Data Loading

In [49]:
```
import tensorflow as tf
from tensorflow.keras import models, layers
import matplotlib.pyplot as plt
import numpy as np
import os
```

In [50]:
```
IMAGE_SIZE = 256
BATCH_SIZE = 32
CHANNELS = 3
EPOCHS =20
```

In [51]:
```
dataset = tf.keras.preprocessing.image_dataset_from_directory(
    'rice_leaf_disease_images',
    shuffle = True,
    image_size = (IMAGE_SIZE, IMAGE_SIZE),
    batch_size = BATCH_SIZE
)
```

```
Found 7926 files belonging to 5 classes.
```

In [52]:
```
class_names = dataset.class_names
class_names
```

Out[52]:
```
['Bacterialblight', 'Blast', 'Brownspot', 'Healthy', 'Tungro']
```

In [53]:
```
len(dataset)
```

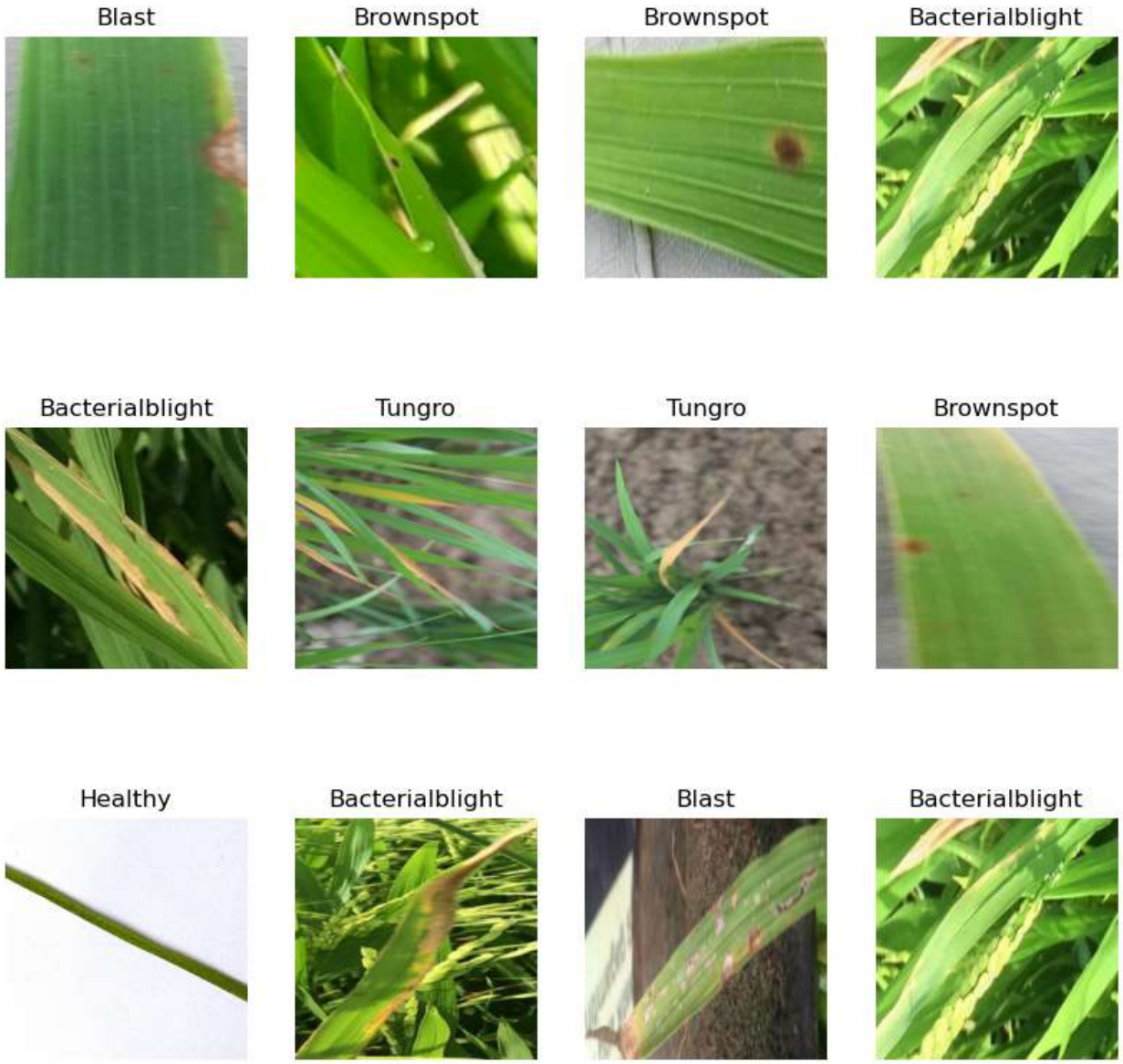
Out[53]:
```
248
```

In [54]:
```
# One random batch of images
for image_batch, label_batch in dataset.take(1):
    print(image_batch.shape)
    print(label_batch.numpy())
```

```
(32, 256, 256, 3)
[2 0 4 3 1 1 4 0 2 3 4 4 4 0 4 2 0 3 0 0 0 1 3 3 0 2 1 3 0 2 2 1]
```

In [55]:
```
plt.figure(figsize=(10,10))
for image_batch, label_batch in dataset.take(1):
    print(image_batch.shape)
    print(label_batch.numpy())
    for i in range(12): #showing 12 images out of 32
        ax = plt.subplot(3,4,i+1)
        plt.imshow(image_batch[i].numpy().astype("uint8"))
        plt.title(class_names[label_batch[i]])
        plt.axis("off")
```

```
(32, 256, 256, 3)
[1 2 2 0 0 4 4 2 3 0 1 0 2 2 0 1 0 4 0 0 3 3 2 3 3 1 3 1 1 2 4 1]
```



In [56]:
```
# (32=batch_size, 256, 256=image_size, 0 to 3=typesofdiseases)
# 0 - Bacterial Blight
# 1 - Blast
# 2 - Brownspot
# 3 - Tungro
```

In [57]:
```
# Spitting dataset for training, validation and testing
# 80% for training 10% for validation and 10% for testing
def get_dataset_partitions_tf(ds, train_split=0.8, val_split=0.1, test_split=0.1, shuffle
    ds_size = len(ds)
    if shuffle:
        ds = ds.shuffle(shuffle_size, seed=12)
    train_size = int(train_split*ds_size)
    val_size = int(val_split*ds_size)

    train_ds = ds.take(train_size)
    val_ds = ds.skip(train_size).take(val_size)
    test_ds = ds.skip(train_size).skip(val_size)

    return train_ds, val_ds, test_ds
```

In [58]:
```
train_ds, val_ds, test_ds =get_dataset_partitions_tf(dataset)
```

In [59]:
```
# Catching and prefeching
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUNE)
val_ds = val_ds.cache().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUNE)
test_ds = test_ds.cache().prefetch(buffer_size=tf.data.AUTOTUNE)
```

Preprocessing

In [12]:
```
# Layer for resizing and rescaling
resize_and_rescale = tf.keras.Sequential([
    layers.experimental.preprocessing.Resizing(IMAGE_SIZE, IMAGE_SIZE),
    layers.experimental.preprocessing.Rescaling(1.0/255)
])
```

In [13]:
```
# Data Augmentation
data_augmentation = tf.keras.Sequential([
    layers.experimental.preprocessing.RandomFlip("horizontal_and_vertical"),
    layers.experimental.preprocessing.RandomRotation(0.2)
])
```

Convolution Neural Network

In [14]:
```
#input_shape = (IMAGE_SIZE, IMAGE_SIZE, CHANNELS)
input_shape = (BATCH_SIZE, IMAGE_SIZE, IMAGE_SIZE, CHANNELS)
n_classes= 5

model = models.Sequential([
    resize_and_rescale,
    data_augmentation,

    layers.Conv2D(32,(3,3), activation='relu', input_shape = input_shape),
    layers.MaxPooling2D((2,2)),

    layers.Conv2D(64,kernel_size = (3,3), activation='relu'),
    layers.MaxPooling2D((2,2)),

    layers.Conv2D(64,kernel_size = (3,3), activation='relu'),
    layers.MaxPooling2D((2,2)),

    layers.Conv2D(64,kernel_size = (3,3), activation='relu'),
    layers.MaxPooling2D((2,2)),

    layers.Conv2D(64,kernel_size = (3,3), activation='relu'),
    layers.MaxPooling2D((2,2)),

    layers.Conv2D(64,kernel_size = (3,3), activation='relu'),
    layers.MaxPooling2D((2,2)),

    layers.Flatten(),
    layers.Dense(64, activation='relu'),
    layers.Dense(n_classes, activation='softmax'),
])
```

In [15]:
```
model.build(input_shape = input_shape)
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there is no re
gistered converter for this op.
WARNING:tensorflow:Using a while_loop for converting Bitcast cause there is no registere
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WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3 cause th
ere is no registered converter for this op.
```

In [16]:
```
model.summary()
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 sequential (Sequential)     (32, 256, 256, 3)         0

 sequential_1 (Sequential)   (None, 256, 256, 3)       0

 conv2d (Conv2D)             (None, 254, 254, 32)      896

 max_pooling2d (MaxPooling2D  (None, 127, 127, 32)     0
 )

 conv2d_1 (Conv2D)           (None, 125, 125, 64)      18496

 max_pooling2d_1 (MaxPooling  (None, 62, 62, 64)       0
 2D)

 conv2d_2 (Conv2D)           (None, 60, 60, 64)        36928

 max_pooling2d_2 (MaxPooling  (None, 30, 30, 64)       0
 2D)

 conv2d_3 (Conv2D)           (None, 28, 28, 64)        36928

 max_pooling2d_3 (MaxPooling  (None, 14, 14, 64)       0
 2D)

 conv2d_4 (Conv2D)           (None, 12, 12, 64)        36928

 max_pooling2d_4 (MaxPooling  (None, 6, 6, 64)         0
 2D)

 conv2d_5 (Conv2D)           (None, 4, 4, 64)          36928

 max_pooling2d_5 (MaxPooling  (None, 2, 2, 64)         0
 2D)

 flatten (Flatten)           (None, 256)               0

 dense (Dense)               (None, 64)                16448

 dense_1 (Dense)             (None, 5)                 325

=================================================================
Total params: 183,877
Trainable params: 183,877
Non-trainable params: 0
_________________________________________________________________
```

In [17]:
```
model.compile(
    optimizer='adam',
    loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=False),
    metrics=['accuracy'])
```

In [18]:
```
logdir='logs'
```

In [19]:
```
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

In [20]:
```
callback = tf.keras.callbacks.EarlyStopping(
    monitor="val_loss",
    min_delta=0,
    patience=0,
    verbose=0,
    mode="auto",
    baseline=None,
    restore_best_weights=False,
)
```

In [21]:
```
history = model.fit(
    train_ds,
    epochs=EPOCHS,
    batch_size=BATCH_SIZE,
    verbose=1,
    validation_data=val_ds,
    callbacks=tensorboard_callback
)
```

```
Epoch 1/20
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WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3 cause th
ere is no registered converter for this op.
198/198 [==============================] - 534s 2s/step - loss: 1.0929 - accuracy: 0.534
8 - val_loss: 0.8955 - val_accuracy: 0.6484
Epoch 2/20
198/198 [==============================] - 382s 2s/step - loss: 0.8101 - accuracy: 0.682
1 - val_loss: 0.7629 - val_accuracy: 0.6940
Epoch 3/20
198/198 [==============================] - 338s 2s/step - loss: 0.6644 - accuracy: 0.751
0 - val_loss: 0.6418 - val_accuracy: 0.7604
Epoch 4/20
198/198 [==============================] - 340s 2s/step - loss: 0.5215 - accuracy: 0.803
7 - val_loss: 0.4311 - val_accuracy: 0.8464
Epoch 5/20
198/198 [==============================] - 332s 2s/step - loss: 0.4603 - accuracy: 0.830
5 - val_loss: 0.3430 - val_accuracy: 0.8841
Epoch 6/20
198/198 [==============================] - 345s 2s/step - loss: 0.3659 - accuracy: 0.863
3 - val_loss: 0.3713 - val_accuracy: 0.8503
Epoch 7/20
198/198 [==============================] - 349s 2s/step - loss: 0.3200 - accuracy: 0.882
5 - val_loss: 0.4407 - val_accuracy: 0.8659
Epoch 8/20
```

```
198/198 [==============================] - 332s 2s/step - loss: 0.2823 - accuracy: 0.893
0 - val_loss: 0.2581 - val_accuracy: 0.9154
Epoch 9/20
198/198 [==============================] - 332s 2s/step - loss: 0.2394 - accuracy: 0.913
7 - val_loss: 0.1934 - val_accuracy: 0.9323
Epoch 10/20
198/198 [==============================] - 334s 2s/step - loss: 0.2168 - accuracy: 0.921
0 - val_loss: 0.2242 - val_accuracy: 0.9154
Epoch 11/20
198/198 [==============================] - 388s 2s/step - loss: 0.1742 - accuracy: 0.936
6 - val_loss: 0.2207 - val_accuracy: 0.9271
Epoch 12/20
198/198 [==============================] - 383s 2s/step - loss: 0.1895 - accuracy: 0.932
3 - val_loss: 0.3205 - val_accuracy: 0.8724
Epoch 13/20
198/198 [==============================] - 353s 2s/step - loss: 0.1800 - accuracy: 0.938
0 - val_loss: 0.2419 - val_accuracy: 0.9245
Epoch 14/20
198/198 [==============================] - 353s 2s/step - loss: 0.1284 - accuracy: 0.954
0 - val_loss: 0.1875 - val_accuracy: 0.9401
Epoch 15/20
198/198 [==============================] - 341s 2s/step - loss: 0.1637 - accuracy: 0.942
6 - val_loss: 0.1887 - val_accuracy: 0.9401
Epoch 16/20
198/198 [==============================] - 340s 2s/step - loss: 0.1036 - accuracy: 0.965
2 - val_loss: 0.2069 - val_accuracy: 0.9232
Epoch 17/20
198/198 [==============================] - 499s 3s/step - loss: 0.1078 - accuracy: 0.958
9 - val_loss: 0.1087 - val_accuracy: 0.9661
Epoch 18/20
198/198 [==============================] - 451s 2s/step - loss: 0.1010 - accuracy: 0.967
8 - val_loss: 0.1451 - val_accuracy: 0.9518
Epoch 19/20
198/198 [==============================] - 668s 3s/step - loss: 0.1034 - accuracy: 0.964
7 - val_loss: 0.1204 - val_accuracy: 0.9583
Epoch 20/20
198/198 [==============================] - 1102s 6s/step - loss: 0.0915 - accuracy: 0.96
92 - val_loss: 0.1756 - val_accuracy: 0.9388
```

In [22]:
```
scores = model.evaluate(test_ds)
scores
```

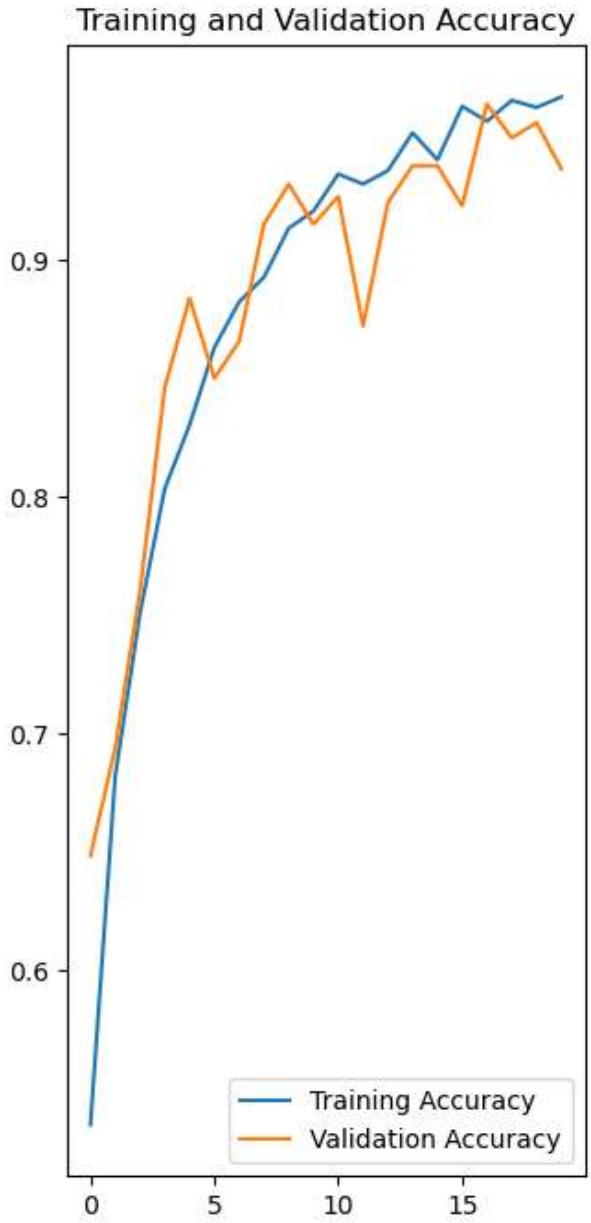
```
26/26 [==============================] - 461s 2s/step - loss: 0.1224 - accuracy: 0.9519
```

Out[22]:
```
[0.12244930863380432, 0.9519230723381042]
```

In [23]:
```
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
```

In [24]:
```
plt.figure(figsize=(8,8))
plt.subplot(1,2,1)
plt.plot(range(EPOCHS), acc, label='Training Accuracy')
plt.plot(range(EPOCHS), val_acc, label='Validation Accuracy')
plt.legend(loc = 'lower right')
plt.title('Training and Validation Accuracy')
```

Out[24]:
```
Text(0.5, 1.0, 'Training and Validation Accuracy')
```



In [25]:
```
def predict(model, img):
    img_array = tf.keras.preprocessing.image.img_to_array(images[i].numpy())
    img_array = tf.expand_dims(img_array, 0)

    prediction = model.predict(img_array)

    prediction_class = class_names[np.argmax(prediction[0])]
    confidence = round(100 * (np.max(prediction[0])),2)

    return prediction_class, confidence
```

In [26]:
```
plt.figure(figsize=(15,15))
for images, labels in test_ds.take(1):
    for i in range(9):
        ax = plt.subplot(3,3,i+1)
        plt.imshow(images[i].numpy().astype('uint8'))

        predicted_class, confidence = predict(model, images[i].numpy())
        actual_class = class_names[labels[i]]
        plt.title(f'predicted: {predicted_class},\n confidence: {confidence}, \n Actual:
        plt.axis("off")
```

```
1/1 [==============================] - 3s 3s/step
1/1 [==============================] - 0s 183ms/step
1/1 [==============================] - 0s 326ms/step
1/1 [==============================] - 1s 553ms/step
1/1 [==============================] - 0s 440ms/step
1/1 [==============================] - 1s 774ms/step
1/1 [==============================] - 0s 372ms/step
1/1 [==============================] - 0s 282ms/step
1/1 [==============================] - 1s 619ms/step
```

predicted: Tungro,
confidence: 99.99,
Actual: Tungro

predicted: Brownspot,
confidence: 43.71,
Actual: Brownspot

predicted: Blast,
confidence: 77.58,
Actual: Blast

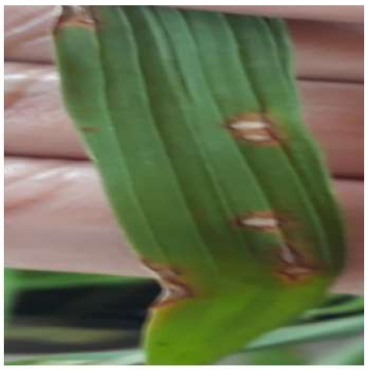
predicted: Brownspot,
confidence: 99.98,
Actual: Brownspot

predicted: Bacterialblight,
confidence: 99.91,
Actual: Bacterialblight

predicted: Bacterialblight,
confidence: 100.0,
Actual: Bacterialblight

predicted: Bacterialblight,
confidence: 99.37,
Actual: Bacterialblight

predicted: Blast,
confidence: 100.0,
Actual: Blast



predicted: Bacterialblight,
confidence: 99.6,
Actual: Bacterialblight

In [27]:
```
# Saving the model
model_version = max([int(i) for i in os.listdir("new_models") + [0]])+1
model.save(f'new_models\{model_version}')
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there is no re
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WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3 cause th
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WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_compile
d_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compi
led_convolution_op while saving (showing 5 of 7). These functions will not be directly c
allable after loading.

INFO:tensorflow:Assets written to: new_models\2\assets

INFO:tensorflow:Assets written to: new_models\2\assets
```

In [60]:
```
new_model = tf.keras.models.load_model('new_models/2')

# Check its architecture
new_model.summary()
```

```
WARNING:tensorflow:Using a while_loop for converting RngReadAndSkip cause there is no re
gistered converter for this op.

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WARNING:tensorflow:Using a while_loop for converting ImageProjectiveTransformV3 cause th
ere is no registered converter for this op.
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 sequential (Sequential)     (None, 256, 256, 3)       0

 sequential_1 (Sequential)   (None, 256, 256, 3)       0

 conv2d (Conv2D)             (None, 254, 254, 32)      896

 max_pooling2d (MaxPooling2D  (None, 127, 127, 32)     0
 )

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 2D)

 conv2d_3 (Conv2D)           (None, 28, 28, 64)        36928

 max_pooling2d_3 (MaxPooling  (None, 14, 14, 64)       0
 2D)

 conv2d_4 (Conv2D)           (None, 12, 12, 64)        36928

 max_pooling2d_4 (MaxPooling  (None, 6, 6, 64)         0
 2D)

 conv2d_5 (Conv2D)           (None, 4, 4, 64)          36928

 max_pooling2d_5 (MaxPooling  (None, 2, 2, 64)         0
 2D)

 flatten (Flatten)           (None, 256)               0

 dense (Dense)               (None, 64)                16448

 dense_1 (Dense)             (None, 5)                 325

=================================================================
Total params: 183,877
Trainable params: 183,877
Non-trainable params: 0
_________________________________________________________________
```

In [61]:
```
scores = new_model.evaluate(test_ds)
scores
```

```
26/26 [==============================] - 243s 1s/step - loss: 0.1314 - accuracy: 0.9543
```

Out[61]:
```
[0.13144931197166443, 0.9543269276618958]
```

In [62]:
```
print("Accuracy : {:.3f}".format(scores[1]))
```

```
Accuracy : 0.954
```

In [ ]:

New Image Prediction

In [63]:
```
import cv2
import numpy as np
```

In [92]:
```
img_path = cv2.imread(os.path.join('rice_leaf_disease_images','Tungro','TUNGRO1_020.jpg')
#img_path = cv2.imread(os.path.join('Testing images','bb1.jpg'))
img_path = cv2.cvtColor(img_path,cv2.COLOR_BGR2RGB)
plt.imshow(img_path)
```

Out[92]: <matplotlib.image.AxesImage at 0x27d8544fdf0>

In [93]:
```
img = cv2.resize(img_path,(256,256))
img = np.reshape(img,[1,256,256,3])
```

In [94]:
```
pred = new_model.predict(img)
```

```
1/1 [==============================] - 0s 105ms/step
```

In [95]:
```
pred
```

Out[95]:
```
array([[2.4744952e-07, 2.6614054e-05, 1.1063103e-07, 1.4974265e-10,
        9.9997306e-01]], dtype=float32)
```

In [96]:
```
prediction_class = class_names[np.argmax(pred)]
prediction_class
```

Out[96]: 'Tungro'

In [ ]:

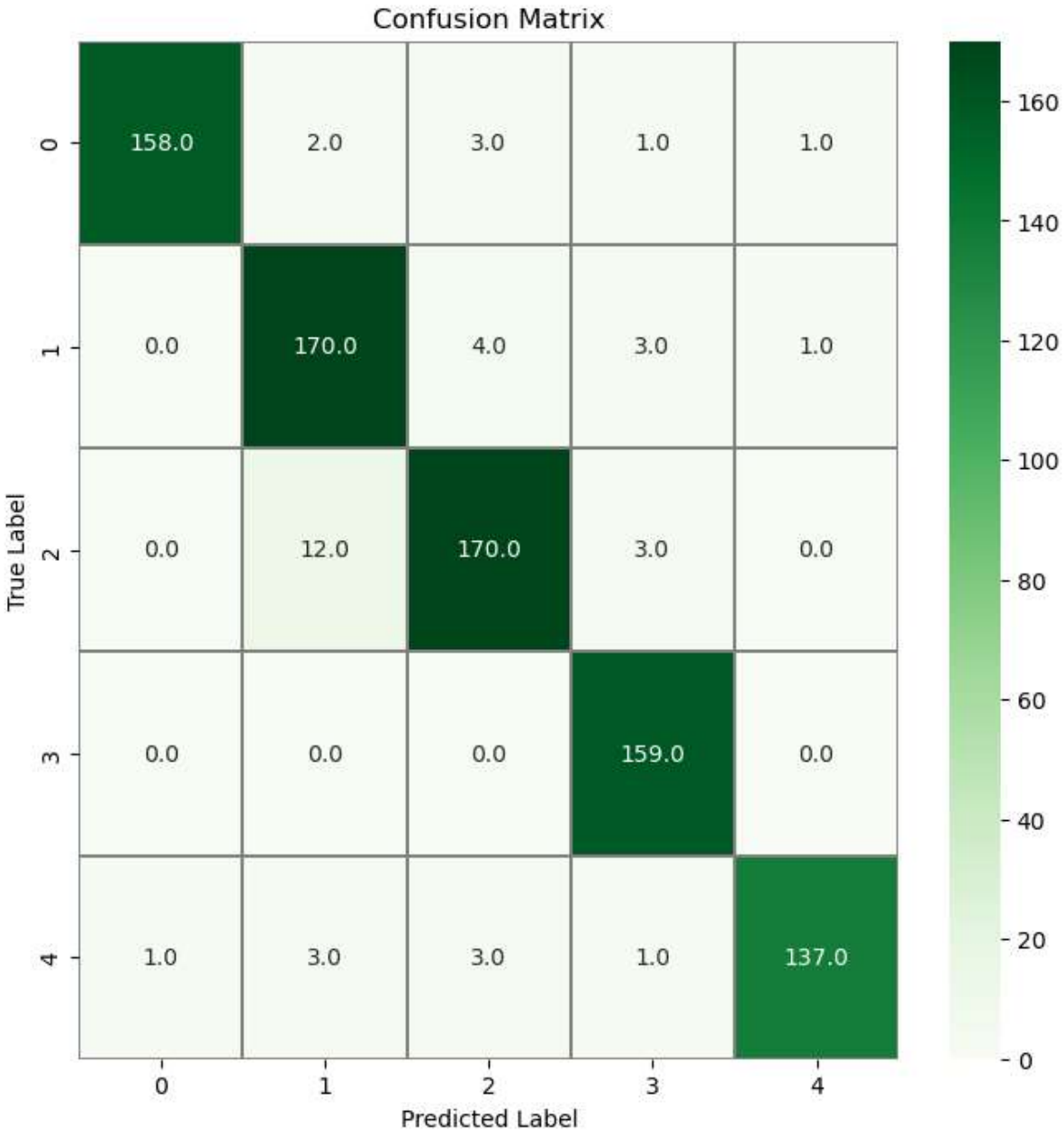
In [ ]:

In [ ]:
```
#Confusion Matrix
```

In [69]:
```
from sklearn.metrics import confusion_matrix , classification_report
```

In [70]:
```
# confusion matrix
import seaborn as sns
# Predict the values from the validation dataset
Y_pred = new_model.predict(test_ds)
# Convert predictions classes to one hot vectors
Y_pred_classes = np.argmax(Y_pred,axis = 1)
# Convert validation observations to one hot vectors
Y_true = tf.concat([y for x, y in test_ds], axis=0)
# compute the confusion matrix
confusion_mtx = confusion_matrix(Y_true, Y_pred_classes)
# plot the confusion matrix
f,ax = plt.subplots(figsize=(8, 8))
sns.heatmap(confusion_mtx, annot=True, linewidths=0.01,cmap="Greens",linecolor="gray", fm
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.title("Confusion Matrix")
plt.show()
```

```
26/26 [==============================] - 22s 802ms/step
```



In [71]:
```
print(classification_report(Y_true, Y_pred_classes, target_names=class_names))
```

```
                precision    recall  f1-score   support

Bacterialblight       0.99      0.96      0.98       165
          Blast       0.91      0.96      0.93       178
      Brownspot       0.94      0.92      0.93       185
        Healthy       0.95      1.00      0.98       159
         Tungro       0.99      0.94      0.96       145

       accuracy                           0.95       832
      macro avg       0.96      0.96      0.96       832
   weighted avg       0.96      0.95      0.95       832
```

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