Biodegradable Agricultural Mulch Films From Wastepaper Pulp and Calcium Alginate

Huang, Louis (School: Herbert Henry Dow High School)

Traditional petroleum-based plastic mulch films are widely used in agriculture because of their superior weed and pest prevention as well as their longevity, but they depend on non-renewable resources and are nonbiodegradable, causing plastic pollution. Globally, over 400 million tons of paper waste is produced yearly, with no current uses. Using paper waste to create biodegradable mulch films turns useless waste into a useful product and reduces plastic pollution. In this study, ten different solutions with varying concentrations of wastepaper pulp and sodium alginate were created. After film casting, the solutions were crosslinked with calcium chloride, and dried to form the films. Over 30 films were manufactured in total. The films were tested for material properties and real-world feasibility. Crosslinking improved water retention by 65%, tensile strength by up to 250%, and elongation at break by up to 97%. In addition, crosslinked films, unlike their uncrosslinked counterparts, were water resistant. Optical microscope images showed dispersion of film components. FTIR spectra confirmed crosslinking had occurred. In the field test, the mulch films stopped all weed growth and significantly reduced the irrigation required. Furthermore, a scalable manufacturing process was designed and tested using prototypes. Cost analysis demonstrated that the near-zero cost of paper waste offsets the greater cost of sodium alginate, lowering film costs significantly. It is concluded that wastepaper/alginate mulch films have satisfactory performance and are cheap enough to replace traditional mulch films worldwide. Suggested further research includes optimization of film composition and manufacturing scale-up.

Awards Won: