Transient activation of herbicide resistance circuits via sugar-based nanomaterials in crops

Supervisory team:
Main supervisor: Dr Heather Whitney (University of Bristol)
Second supervisor: Dr Tom Gorochowski (University of Bristol)
Non-academic (CASE) supervisor: Dr Fran Robson (CDotBio)
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Host institution: University of Bristol
CASE partner: CDotBio

Project description:
Herbicide resistant weeds are a significant and growing agricultural problem. This is illustrated by the problems currently faced by famers when dealing with herbicide resistant blackgrass, which currently costs the UK nearly £400 million with 800,000 tonnes of lost harvest each year. The continuous overuse of a single herbicide multiple times in a growing season increases the potential risk of evolution of resistant weeds and higher doses of herbicide applications are a major threat to the environment These problems can be managed by alternating use of multiple herbicides along with conventional weed-management practices. However, to do this crop species would need to be resistant to a range of herbicides, but without increasing risk that those resistance genes might spread to related weed species. A combination of cutting-edge synthetic biology and nanotechnology might have a solution. Gene cassettes can be produced that are transformed into plants. These cassettes would include an integrated switch that controls the expression of any genes in the cassette. A 'trigger' is required to activate the switch and initiate the expression of the genes in the cassette, with the trigger delivered by sugar-based nanomaterials. This would mean that herbicide resistance genes could be present in crops, but only expressed temporarily as needed. A collaboration between three of the project supervisors (Heather Whitney, Tom Gorochowski and Carmen Galan) has recently combined synthetic biology and nanotechnology to establish a new system by which reporter genes are transformed into the plant genome, but initially with a non-functional promoter – such that the reporter gene is present in the plant genome but not initially expressed. A synthetic 'switch' is then delivered to the plant (via sugar-based nanomaterials) which corrects the promoter and switches the reporter gene on.

Working with an expert in herbicide resistance and its impacts on crop yield, the aim of this project would be to use this established system but replace the reporter gene in the established system for specific herbicide resistance genes (e.g. resistance to bensulfuron methyl (BM) and glufosinate herbicides). We would then aim to test the system in crop plants, with the ultimate aim to see if it is possible to use spray on nanomaterials to control the herbicide resistance in crops so that is is only switched on as needed. Working with our CASE partners (CDotBio), we would also have to potential to investigate potential applications of this technology.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.