Diagnose of herbicide damage on soybean using hyperspectral imaging

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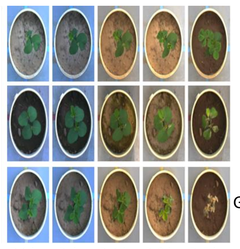
농촌진흥청 60주년
농업혁신 60년, 국민행복 100년

Abstracts

In soybean cultivation, damage caused by selective and non-selective herbicides application is considered as fundamental problem in conventional agriculture. In particular, physiological disorders and herbicide damage are commonly assessed manually with visual inspection and the laboratory detection analysis, which are quite time and manpower consuming analysis. In this study, about 11,922 hyperspectral images were classified by herbicide component through a total of 4 imaging sessions. For hyperspectral images processing, one set of hyperspectral images was composed, and a semi-auto analysis algorithm was developed using the Matlab (USA, Matlab 2016a) tool. The developed program was designed to enable one-way and two-way ANOVA analysis. Due to difficult in checking significance of all the 200-400 bands, a heat map was used to output visualization data, and boost the efficacy (F-value) of the wavelength value of top 10% (about 10,000) value and designed for additional confirmation. The difference in the 900 nm range was confirmed by analyzing the variance from pre- spraying of Bentazon to 3 days after spraying, and by analyzing the image of spraying Glufosinate. The difference was found at 750 nm on the 1 day after spraying. It was confirmed that both groups of foliage treatments were able to discriminate by hyperspectral images before visual discrimination.

Material & Methods

Glycine max (L.) Merrill beans were treated with fungicides(bentazon and glufosinate).The bentazon treatment group was treated at the standard amount, 2 times, 4 times, 8 times, and 16 times. The glufosinate was a non-selective herbicide for soybeans. It was treated standard amount, ½ times, ¼ tiemes, 1/8 times, 1/16 times. The fungicide treatment group was treated after growth until the 1-vegetative stage(10 to 15 days), and imaging and actual measurement were performed for 20 days from 1 day before spraying to foliar. Water was supplied directly to the pot to prevent leaching of the fungicide. The acquired hyperspectral images (11,922 images, 1TB) were classified by fungicide. The classified images were extracted using NDVI-GreenNDVI to extract only the plant area. Gaussian filtering was applied to remove white noise. A 2-way ANOVA analysis was performed using the extracted ROI image. ANOVA analysis was developed so that nine formulas could be selected so that significance verification between multiple wavelengths could be performed.



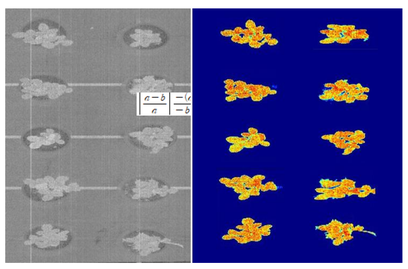
Control group

Bentazon

Glufosinate

Herbicide formulation amount for image diagnosis of herbicide damage(based on 5 Wagner pots)

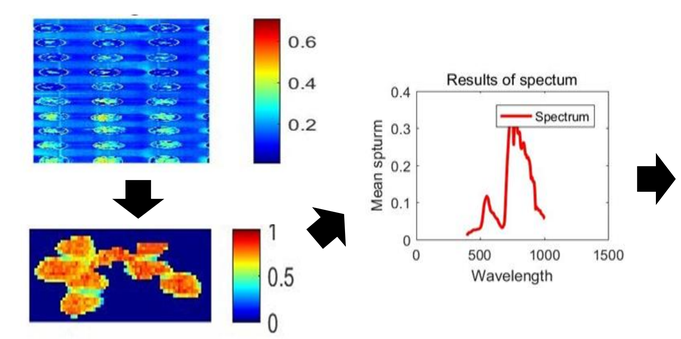
Herbicide ingredients	Density	Herbicide amount	Water amount(㎖)	Applicable area(㎡)
Bentazon	1x	0.074 ㎖	24.53	0.2453
	2x	0.147 ㎖		
	4x	0.294 ㎖		
	8x	0.588 ㎖		
	16x	1.177 ㎖		
Glufocinate	1x	0.074 ㎖		
	1/2x	0.037 ㎖		
	1/4x	0.019 ㎖		
	1/8x	0.009 ㎖		
	1/16x	0.005 ㎖		



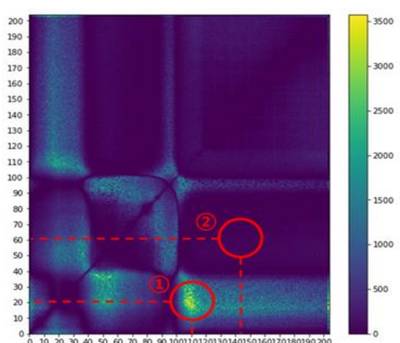
select	formulas	select	formulas
1	$\lvert a-b \rvert$	6	$\lvert \log_a b \rvert$
2	$\lvert a+b \rvert$	7	$\left\lvert \frac{a-b}{b} \right\rvert$
3	$\left\lvert \frac{a}{b} \right\rvert$	8	$\left\lvert \frac{(a+b)+(a-b)}{a+b} \right\rvert$
4	$\left\lvert \frac{a+b}{a} \right\rvert$	9	$\left\lvert \frac{(a+b)-(a-b)}{a-b} \right\rvert$
5	$\left\lvert \frac{a-b}{a} \right\rvert$		

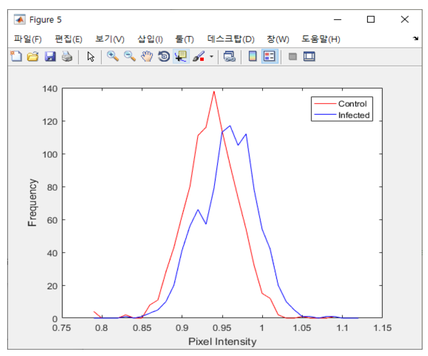
Results & Dicussoion

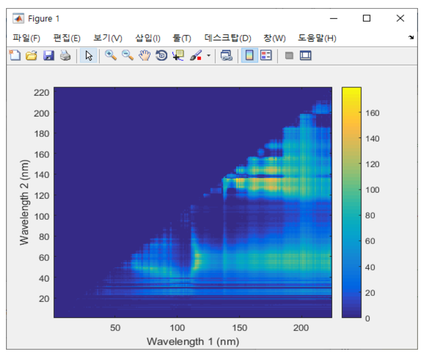
In the fungicides treatment group, damage responses were confirmed by orgnoleptic grading from the 4th day for bentazon and the 2nd day for glufosinate after herbicide spraying. For early damage diagnosis, it was checked whether data could be classified before orgnoleptic grading. As a result of the analysis, Bentazone was able to confirm a difference at 900 nm wavelength on the third day after spraying, and glufosinate was able to confirm a difference at 750 nm wavelength from the first day after spraying. In the case of Bentazone, R^2 after spraying was 0.62 for 1x, 0.67 for 2x, 0.81 for 4x, 0.97 for 8x, and 0.97 for 16x. As a result of the analysis, it was difficult to confirm the difference in 1x and 2x, but it was possible to confirm the difference from 4x. In the case of bentazone, as a selective herbicide for soybeans, it did not appear because it was not damaged up to 2x. Glufosinate is a non-selective herbicide, and on the first day of spraying (after 24 hours), R^2 was 1/16x 0.84, 1/8x was 0.81, 1/4x was 0.86, 1/2x was 0.93, and 1x was 0.99. there was. Through this study, it is judged that even non-experts will be able to confirm whether and what kind of damage is caused by herbicide.



	index	F-value	a	b	Accuracy	Threshold	True	False
2	689	148.357	3	16	42.85714	14.66443	3	4
3	15260	142.7975	68	27	57.14286	2.972167	4	3
4	12460	114.1388	55	139	71.42857	3.599226	5	2
5	10962	112.5295	48	209	71.42857	6.060083	5	2
6	2813	106.4629	12	124	57.14286	6.06919	4	3
7	2809	104.7583	12	120	57.14286	6.278652	4	3
8	7773	104.4629	34	156	42.85714	2.247119	3	4
9	1734	100.5852	7	165	85.71429	1.690826	6	1
10	6238	100.4232	27	189	42.85714	17.93567	3	4
11	13235	96.19667	59	18	85.71429	2.577393	6	1
12	3004	84.48081	13	91	71.42857	4.87027	5	2
13	10500	83.50217	46	195	57.14286	4.474571	4	3
14	10496	78.4641	46	191	71.42857	7.593476	5	2
15	13983	77.38988	62	94	85.71429	3.673333	6	1
16	3637	76.94307	16	52	57.14286	10.1913	4	3







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**(Acknowledgement) 본 연구는 농촌진흥청 어젠다사업(사업번호: PJ015697)의 지원에 의해 이루어진 결과로 이에 감사드립니다.