In [2]:
```
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras import layers,models,Sequential
import tensorflow_hub as hub
%matplotlib inline
```

In [3]:
```
IMAGE_SIZE=256
BATCH_SIZE=32
```

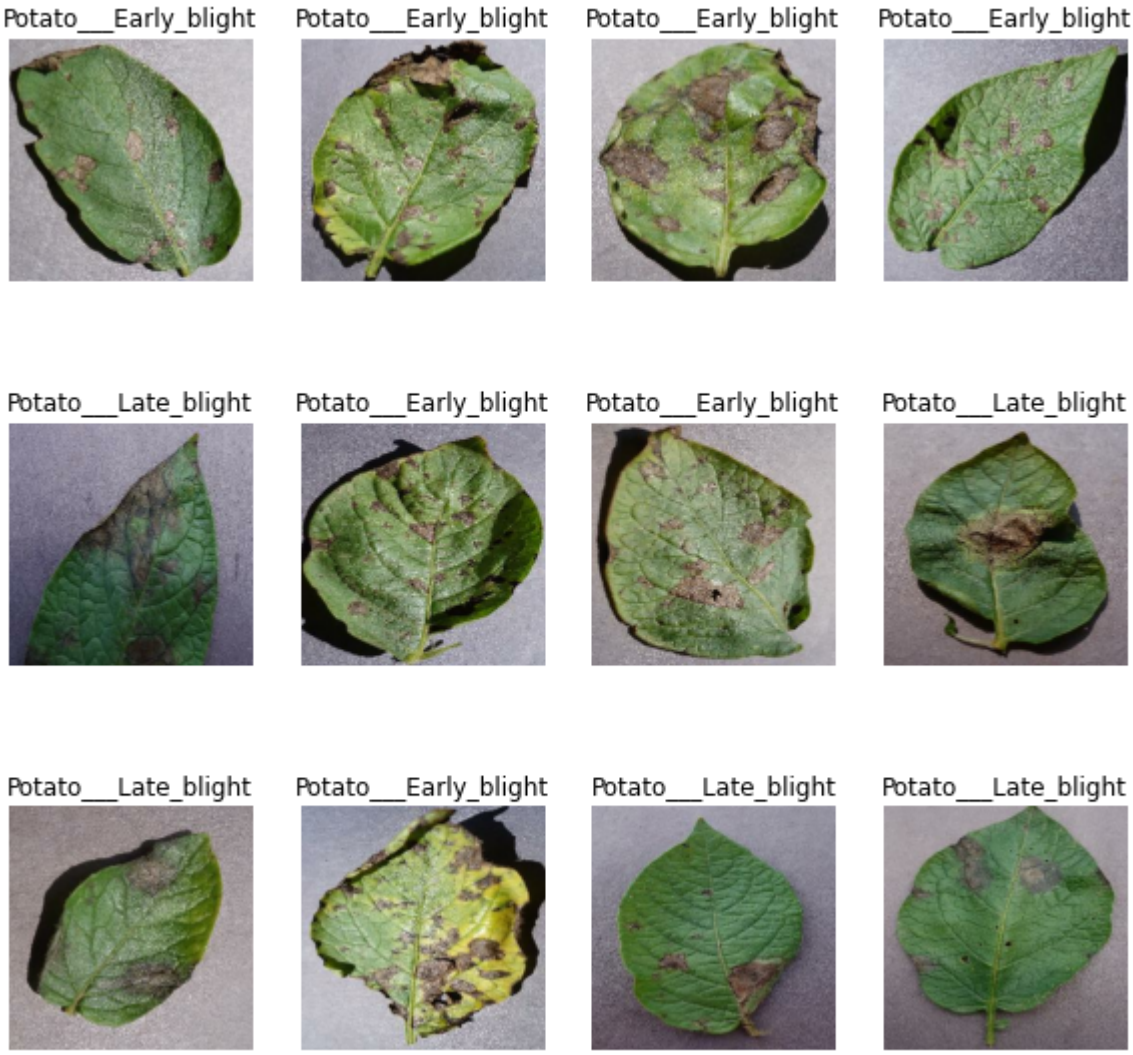
In [4]:
```
dataset=tf.keras.preprocessing.image_dataset_from_directory(
    'PlantVillage',
    shuffle=True,
    image_size=(IMAGE_SIZE,IMAGE_SIZE),
    batch_size=BATCH_SIZE
)
```

```
Found 2152 files belonging to 3 classes.
```

In [6]:
```
class_name=dataset.class_names
class_name
```

Out[6]:
```
['Potato___Early_blight', 'Potato___Late_blight', 'Potato___healthy']
```

In [6]:
```
plt.figure(figsize=(10,10))
for image, labels in dataset.take(1):
    for i in range(12) :
        ax=plt.subplot(3,4,i+1)
        plt.imshow(image[i].numpy().astype('uint8'))
        plt.axis('off')
        plt.title(class_name[labels[i]])
```



In [7]:
```
len(dataset)
int(0.8*len(dataset))
```

Out[7]:
```
54
```

In [7]:
```
def train_test_val_split(ds,train_size=0.8,test_size=0.1,val_size=0.1,shuffle=Tru
    if shuffle:
        ds=ds.shuffle(shuffle_size,seed=12)
    ds_size=len(ds)

    train_size=int(train_size*ds_size)
    val_size=int(val_size*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 [8]:
```
train_ds,val_ds,test_ds=train_test_val_split(dataset)
```

In [9]:
```
print(len(train_ds))
print(len(val_ds))
print(len(test_ds))
```

```
54
6
8
```

In [10]:
```
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().shuffle(1000).prefetch(buffer_size=tf.data.AUTOTUNE)
```

In [12]:
```
resize_and_rescale=Sequential([
    layers.experimental.preprocessing.Resizing(IMAGE_SIZE,IMAGE_SIZE),
    layers.experimental.preprocessing.Rescaling(1.0/255)
])
```

In [13]:
```
data_aug=Sequential([
    layers.experimental.preprocessing.RandomFlip('horizontal_and_vertical'),
    layers.experimental.preprocessing.RandomRotation(0.2)
])
```

In [18]:
```
model=Sequential([
    resize_and_rescale,
    data_aug,

    layers.Conv2D(32,(3,3),activation='relu',input_shape=(BATCH_SIZE,IMAGE_SIZE,I
    layers.MaxPooling2D((2,2)),
    layers.Conv2D(64,(3,3),activation='relu'),
    layers.MaxPooling2D((2,2)),
    layers.Conv2D(64,(3,3),activation='relu'),
    layers.MaxPooling2D((2,2)),
    layers.Conv2D(64,(3,3),activation='relu'),
    layers.MaxPooling2D((2,2)),

    layers.Flatten(),
    layers.Dense(32,activation='relu'),
    layers.Dense(64,activation='relu'),
    layers.Dense(3,activation='softmax')

])

model.build(input_shape=(BATCH_SIZE,IMAGE_SIZE,IMAGE_SIZE,3))
model.summary()
```

```
Model: "sequential_5"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
sequential (Sequential)      (32, 256, 256, 3)         0
_________________________________________________________________
sequential_1 (Sequential)    (32, 256, 256, 3)         0
_________________________________________________________________
conv2d_10 (Conv2D)           (32, 254, 254, 32)        896
_________________________________________________________________
max_pooling2d_10 (MaxPooling (32, 127, 127, 32)        0
_________________________________________________________________
conv2d_11 (Conv2D)           (32, 125, 125, 64)        18496
_________________________________________________________________
max_pooling2d_11 (MaxPooling (32, 62, 62, 64)          0
_________________________________________________________________
conv2d_12 (Conv2D)           (32, 60, 60, 64)          36928
_________________________________________________________________
max_pooling2d_12 (MaxPooling (32, 30, 30, 64)          0
_________________________________________________________________
conv2d_13 (Conv2D)           (32, 28, 28, 64)          36928
_________________________________________________________________
max_pooling2d_13 (MaxPooling (32, 14, 14, 64)          0
_________________________________________________________________
flatten_3 (Flatten)          (32, 12544)               0
_________________________________________________________________
dense_9 (Dense)              (32, 32)                  401440
_________________________________________________________________
dense_10 (Dense)             (32, 64)                  2112
_________________________________________________________________
dense_11 (Dense)             (32, 3)                   195
=================================================================
Total params: 496,995
```

```
Trainable params: 496,995
Non-trainable params: 0
_________________________________________________________________
```

In [21]:
```
model.compile(
    optimizer='adam',
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)
```

In [22]:
```
history=model.fit(
    train_ds,
    epochs=10,
    validation_data=val_ds,
    verbose=1,
    batch_size=BATCH_SIZE
)
```

```
Epoch 1/10
54/54 [==============================] - 371s 5s/step - loss: 0.9167 - accurac
y: 0.4844 - val_loss: 0.7988 - val_accuracy: 0.4375
Epoch 2/10
54/54 [==============================] - 223s 4s/step - loss: 0.5124 - accurac
y: 0.7928 - val_loss: 0.4022 - val_accuracy: 0.8333
Epoch 3/10
54/54 [==============================] - 201s 4s/step - loss: 0.3406 - accurac
y: 0.8576 - val_loss: 0.3056 - val_accuracy: 0.8542
Epoch 4/10
54/54 [==============================] - 203s 4s/step - loss: 0.2806 - accurac
y: 0.8843 - val_loss: 0.2415 - val_accuracy: 0.9219
Epoch 5/10
54/54 [==============================] - 203s 4s/step - loss: 0.2365 - accurac
y: 0.9034 - val_loss: 0.2129 - val_accuracy: 0.8958
Epoch 6/10
54/54 [==============================] - 202s 4s/step - loss: 0.1733 - accurac
y: 0.9363 - val_loss: 0.1309 - val_accuracy: 0.9427
Epoch 7/10
54/54 [==============================] - 202s 4s/step - loss: 0.1667 - accurac
y: 0.9375 - val_loss: 0.1784 - val_accuracy: 0.9271
Epoch 8/10
54/54 [==============================] - 200s 4s/step - loss: 0.1668 - accurac
y: 0.9329 - val_loss: 0.1107 - val_accuracy: 0.9688
Epoch 9/10
54/54 [==============================] - 198s 4s/step - loss: 0.1186 - accurac
y: 0.9589 - val_loss: 0.1140 - val_accuracy: 0.9583
Epoch 10/10
54/54 [==============================] - 205s 4s/step - loss: 0.1383 - accurac
y: 0.9410 - val_loss: 0.1324 - val_accuracy: 0.9531
```

In [23]:
```
model.evaluate(test_ds)
```

```
8/8 [==============================] - 76s 1s/step - loss: 0.1788 - accuracy:
0.9336
```

Out[23]:
```
[0.17877119779586792, 0.93359375]
```

In [24]:
```
history
```

Out[24]:
```
<keras.callbacks.History at 0x24949e05310>
```

In [25]:
```
history.params
```

Out[25]:
```
{'verbose': 1, 'epochs': 10, 'steps': 54}
```

In [27]:
```
history.history.keys()
```

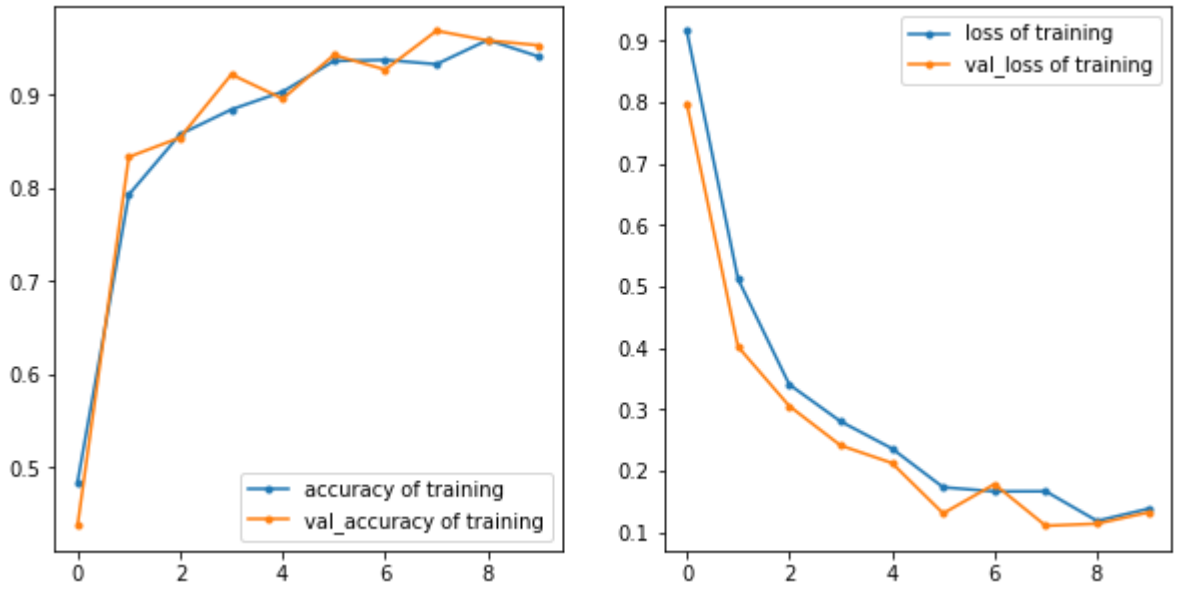
Out[27]:
```
dict_keys(['loss', 'accuracy', 'val_loss', 'val_accuracy'])
```

In [31]:
```
history.history['accuracy']
```

Out[31]:
```
[0.484375,
 0.7928240895271301,
 0.8576388955116272,
 0.8842592835426331,
 0.9033564925193787,
 0.9363425970077515,
 0.9375,
 0.9328703880310059,
 0.9589120149612427,
 0.9409722089767456]
```

In [43]:
```
plt.figure(figsize=(10,5))
plt.subplot(1,2,1)
plt.plot(range(10),history.history['accuracy'],label='accuracy of training',marke
plt.plot(range(10),history.history['val_accuracy'],label='val_accuracy of trainir
plt.legend()
plt.subplot(1,2,2)
plt.plot(range(10),history.history['loss'],label='loss of training',marker='.')
plt.plot(range(10),history.history['val_loss'],label='val_loss of training',marke
plt.legend()
```

Out[43]: <matplotlib.legend.Legend at 0x249079e8d60>



Transfer learning

In [11]:
```
transfer_resize_resclae=Sequential([
    layers.experimental.preprocessing.Resizing(224,224),
    layers.experimental.preprocessing.Rescaling(1./255.0)
])
```

In [12]:
```
classifier=Sequential([
    hub.KerasLayer("https://tfhub.dev/google/tf2-preview/mobilenet_v2/feature_vec
])
```

In [15]:
```
transfer_model=Sequential([
    transfer_resize_resclae,
    classifier,
    layers.Dense(3,activation='softmax')
])
transfer_model.build(input_shape=(32,224,224,3))
transfer_model.summary()
```

```
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
sequential (Sequential)      (32, 224, 224, 3)         0
_________________________________________________________________
sequential_1 (Sequential)    (None, 1280)              2257984
_________________________________________________________________
dense_1 (Dense)              (32, 3)                   3843
=================================================================
Total params: 2,261,827
Trainable params: 3,843
Non-trainable params: 2,257,984
_________________________________________________________________
```

In [16]:
```
transfer_model.compile(
    optimizer='adam',
    loss='sparse_categorical_crossentropy',
    metrics=['accuracy']
)
```

In [17]:
```
transfer_history=transfer_model.fit(
    train_ds,
    epochs=3,
    validation_data=val_ds,
    batch_size=BATCH_SIZE,
    verbose=1
)
```

```
Epoch 1/3
54/54 [==============================] - ETA: 0s - loss: 0.3872 - accuracy: 0.8
6 - 237s 3s/step - loss: 0.3872 - accuracy: 0.8669 - val_loss: 0.2007 - val_acc
uracy: 0.9323
Epoch 2/3
54/54 [==============================] - 96s 2s/step - loss: 0.1339 - accuracy:
0.9612 - val_loss: 0.1393 - val_accuracy: 0.9583
Epoch 3/3
54/54 [==============================] - 85s 2s/step - loss: 0.0940 - accuracy:
0.9740 - val_loss: 0.1066 - val_accuracy: 0.9688
```

In [18]:
```
transfer_model.evaluate(test_ds)
```

```
8/8 [==============================] - 51s 1s/step - loss: 0.0547 - accuracy:
1.0000
```

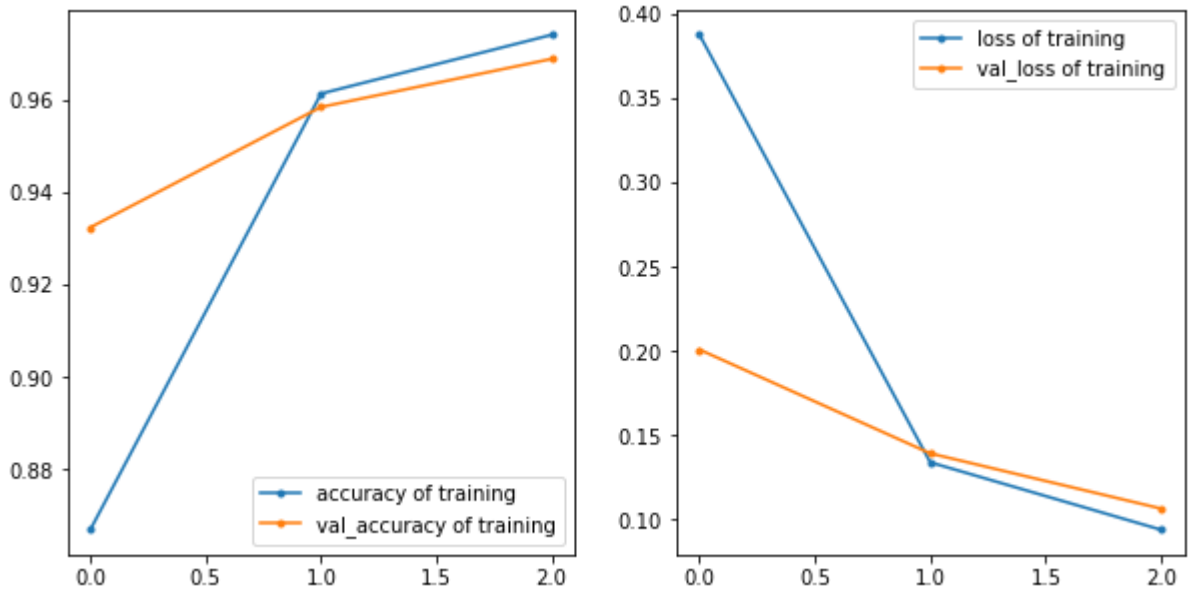
Out[18]:
```
[0.05472499877214432, 1.0]
```

In [19]:
```
transfer_history
```

Out[19]:
```
<keras.callbacks.History at 0x27420f93c10>
```

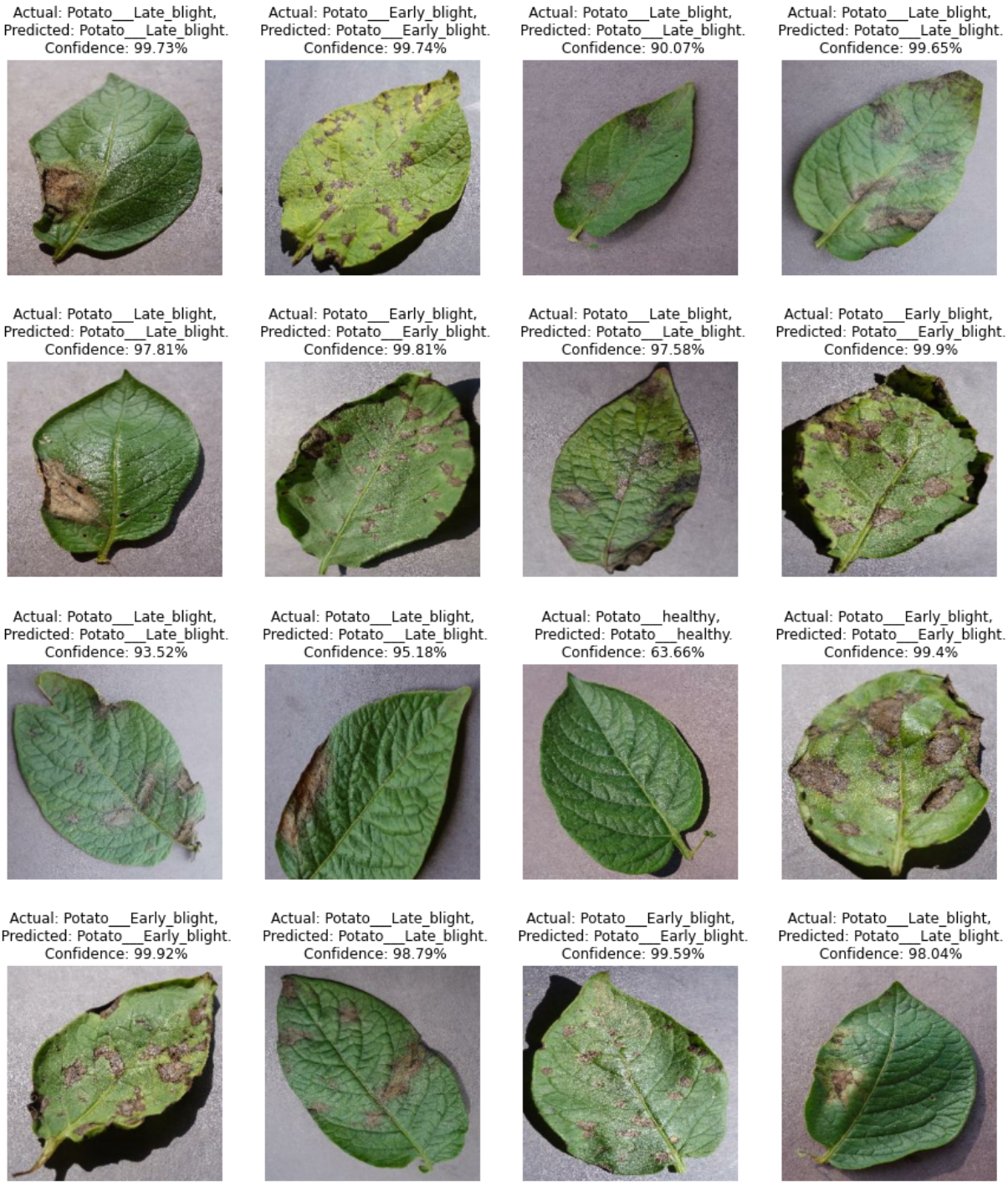
In [21]:
```
plt.figure(figsize=(10,5))
plt.subplot(1,2,1)
plt.plot(range(3),transfer_history.history['accuracy'],label='accuracy of trainir
plt.plot(range(3),transfer_history.history['val_accuracy'],label='val_accuracy of
plt.legend()
plt.subplot(1,2,2)
plt.plot(range(3),transfer_history.history['loss'],label='loss of training',marke
plt.plot(range(3),transfer_history.history['val_loss'],label='val_loss of trainir
plt.legend()
```

Out[21]:
```
<matplotlib.legend.Legend at 0x2740a092bb0>
```



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)

    predictions = transfer_model.predict(img_array)

    predicted_class = class_name[np.argmax(predictions[0])]
    confidence = round(100 * (np.max(predictions[0])), 2)
    return predicted_class, confidence
```

In [30]:
```
plt.figure(figsize=(15, 18))
for images, labels in test_ds.take(1):
    for i in range(16):
        ax = plt.subplot(4, 4, i + 1)
        plt.imshow(images[i].numpy().astype("uint8"))

        predicted_class, confidence = predict(transfer_model, images[i].numpy())
        actual_class = class_name[labels[i]]

        plt.title(f"Actual: {actual_class},\n Predicted: {predicted_class}.\n Cor

        plt.axis("off")
```

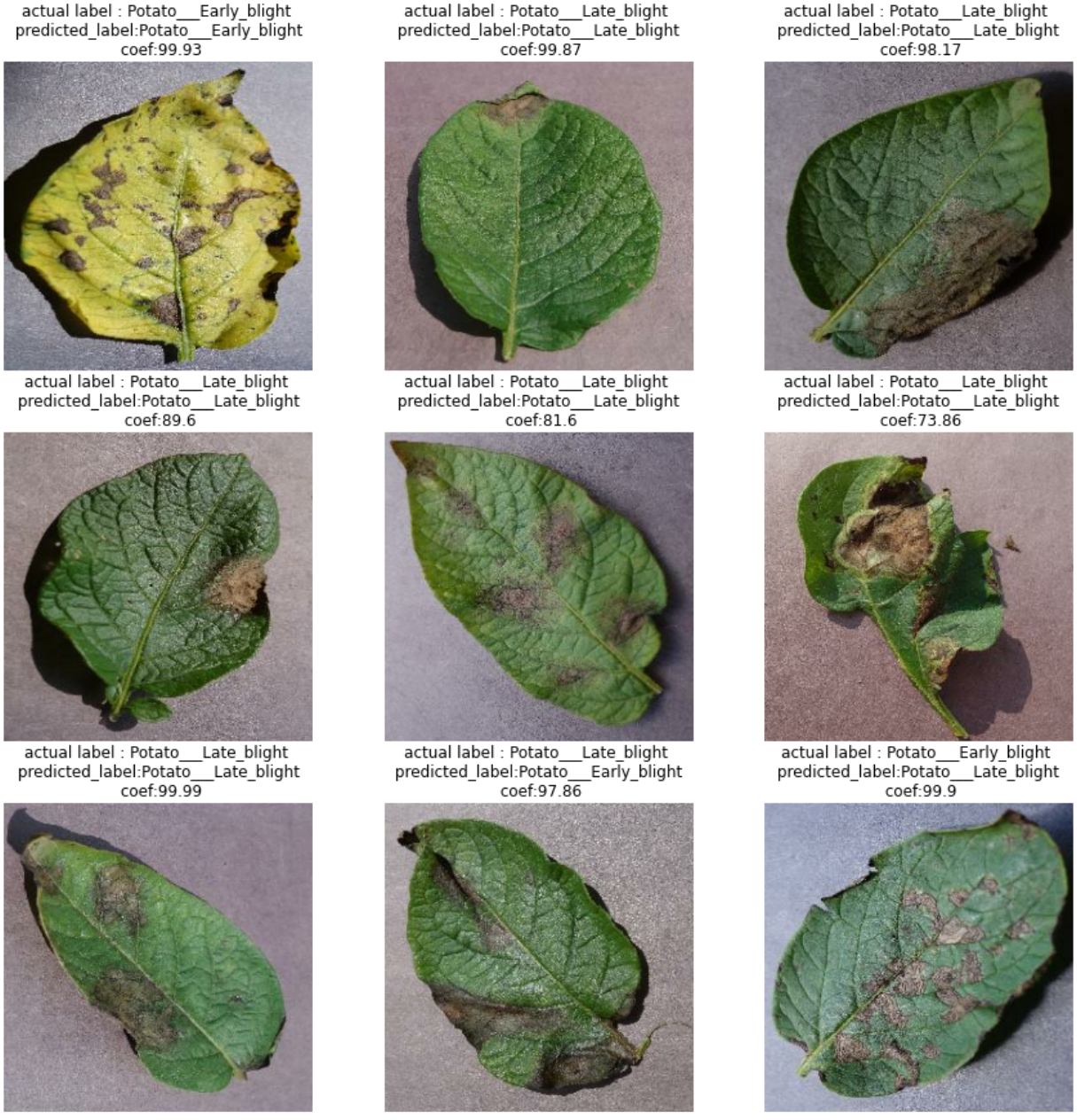


In [33]:
```
import os
model_version=max([int(i) for i in os.listdir('../saved_models')]+[0])+1
transfer_model.save(f'../saved_models/{model_version}')
```

```
INFO:tensorflow:Assets written to: ../saved_models/3\assets

INFO:tensorflow:Assets written to: ../saved_models/3\assets
```

In [ ]:
```

```

In [91]:
```
plt.figure(figsize=(15,15))
predicted=model.predict(test_ds.take(1))
predicted1=[np.argmax(j) for j in predicted]
coef=[round(np.max(k)*100,2) for k in predicted]
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'))
        plt.axis('off')
        plt.title(f"actual label : {class_name[labels[i]]} \n predicted_label:{cl
```



In [86]:
```
for i in model.predict(test_ds.take(1)):
    print(np.max(i)*100)
```

. . .

In [92]:
```
import os
model_version=max([int(i) for i in os.listdir('../models')]+[0])+1
model.save(f'../models/{model_version}')
```

```
INFO:tensorflow:Assets written to: ../models/2\assets
```

In [ ]:
```

```