

# Evaluation of Image Pre-processing Techniques for Improved Rice Leaf Disease Detection

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# Introduction

- Rice
- Crop Loss
- Disease Management and Disease Detection
- Image pre-processing



*Oryza sativa L.*  
(Healthy)



*Xanthomonas oryzae*  
pv. *oryzae*  
(Bacterial Leaf Blight)



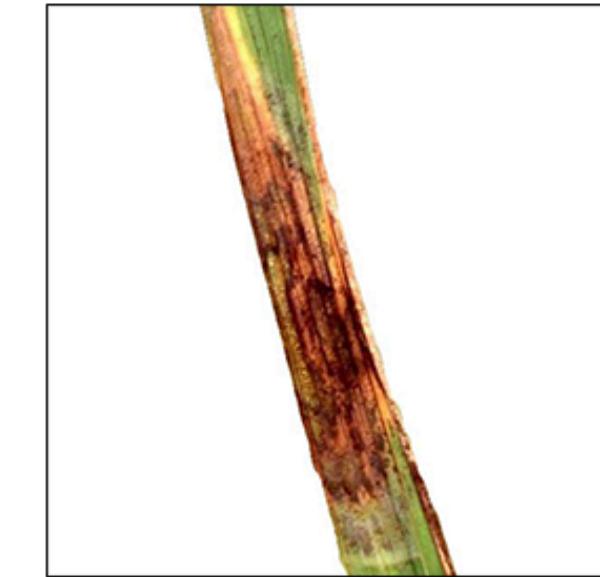
*Cochliobolus miyabeanus*  
(Brown Spot)



*Magnaporthe grisea*  
(Leaf Blast)

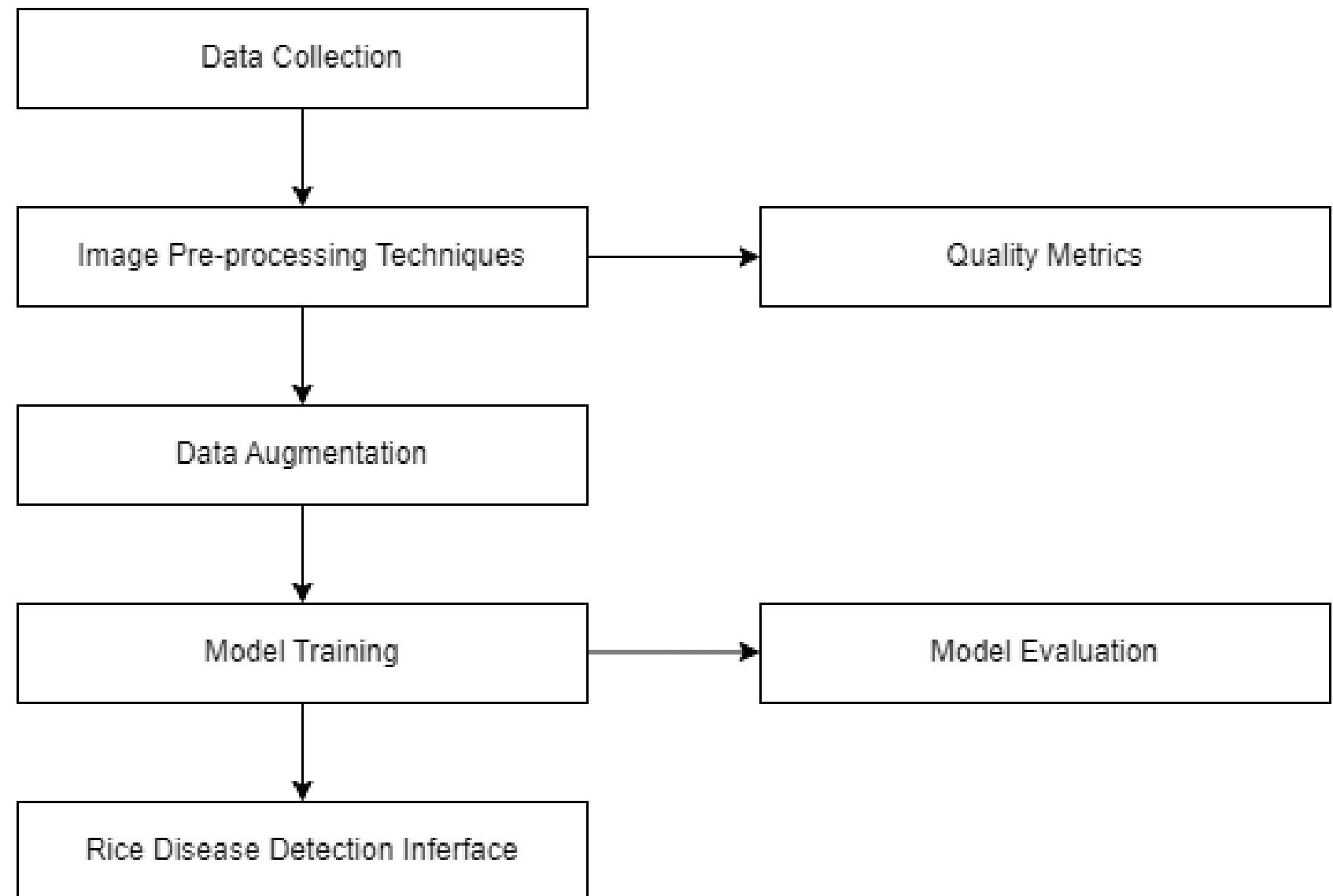


*Cercospora oryzae*  
(Narrow Brown Spot)



*Microdochium oryzae*  
(Leaf Scald)

# Methodology



- The chosen dataset of rice leaf disease images used were from Roboflow Universe entitled "Rice Leaf Disease detection obj Computer Vision Project"
- Image pre-processing techniques used are Histogram Equalization and Contrast Stretching
- Images were evaluated using quality metrics specifically Peak Signal-to-Noise Ratio, Normalized Root Mean Square Error, and Structural Similarity Index
- Data Augmentation and Model Training were done using ConvXT, a convolutional neural network (CNN) development tool, available at CINTERLABS
- The web application was built using HTML5, JS, CSS and Flask.

# Results

Original Image



Contrast Stretching 1 Contrast Stretching 2



HE - L



HE - V

# PSNR

- tells you how much noise or distortion is present in the reconstructed image
- Higher PSNR indicates better quality

	HE-L	HE-V	CS	CS2
brown spot	10.84210660	11.08748731	20.29281726	18.64096447
healthy	9.5495	9.5659	19.41013825	17.7859447
leaf blast	11.013071429	11.1160	20.18447619	18.07047619
leaf blight	14.39448753	14.0008	19.38709141	17.18451524
leaf scald	14.57215084	15.0500	24.3503352	23.51162011
narrow brown spot	14.281593137	14.8591	22.50928922	22.16166667
<b>MEAN</b>	<b>12.4422</b>	<b>12.6132</b>	<b>21.02235792</b>	<b>19.5591979</b>

# NRMSE

- similar to PSNR; Similar to PSNR, it calculates the average squared intensity difference between corresponding pixels.
- Lower NRMSE indicates better quality

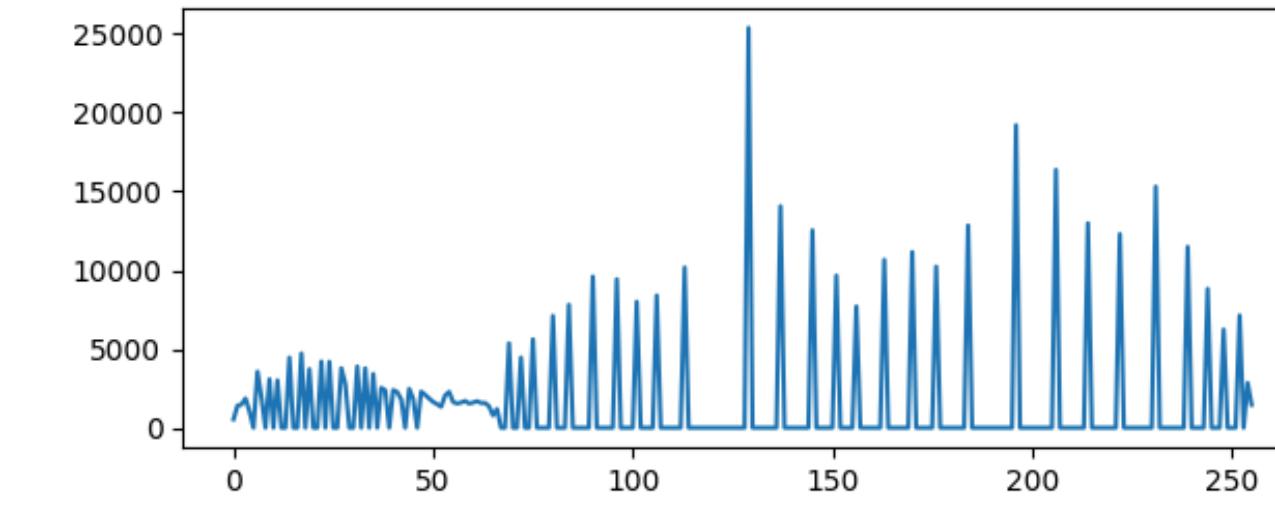
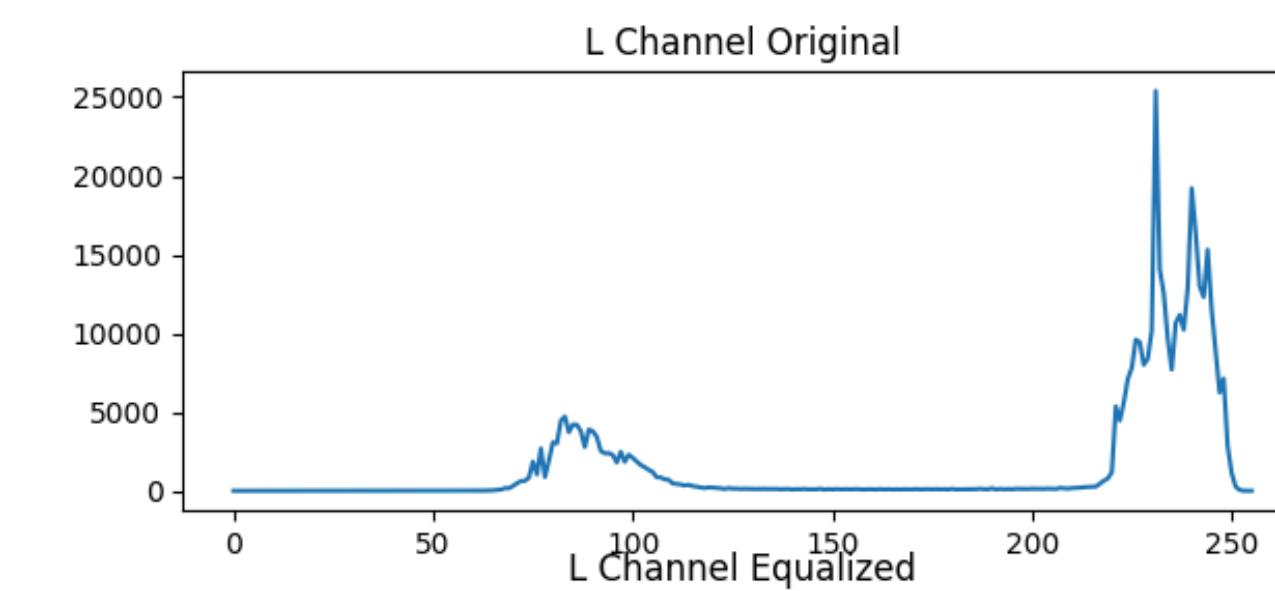
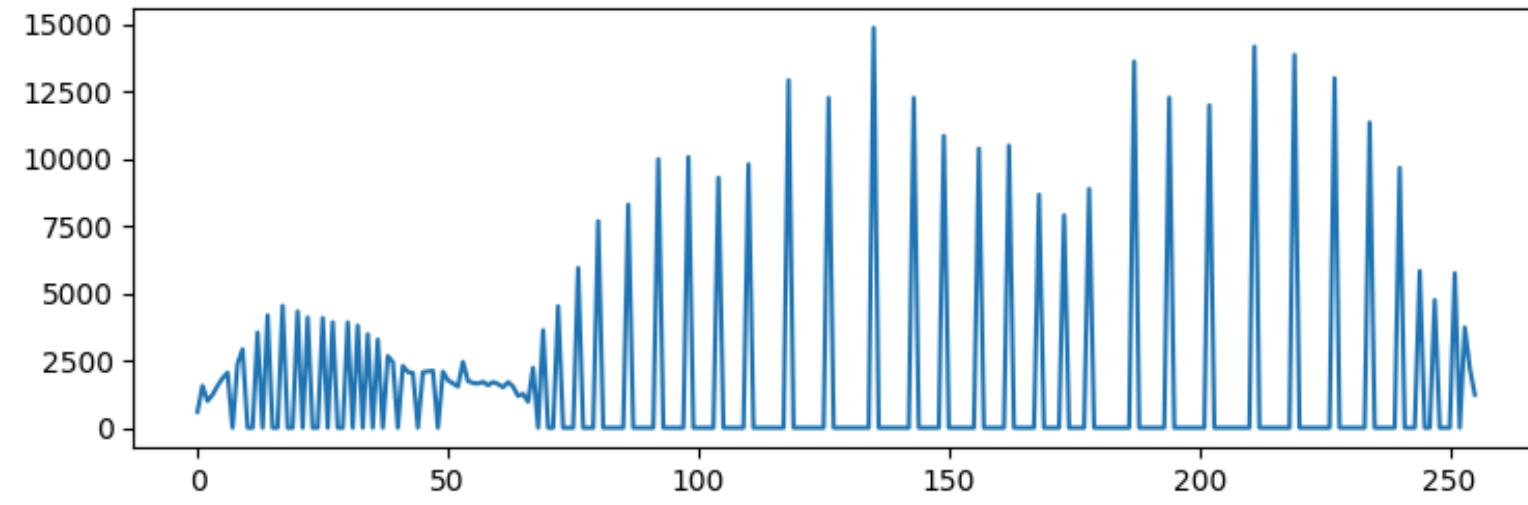
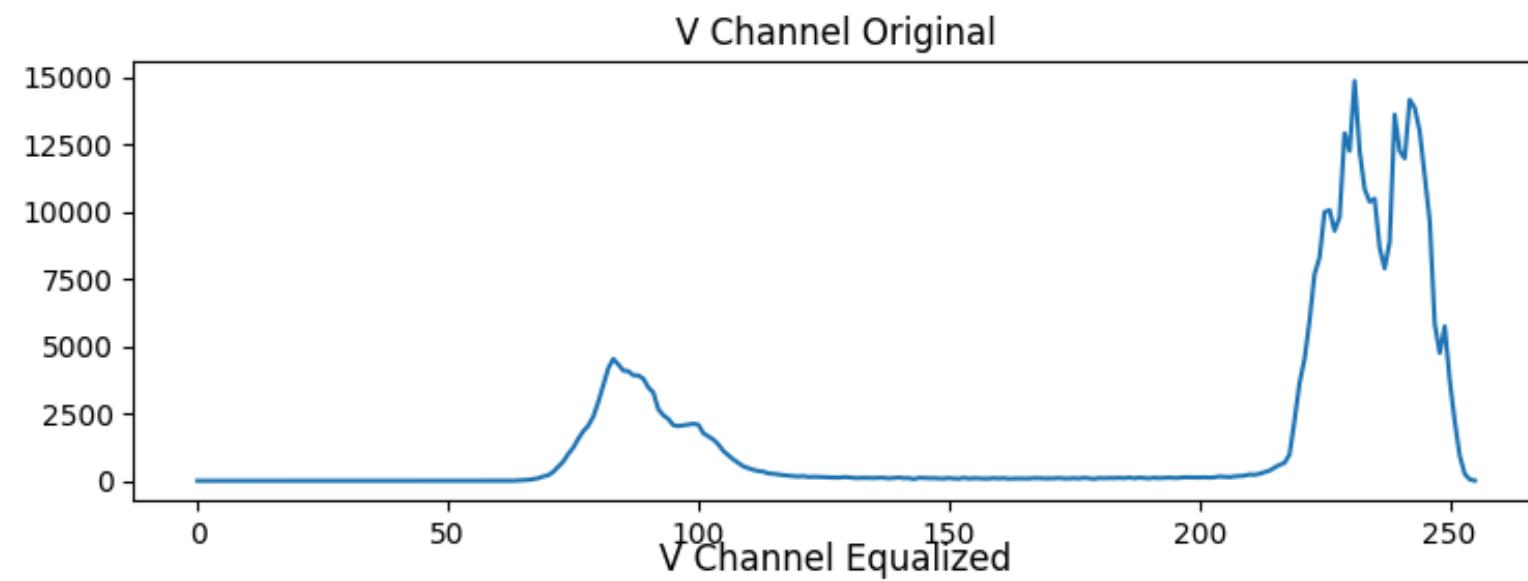
	HE-L	HE-V	CS	CS2
brown spot	0.3026	0.2947	0.1009069289	0.1237681472
healthy	0.3383	0.3379	0.1089079263	0.1314761751
leaf blast	0.3048	0.3036	0.1083819286	0.1410157143
leaf blight	0.2030	0.2105	0.1120404432	0.1440661773
leaf scald	0.1927	0.1834	0.06319452514	0.0693026815 6
narrow brown spot	0.1977	0.1858	0.0765250980 4	0.0794732598
<b>MEAN</b>	<b>0.2565</b>	<b>0.2527</b>	<b>0.094992808 36</b>	<b>0.1148503592</b>

# SSIM

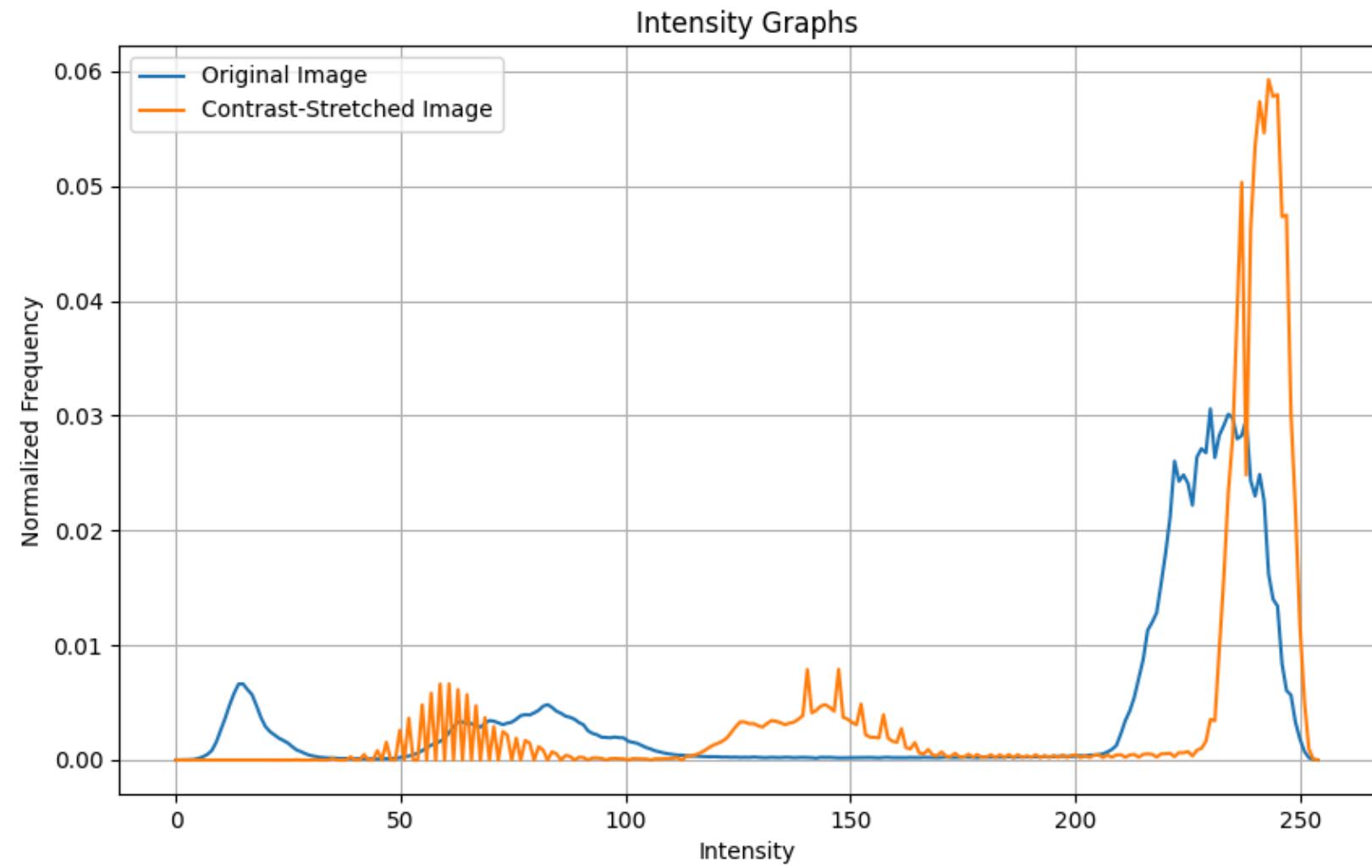
- It takes into account factors like luminance (brightness), contrast, and structural information (arrangement of pixels).
- SSIM index value ranging from 0 to 1. A value of 1 indicates perfect structural similarity.

	HE-L	HE-V	CS	CS2
brown spot	0.5986	0.6155	0.950969797	0.950969797
healthy	0.3823	0.3720	0.9343087558	0.9343087558
leaf blast	0.5083	0.5021	0.9503161905	0.9503161905
leaf blight	0.6815	0.6664	0.9534382271	0.9534382271
leaf scald	0.8659	0.8755	0.9812175978	0.9812175978
narrow brown spot	0.8279	0.8494	0.9694323529	0.9694323529
<b>MEAN</b>	<b>0.6441</b>	<b>0.6468</b>	<b>0.9566138202</b>	<b>0.9566138202</b>

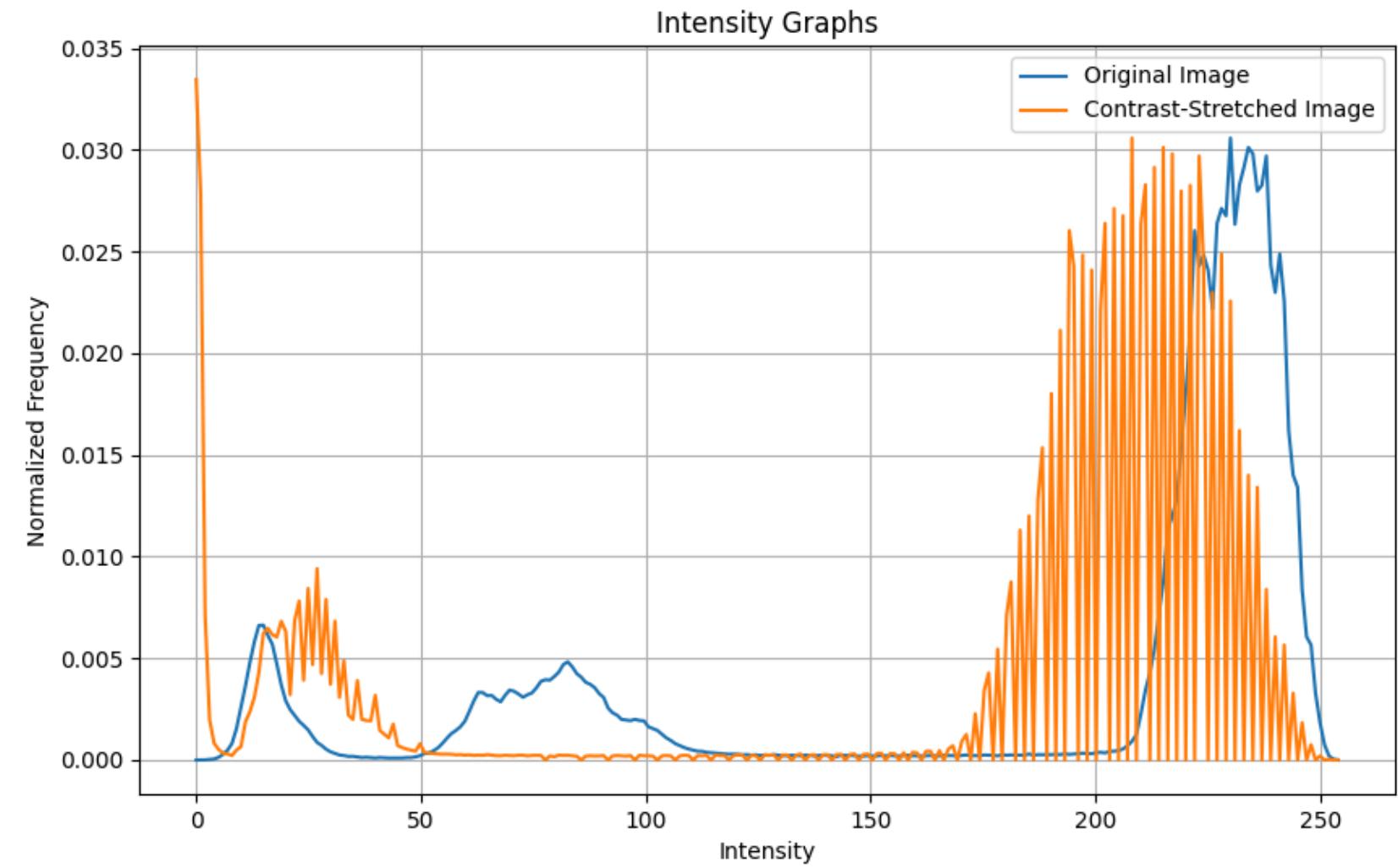
# Histogram Equalization



# Contrast Stretching



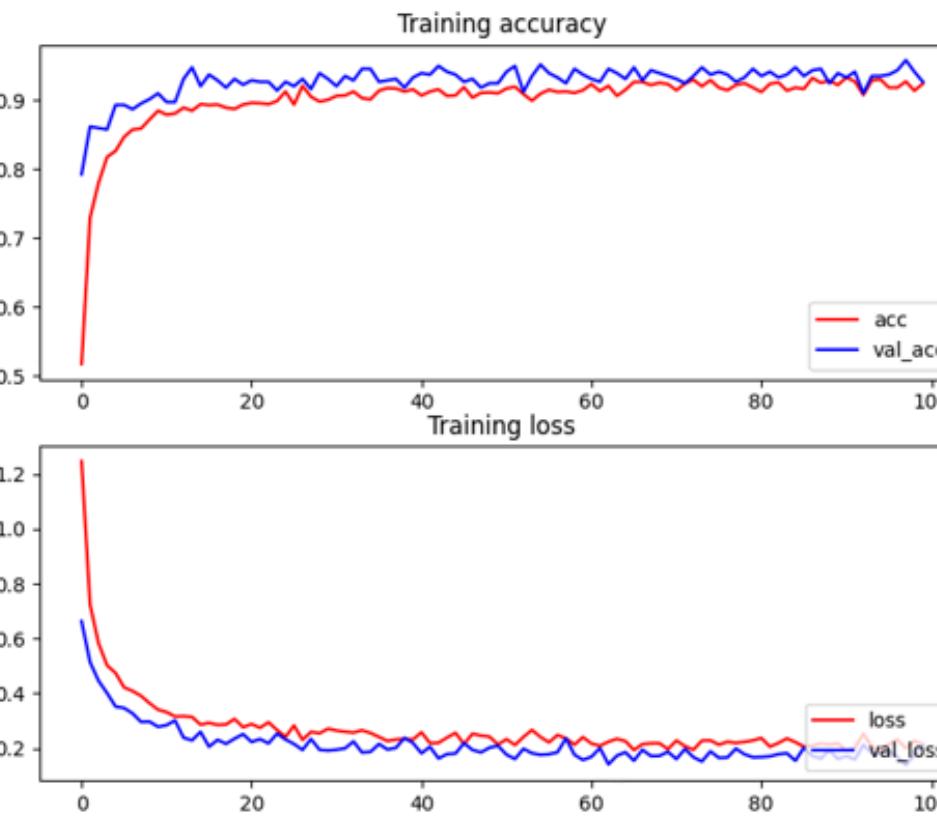
0.5



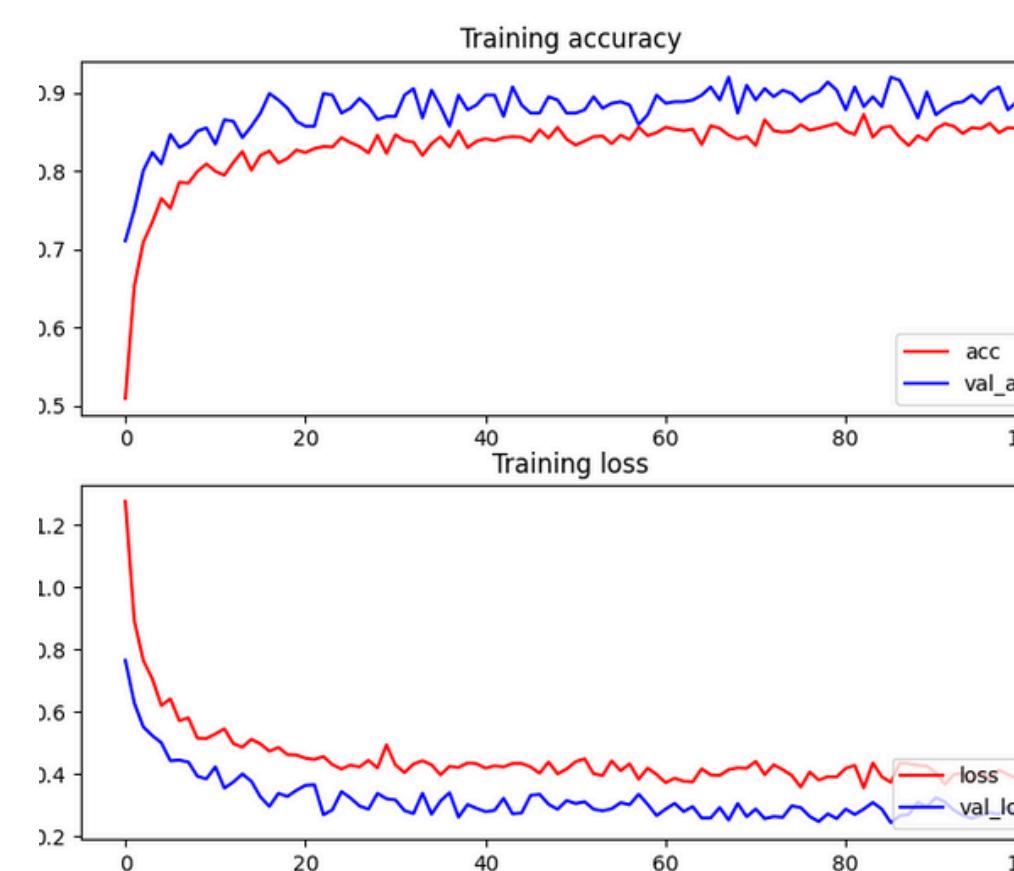
2

# Model Evaluation

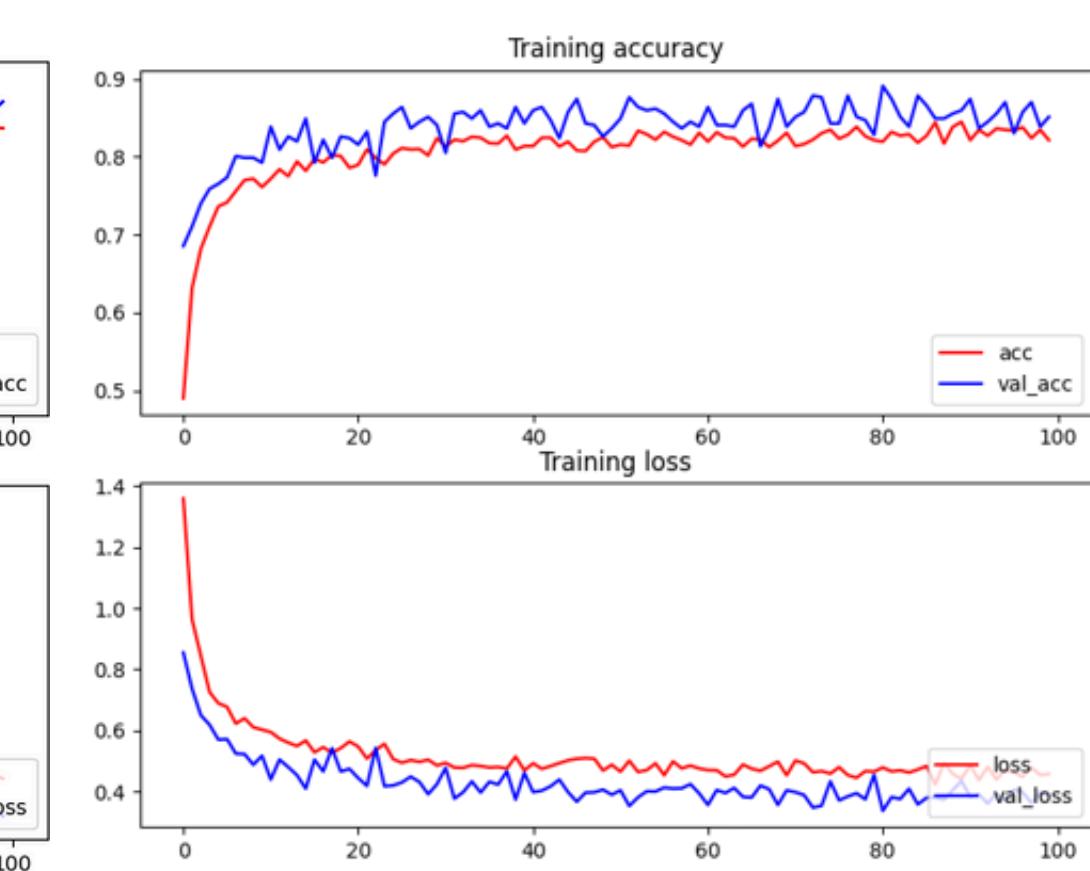
raw



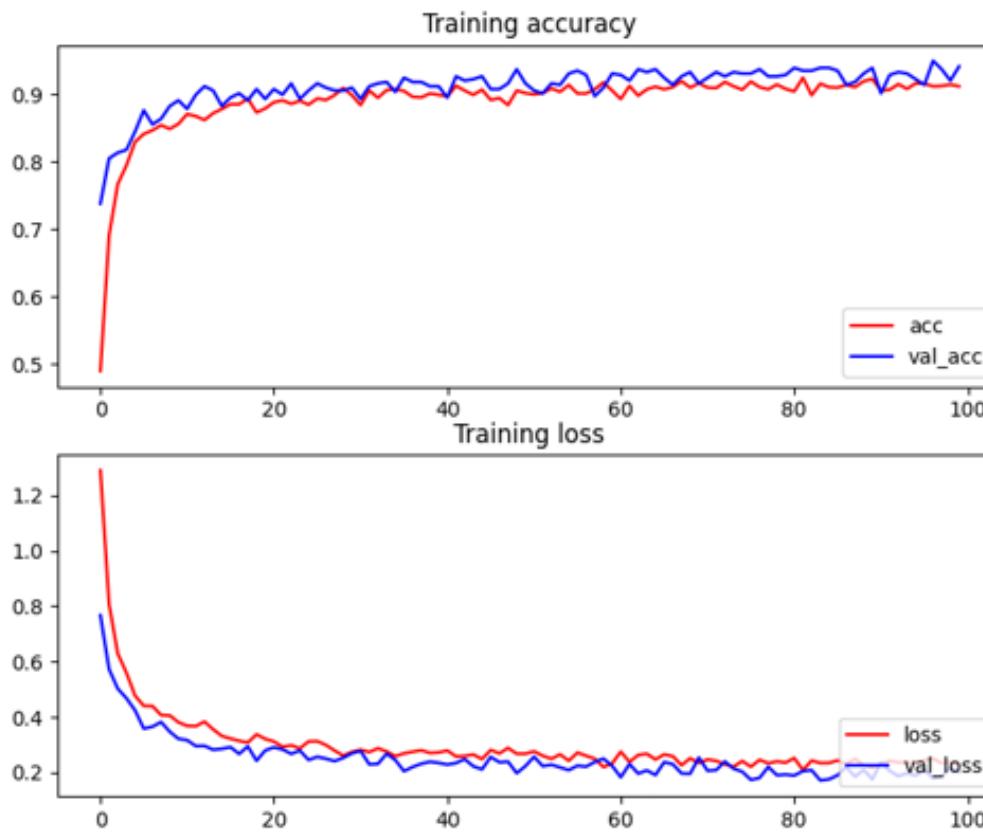
he-II



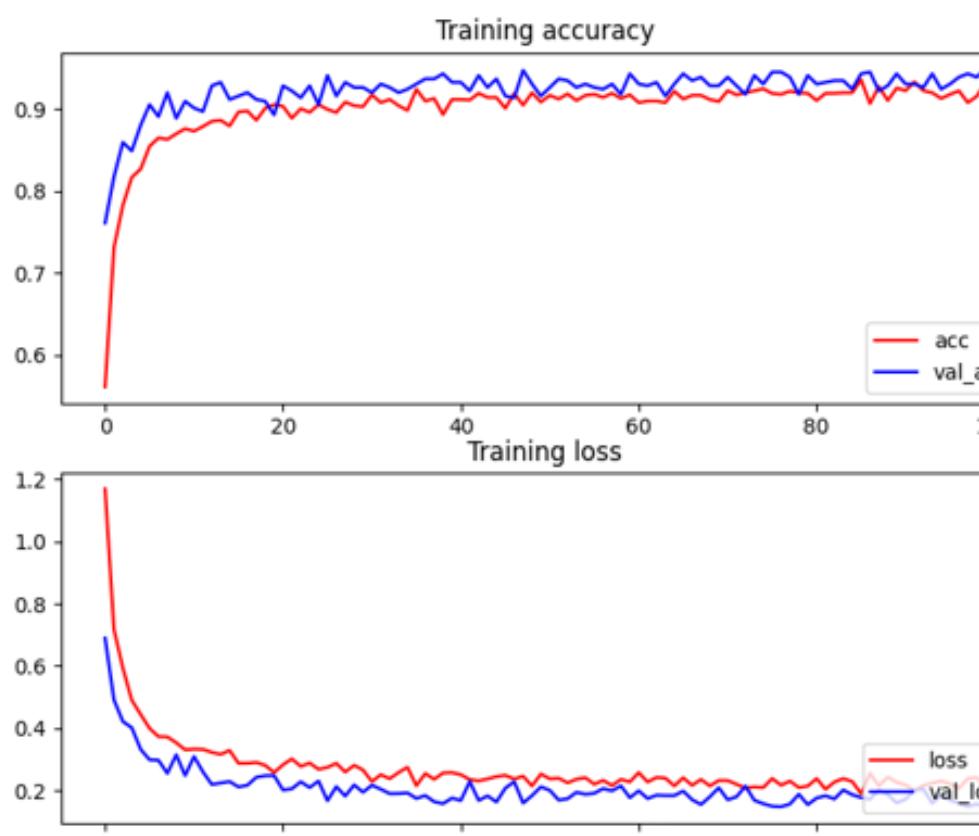
he-v



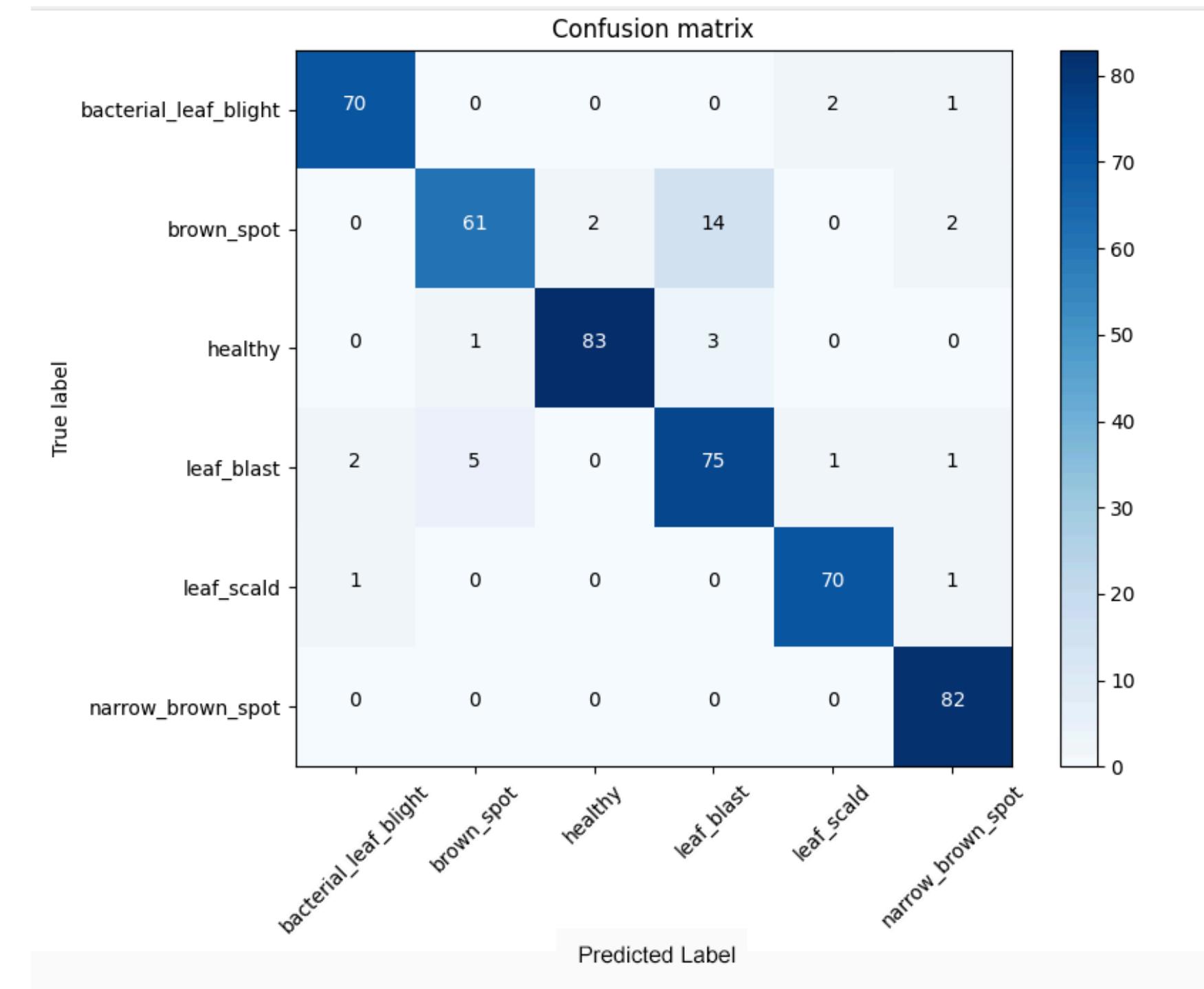
CS

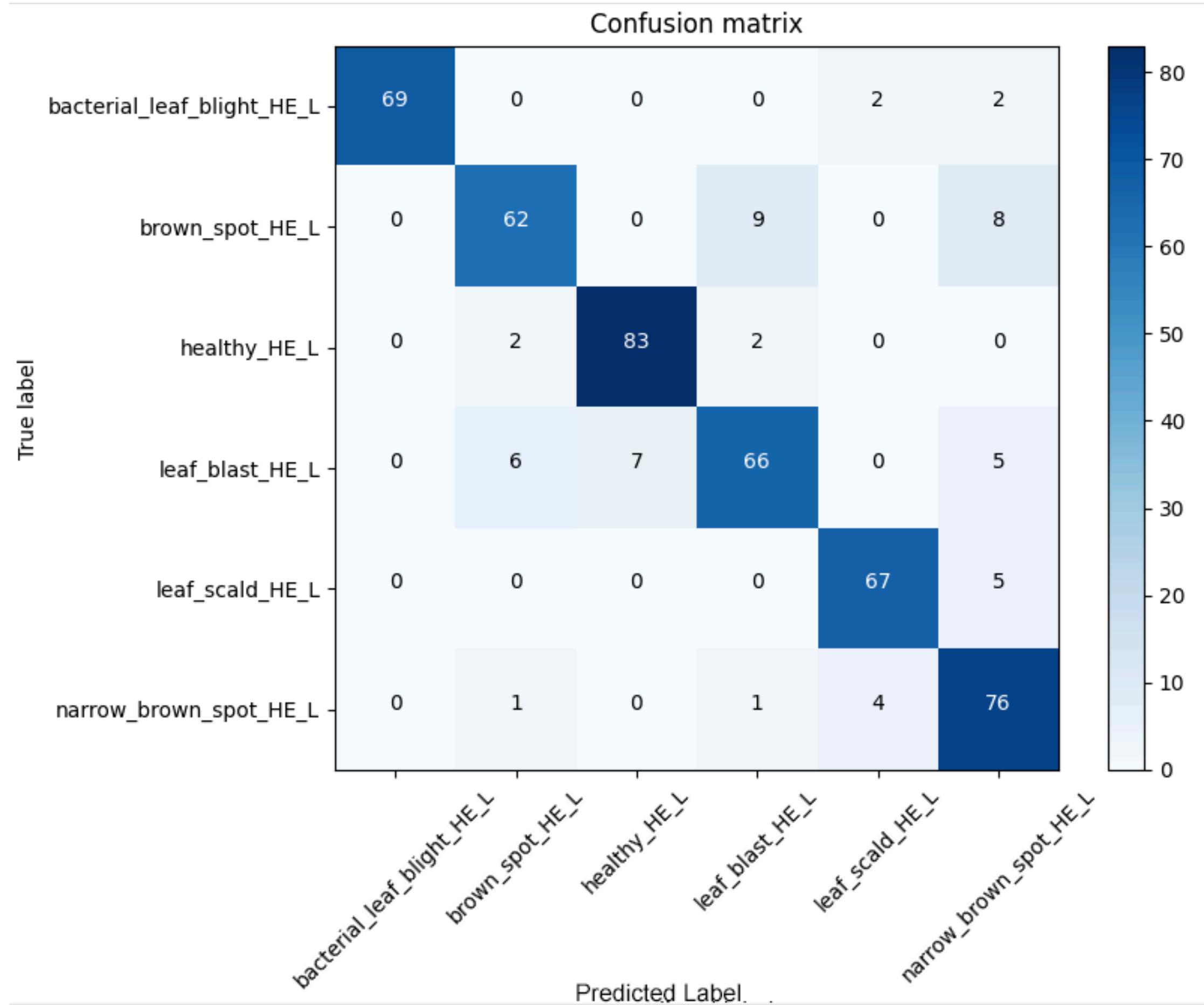


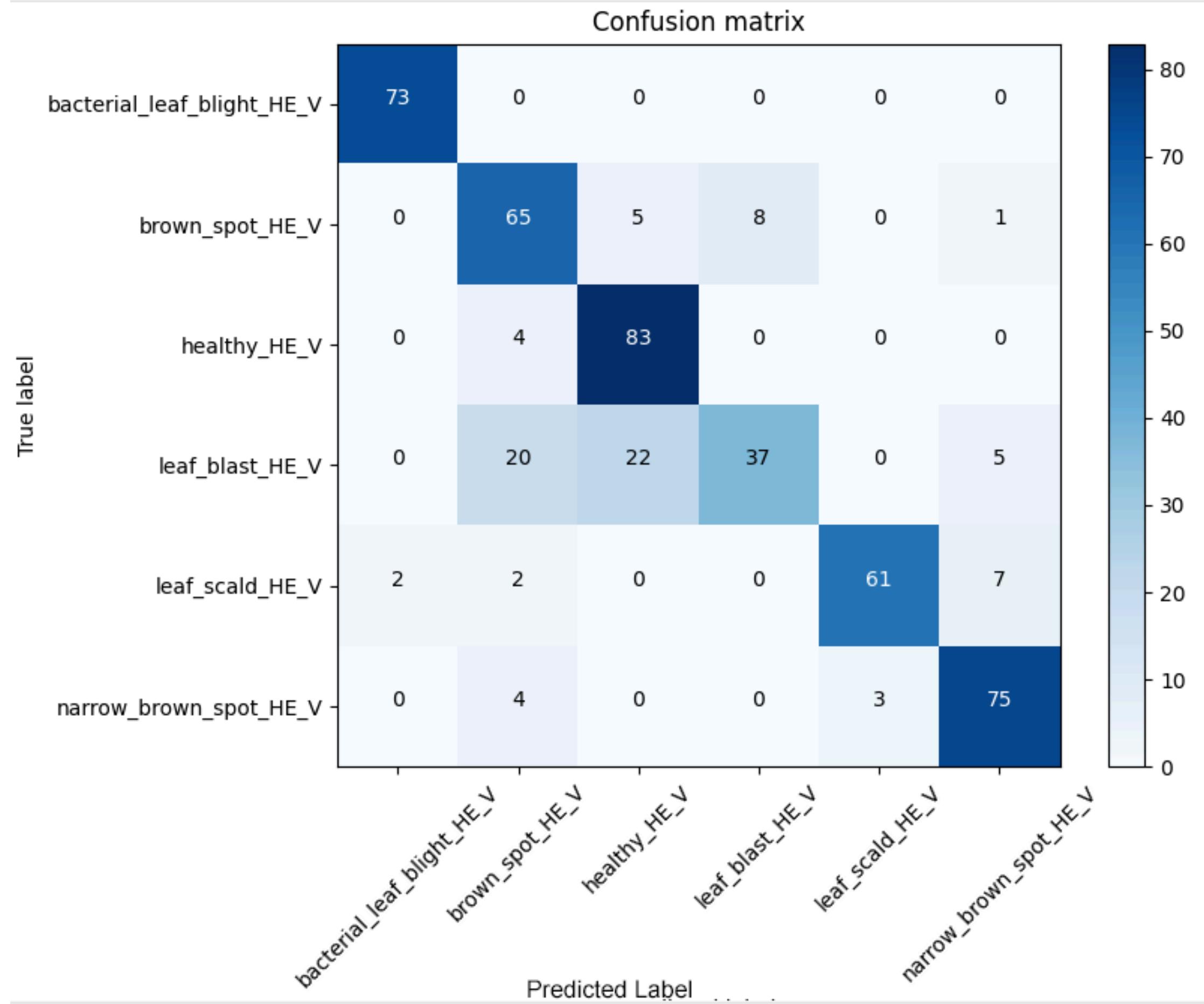
CS2

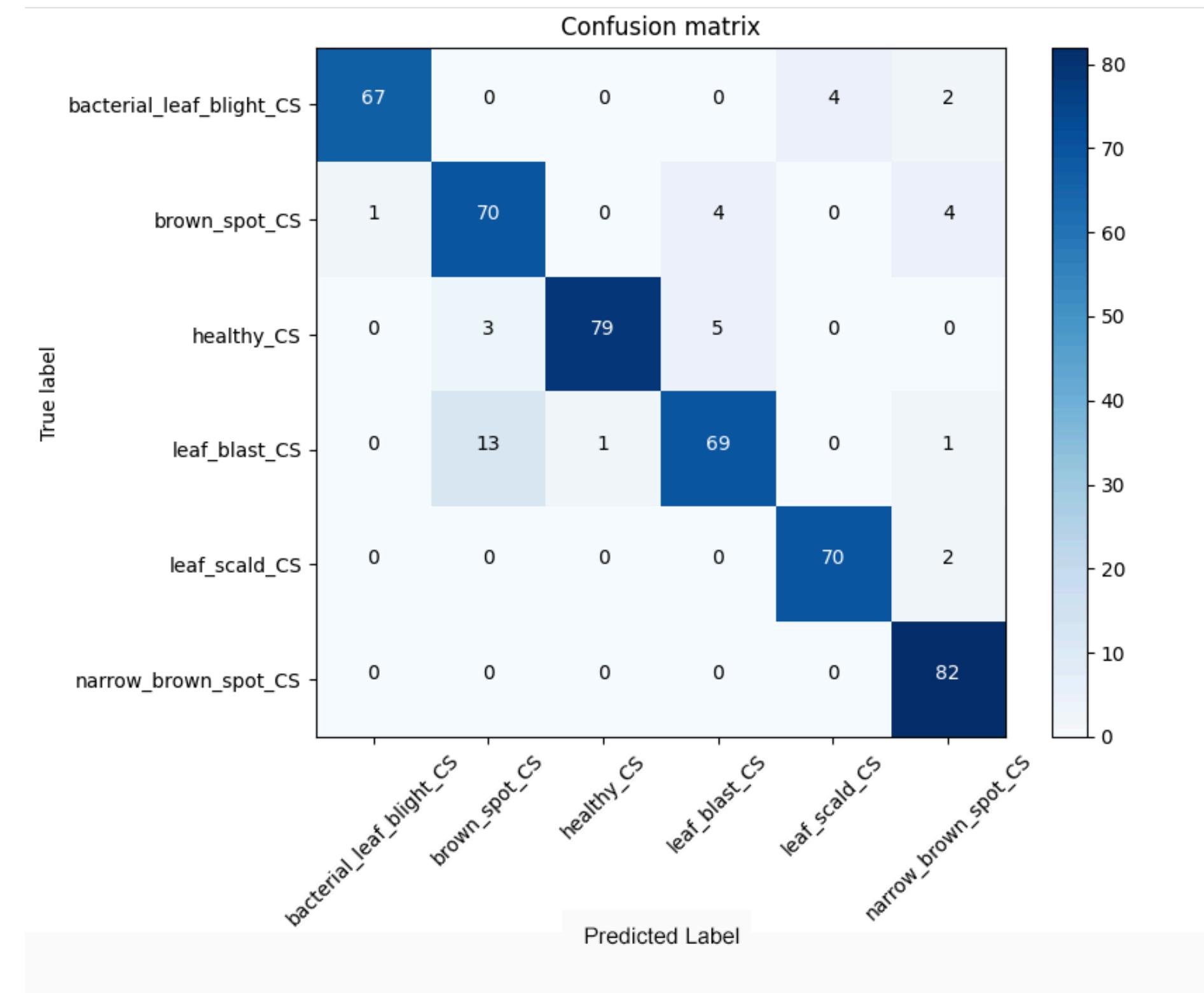


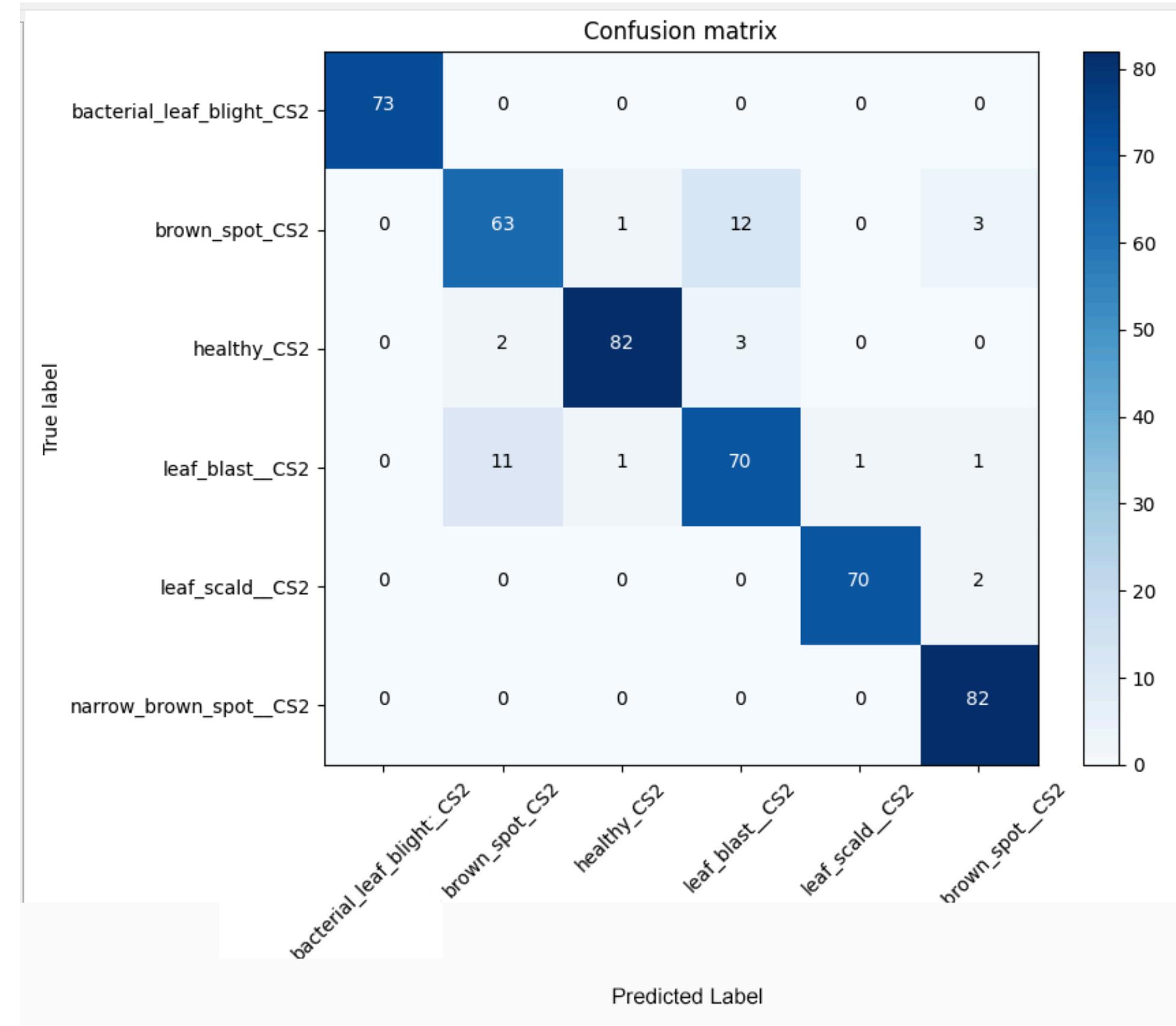
# Classification Results











# Classification Results

Model	Class	Precision	Recall	F1-Score
Orginal Image	bacterial_leaf_blight	<b>1.0000</b>	<b>0.9726</b>	<b>0.9861</b>
	brown_spot	<b>0.8846</b>	<b>0.8734</b>	<b>0.8790</b>
	healthy	<b>0.9880</b>	<b>0.9425</b>	<b>0.9647</b>
	leaf_blast	<b>0.8929</b>	<b>0.8929</b>	<b>0.8929</b>
	leaf_scald	<b>0.9726</b>	<b>0.9861</b>	<b>0.9793</b>
	narrow_brown_spot	<b>0.9318</b>	<b>1.0000</b>	<b>0.9647</b>
	accuracy	<b>0.9434</b>	<b>0.9434</b>	<b>0.9434</b>
HE processed Image (L channel)	bacterial_leaf_blight_HE_L	<b>1.0000</b>	<b>0.9452</b>	<b>0.9718</b>
	brown_spot_HE_L	<b>0.8732</b>	<b>0.7848</b>	<b>0.8267</b>
	healthy_HE_L	<b>0.9222</b>	<b>0.9540</b>	<b>0.9379</b>
	leaf_blast_HE_L	<b>0.8462</b>	<b>0.7857</b>	<b>0.8148</b>
	leaf_scald_HE_L	<b>0.9178</b>	<b>0.9306</b>	<b>0.9241</b>
	narrow_brown_spot_HE_L	<b>0.7917</b>	<b>0.9268</b>	<b>0.8539</b>
	accuracy	<b>0.8868</b>	<b>0.8868</b>	<b>0.8868</b>

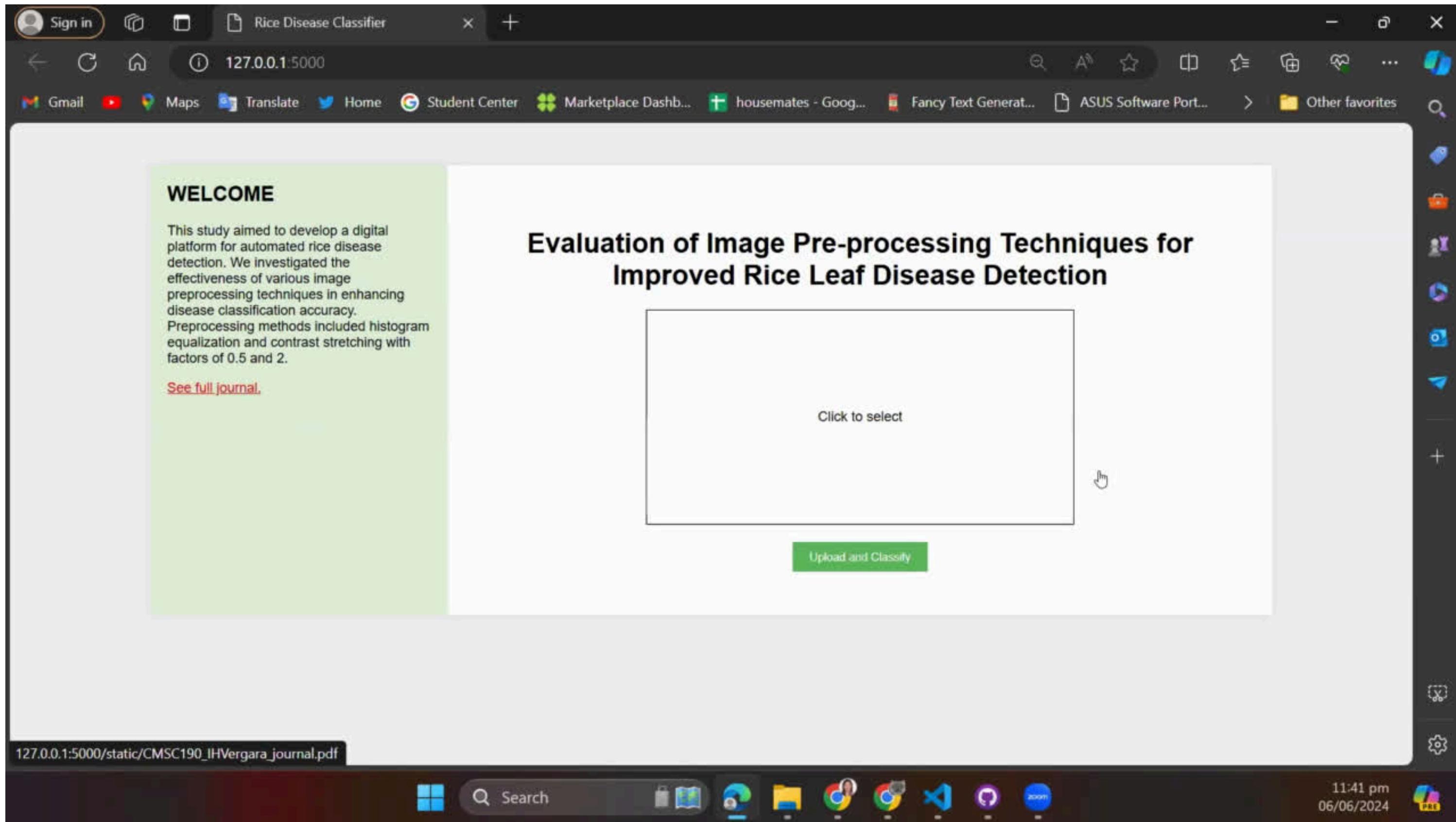
# Classification Results

Model	Class	Precision	Recall	F1-Score
HE-processed Image (V channel)	bacterial_leaf_blight_HE_V	0.9733	1.0000	0.9865
	brown_spot_HE_V	0.6842	0.8228	0.7471
	healthy_HE_V	0.7545	0.9540	0.8426
	leaf_blast_HE_V	0.8222	0.4405	0.5736
	leaf_scald_HE_V	0.9531	0.8472	0.8971
	narrow_brown_spot_HE_V	0.8523	0.9146	0.8824
	accuracy	0.8260	0.8260	0.8260
CS-processed Image (0.5)	bacterial_leaf_blight_CS	0.9853	0.9178	0.9504
	brown_spot_CS	0.8140	0.8861	0.8485
	healthy_CS	0.9875	0.9080	0.9461
	leaf_blast_CS	0.8846	0.8214	0.8519
	leaf_scald_CS	0.9459	0.9722	0.9589
	narrow_brown_spot_CS	0.9011	1.0000	0.9480
	accuracy	0.9161	0.9161	0.9161
CS- processed Image (2)	bacterial_leaf_blight_CS2	1.0000	1.0000	1.0000
	brown_spot_CS2	0.8289	0.7975	0.8129
	healthy_CS2	0.9762	0.9425	0.9591
	leaf_blast__CS2	0.8235	0.8333	0.8284
	leaf_scald__CS2	0.9859	0.9722	0.9790
	narrow_brown_spot__CS2	0.9318	1.0000	0.9647
	accuracy	0.9224	0.9224	0.9224

# Overall Accuracy

Method	Accuracy
Original	94.34%
Contrast Stretching (2)	92.24%
Contrast Stretching (0.5)	91.61%
Histogram Equalization(L)	88.68%
Histogram Equalization(v)	82.60%

# Web Application



# Conclusion

- Image quality metrics (PSNR, NRMSE, SSIM) and classification accuracy measure different things.
  - Image quality metrics focus on noise, sharpness, and structural similarity.
  - Classification accuracy focuses on a classifier's ability to categorize images correctly.
- High image quality metrics don't guarantee optimal classification accuracy.
  - Classification algorithms' complexity and robustness play a role.
- Preprocessing can be beneficial for specific diseases (e.g., contrast stretching for bacterial leaf blight).
- Not all diseases benefit from preprocessing techniques, as shown by the original image achieving higher accuracy for some diseases.

# Future Works

- Investigate how these findings apply to other CNN models (architecture's impact on image quality-accuracy relationship).
- Explore alternative preprocessing techniques for a deeper understanding of image enhancement and classification performance.
- Utilize validated datasets from different organisms/tissues requiring image quality improvement to broaden platform applicability.
- Develop a mobile application to enable real-time disease detection in the field, improving accessibility for a wider user base.

The background of the image is a dense, vibrant green field of grass or crops, likely wheat, filling the entire frame.

**Thank you!**