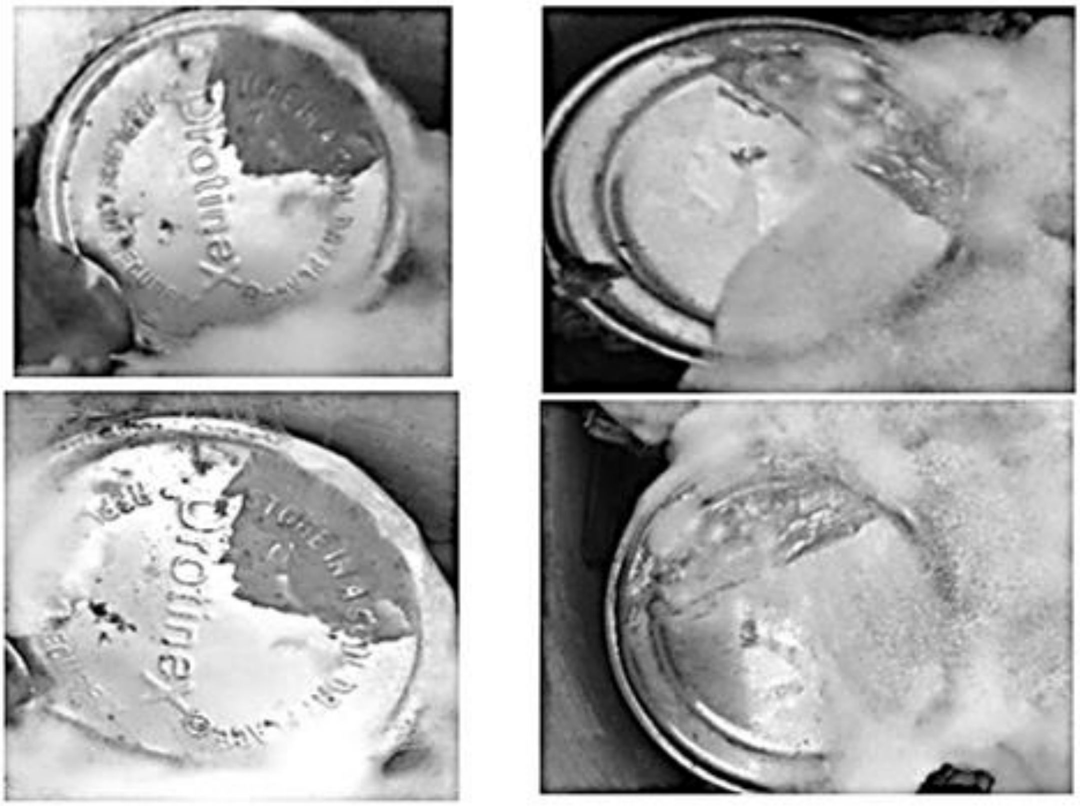
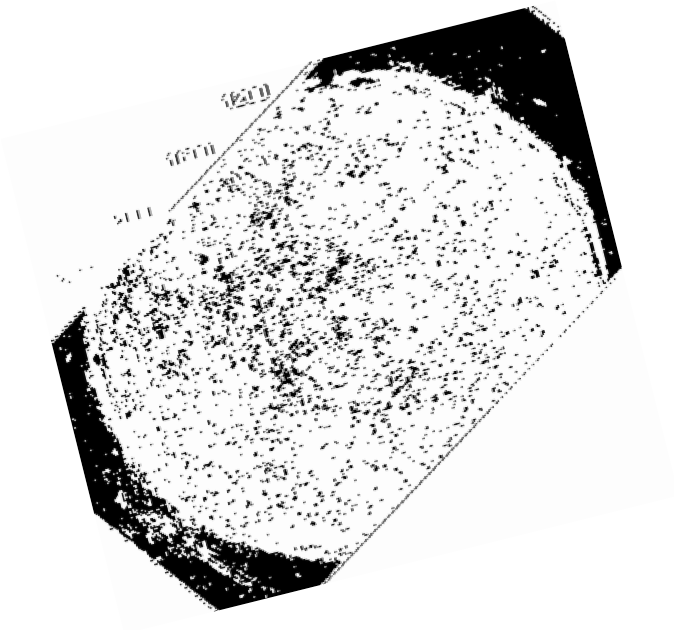


Figure 3 (Left) Lac resin coated tin metal plate inhibits mycelial spread on area of coating **(right) lac resin coated stainless steel plate limits spread of mycelium in** coated area



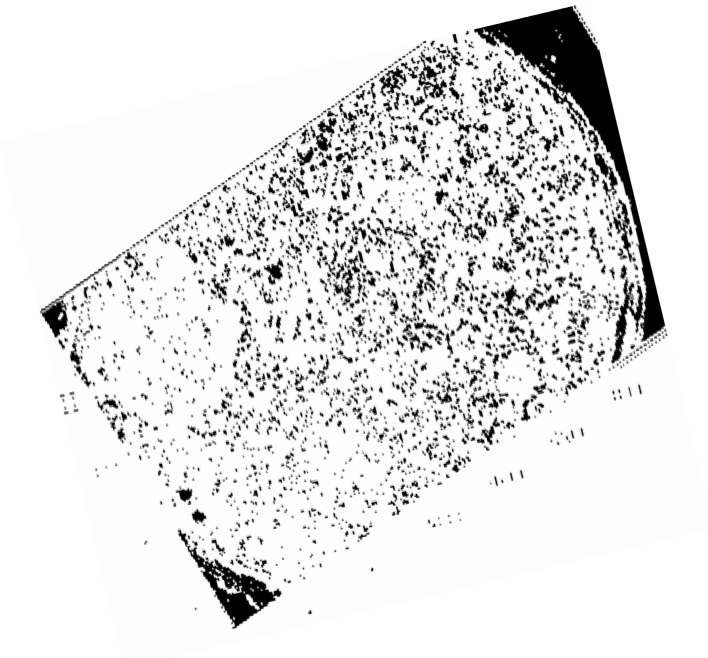


Figure 4 (left) Soil surface of control 72hrs after water logging post no surface free water (right) soil surface of lac mix with organic manure 72hrs after water logging post no surface free water – picture analysed with image j 3d surface plot and converted to black and white image. The dark spots refers to lesser depth and ligh color refers to increased depth as in color image it was red in lesser depth and blue-white in increased depth.

Figure 5 Effect of molten shellac resin on saprophytic fungal decay of Chick Pea seedlings in water logged soil. The left side and central figure depict seed decay in water logged soil as seen by white mycelium growing on the seed and the right side depicts soil treated with molten shellac resin in which the seeds were intact.