Data Loading

In [57]:
```
import tensorflow as tf
from tensorflow.keras import models, layers
import matplotlib.pyplot as plt
import numpy as np
import os
```

In [58]:
```
IMAGE_SIZE = 224
BATCH_SIZE = 32
CHANNELS = 3
EPOCHS =10
```

In [59]:
```
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 [60]:
```
class_names = dataset.class_names
class_names
```

Out[60]:
```
['Bacterialblight', 'Blast', 'Brownspot', 'Healthy', 'Tungro']
```

In [61]:
```
len(dataset) #186*32=5931
```

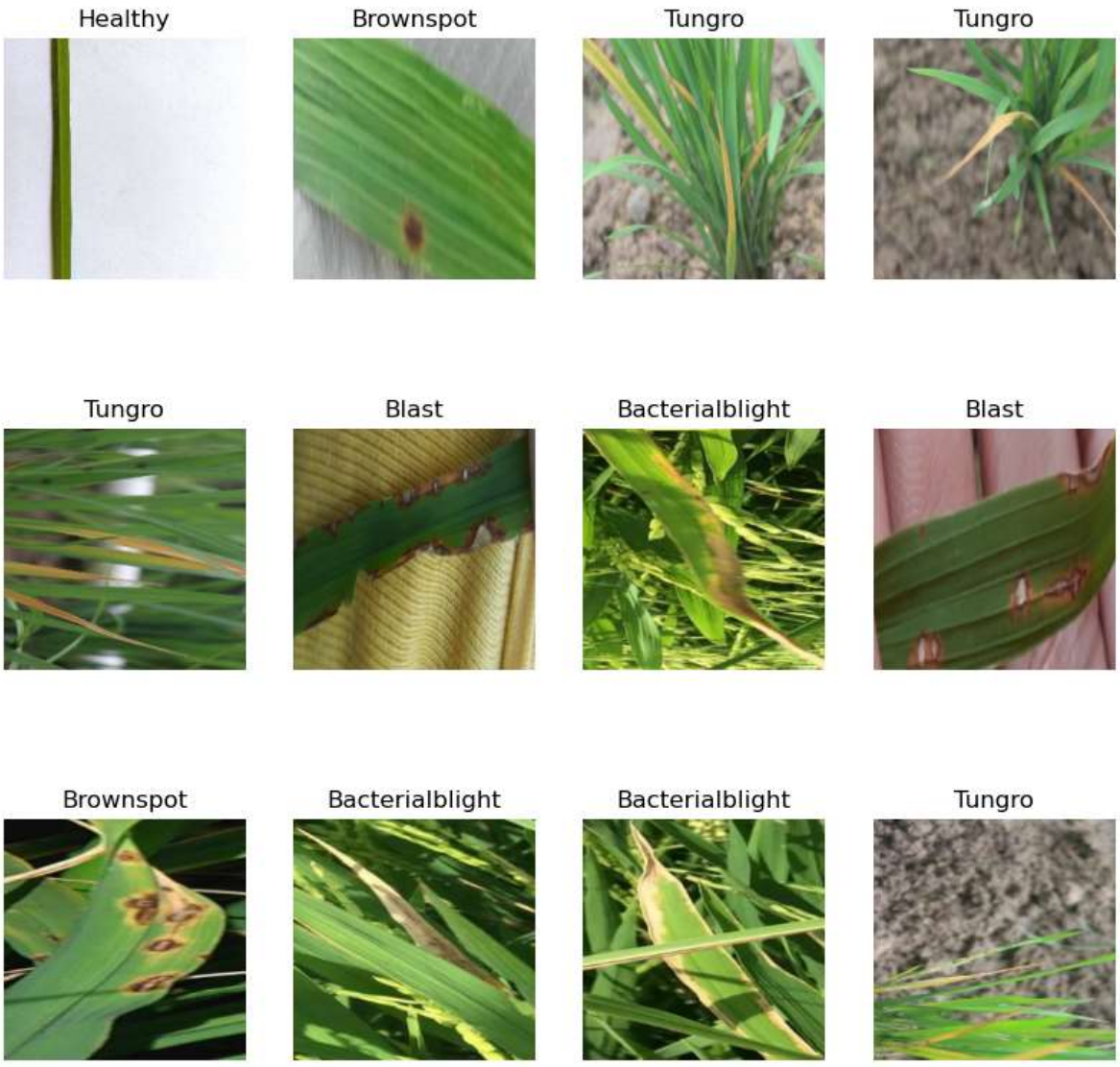
Out[61]:
```
248
```

In [62]:
```
# One random batch of images
for image_batch, label_batch in dataset.take(1):
    print(image_batch.shape)
    print(label_batch.numpy())
```

```
(32, 224, 224, 3)
[2 3 3 3 0 0 4 0 4 4 1 3 1 0 4 2 4 4 1 2 4 4 2 2 4 1 0 1 4 2 4 0]
```

In [63]:
```
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, 224, 224, 3)
[3 2 4 4 4 1 0 1 2 0 0 4 4 3 3 0 4 3 0 3 4 3 0 0 2 0 4 0 4 0 2 0]
```



In [64]:
```
# (32=batch_size, 256, 256=image_size, 0 to 3=typesofdiseases)
# 0 - Bacterial Blight
# 1 - Blast
# 2 - Brownspot
# 3 - Tungro
```

In [65]:
```
# 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
    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 [66]:
```
train_ds, val_ds, test_ds =get_dataset_partitions_tf(dataset)
```

In [67]:
```
# Catching and prefeching
train_ds = train_ds.cache().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUN
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)
])
```

VGG16

In [14]:
```
from tensorflow.keras.applications.vgg19 import VGG19
```

In [15]:
```
vgg19 = VGG19(input_shape=(IMAGE_SIZE,IMAGE_SIZE,CHANNELS),weights='imagenet',
```

In [16]:
```
# Don't train existing weights
for layer in vgg19.layers:
    layer.trainable = False
```

In [17]:
```
x = tf.keras.layers.Flatten()(vgg19.output)
```

In [18]:
```
prediction = tf.keras.layers.Dense(len(class_names),activation='softmax')(x)
```

In [19]:
```
model = tf.keras.Model(inputs=vgg19.input, outputs=prediction)
```

In [20]:
```
model.summary()
```

```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv4 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0

 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv4 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv4 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 flatten (Flatten)           (None, 25088)             0

 dense (Dense)               (None, 5)                 125445

=================================================================
Total params: 20,149,829
Trainable params: 125,445
```

```
Non-trainable params: 20,024,384
_________________________________________________________________
```

In [21]:
```
model.compile(
    optimizer='adam',
    loss=tf.keras.losses.SparseCategoricalCrossentropy(from_logits=False),
    metrics=['accuracy'])
```

In [22]:
```
logdir='logs'
```

In [23]:
```
tensorboard_callback = tf.keras.callbacks.TensorBoard(log_dir=logdir)
```

In [24]:
```
history = model.fit(
    train_ds,
    epochs=EPOCHS,
    batch_size=BATCH_SIZE,
    verbose=1,
    validation_data=val_ds,
    callbacks=[tensorboard_callback]
)
```

```
Epoch 1/10
198/198 [==============================] - 3461s 16s/step - loss: 2.1205 - ac
curacy: 0.8946 - val_loss: 0.8742 - val_accuracy: 0.9492
Epoch 2/10
198/198 [==============================] - 1859s 9s/step - loss: 0.4323 - acc
uracy: 0.9738 - val_loss: 0.4227 - val_accuracy: 0.9753
Epoch 3/10
198/198 [==============================] - 20341s 103s/step - loss: 0.2485 -
accuracy: 0.9832 - val_loss: 0.1618 - val_accuracy: 0.9909
Epoch 4/10
198/198 [==============================] - 1700s 9s/step - loss: 0.2799 - acc
uracy: 0.9842 - val_loss: 0.2276 - val_accuracy: 0.9857
Epoch 5/10
198/198 [==============================] - 1429s 7s/step - loss: 0.1863 - acc
uracy: 0.9889 - val_loss: 0.1811 - val_accuracy: 0.9896
Epoch 6/10
198/198 [==============================] - 1483s 7s/step - loss: 0.1109 - acc
uracy: 0.9945 - val_loss: 0.1456 - val_accuracy: 0.9922
Epoch 7/10
198/198 [==============================] - 1695s 9s/step - loss: 0.0728 - acc
uracy: 0.9949 - val_loss: 0.1907 - val_accuracy: 0.9922
Epoch 8/10
198/198 [==============================] - 1652s 8s/step - loss: 0.0817 - acc
uracy: 0.9940 - val_loss: 0.2431 - val_accuracy: 0.9909
Epoch 9/10
198/198 [==============================] - 1527s 8s/step - loss: 0.1531 - acc
uracy: 0.9926 - val_loss: 0.1087 - val_accuracy: 0.9870
Epoch 10/10
198/198 [==============================] - 1550s 8s/step - loss: 0.0977 - acc
uracy: 0.9948 - val_loss: 0.2186 - val_accuracy: 0.9883
```

In [25]:
```
scores = model.evaluate(test_ds)
scores
```

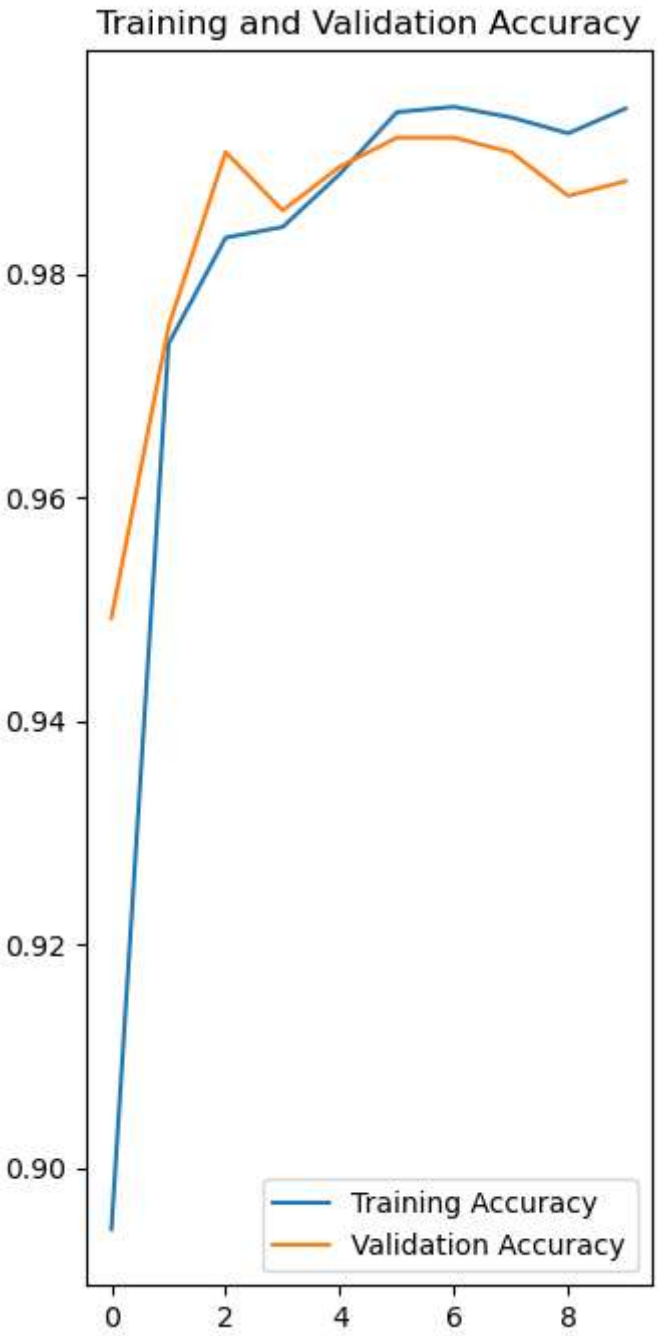
```
26/26 [==============================] - 337s 10s/step - loss: 0.2643 - accur
acy: 0.9880
```

Out[25]:
```
[0.26430729031562805, 0.9879807829856873]
```

In [26]:
```
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']
```

In [27]:
```
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[27]:
```
Text(0.5, 1.0, 'Training and Validation Accuracy')
```



In [28]:
```
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 [29]:
```
plt.figure(figsize=(15,15))
for images, labels in test_ds.take(2):
    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},
        plt.axis("off")
```

```
1/1 [==============================] - 4s 4s/step
1/1 [==============================] - 0s 308ms/step
1/1 [==============================] - 0s 331ms/step
1/1 [==============================] - 0s 297ms/step
1/1 [==============================] - 0s 309ms/step
1/1 [==============================] - 0s 304ms/step
1/1 [==============================] - 0s 468ms/step
1/1 [==============================] - 0s 455ms/step
1/1 [==============================] - 0s 309ms/step
1/1 [==============================] - 0s 404ms/step
1/1 [==============================] - 0s 445ms/step
1/1 [==============================] - 0s 307ms/step
1/1 [==============================] - 0s 289ms/step
1/1 [==============================] - 0s 338ms/step
1/1 [==============================] - 0s 283ms/step
1/1 [==============================] - 0s 340ms/step
1/1 [==============================] - 0s 318ms/step
1/1 [==============================] - 0s 409ms/step
```

In [52]:
```
# 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:absl:Found untraced functions such as _jit_compiled_convolution_op, _
jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_conv
olution_op, _jit_compiled_convolution_op while saving (showing 5 of 17). Thes
e functions will not be directly callable after loading.

INFO:tensorflow:Assets written to: new_models\3\assets

INFO:tensorflow:Assets written to: new_models\3\assets
```

In [53]:
```
new_model = tf.keras.models.load_model('new_models/3')

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

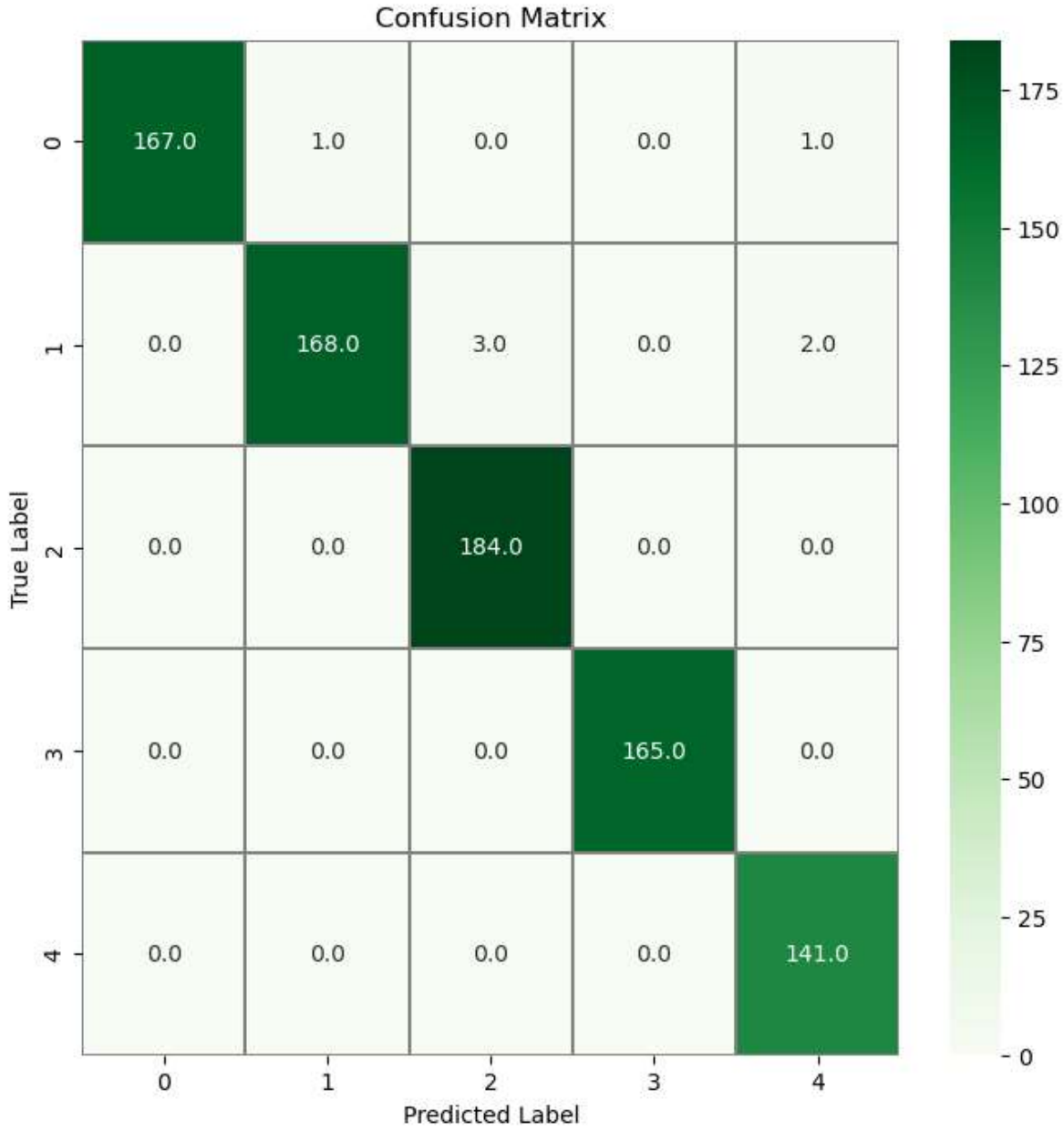
```
Model: "model"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 input_1 (InputLayer)        [(None, 224, 224, 3)]     0

 block1_conv1 (Conv2D)       (None, 224, 224, 64)      1792

 block1_conv2 (Conv2D)       (None, 224, 224, 64)      36928

 block1_pool (MaxPooling2D)  (None, 112, 112, 64)      0

 block2_conv1 (Conv2D)       (None, 112, 112, 128)     73856

 block2_conv2 (Conv2D)       (None, 112, 112, 128)     147584

 block2_pool (MaxPooling2D)  (None, 56, 56, 128)       0

 block3_conv1 (Conv2D)       (None, 56, 56, 256)       295168

 block3_conv2 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv3 (Conv2D)       (None, 56, 56, 256)       590080

 block3_conv4 (Conv2D)       (None, 56, 56, 256)       590080

 block3_pool (MaxPooling2D)  (None, 28, 28, 256)       0

 block4_conv1 (Conv2D)       (None, 28, 28, 512)       1180160

 block4_conv2 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv3 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_conv4 (Conv2D)       (None, 28, 28, 512)       2359808

 block4_pool (MaxPooling2D)  (None, 14, 14, 512)       0

 block5_conv1 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv2 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv3 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_conv4 (Conv2D)       (None, 14, 14, 512)       2359808

 block5_pool (MaxPooling2D)  (None, 7, 7, 512)         0

 flatten (Flatten)           (None, 25088)             0

 dense (Dense)               (None, 5)                 125445

=================================================================
Total params: 20,149,829
Trainable params: 125,445
```

```
Non-trainable params: 20,024,384
_________________________________________________________________
```

In [54]:
```
from sklearn.metrics import confusion_matrix , classification_report
```

In [68]:
```
# 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
plt.xlabel("Predicted Label")
plt.ylabel("True Label")
plt.title("Confusion Matrix")
plt.show()
```

```
26/26 [==============================] - 264s 7s/step
```



In [69]:
```
print(classification_report(Y_true, Y_pred_classes, target_names=class_names))
```

```
                precision    recall  f1-score   support

Bacterialblight       1.00      0.99      0.99       169
          Blast       0.99      0.97      0.98       173
      Brownspot       0.98      1.00      0.99       184
        Healthy       1.00      1.00      1.00       165
         Tungro       0.98      1.00      0.99       141

       accuracy                           0.99       832
      macro avg       0.99      0.99      0.99       832
   weighted avg       0.99      0.99      0.99       832
```

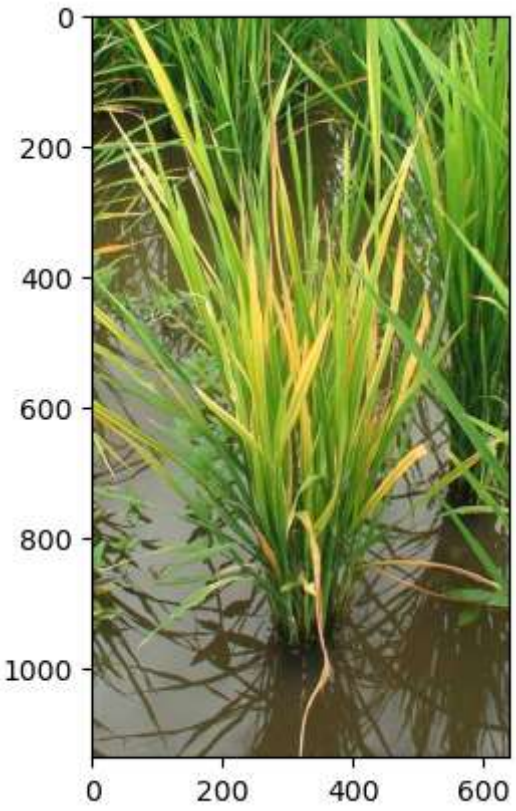
In [ ]:

In [ ]:

In [35]:
```
import numpy as np
import cv2
```

In [75]:
```
img_path = cv2.imread(os.path.join('Testing Images','t.jfif'))
img_path = cv2.cvtColor(img_path,cv2.COLOR_BGR2RGB)
plt.imshow(img_path)
```

Out[75]:
```
<matplotlib.image.AxesImage at 0x1ad09a64e80>
```



In [76]:
```
img = cv2.resize(img_path,(224,224))
img = np.reshape(img,[1,224,224,3])
```

In [77]:
```
pred = new_model.predict(img)
```

```
1/1 [==============================] - 0s 332ms/step
```

In [78]:
```
pred
```

Out[78]:
```
array([[0., 0., 0., 0., 1.]], dtype=float32)
```

In [79]:
```
prediction_class = class_names[np.argmax(pred)]
prediction_class
```

Out[79]: 'Tungro'

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]:

In [ ]: