Rapid Detection of Superweeds (Herbicide-Resistant Weeds) Utilizing Novel Full-Spectrum Imaging and a Hyperparameter-Tuned Convolutional Neural Network (CNN)

Estrada, Pauline Victoria (School: Clovis North High School)

Every year, farmers around the world lose more than $95 billion from uncontrolled weed infestation. Herbicide-resistant weeds, also known as “superweeds”, are fast becoming a significant part of this weed problem and are a significant threat to crop production and food security. Late detection of resistant weeds leads to increasing economic losses and severe environmental damage. Traditionally, genetic sequencing and herbicide dose-response studies are used to detect herbicide-resistant weeds, but these are expensive and slow processes. To address this problem, an AI-based superweed identifier program (SIP) was developed to quickly and accurately distinguish herbicide-resistant from susceptible chickweed (Stellaria media). A regular camera was converted to capture light wavelengths from 300 to 1,100 nm. These full spectrum images were used to develop a hyperparameter-tuned convolutional neural network (CNN) model utilizing a “train from scratch” approach. This novel approach exploits the subtle differences in the spectral signature of resistant and susceptible chickweed plants as they react differently to herbicide treatments. The SIP was able to identify resistant chickweed to acetolactate synthetase (ALS) inhibitor herbicides as early as 72 hours post treatment at an impressive accuracy of 85%. It has broad applicability due to its ability to distinguish resistant from susceptible chickweed plants regardless of the type of ALS herbicide or dosage rate used. Utilizing the superweed identifier program will allow farmers to make timely interventions and develop more effective and safer weed management practices. This can optimize yield, reduce herbicide use, minimize environmental harm, prevent superweed proliferation, and improve overall public health.

Awards Won:
First Award of $5,000