In [1]:

```python
# for manipulations
import numpy as np
import pandas as pd

# for data visualizations
import matplotlib.pyplot as plt
import seaborn as sns
plt.style.use('fivethirtyeight')

# for interactivity
import ipywidgets
from ipywidgets import interact
```

In [3]:

```python
# lets read the dataset
data = pd.read_excel('data.xlsx')

# lets check teh shape of the dataset
print("Shape of the Dataset :", data.shape)
```

```
Shape of the Dataset : (2200, 8)
```

In [4]:

```python
# lets check the head of the dataset
data.head()
```

Out[4]:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

In [5]:

```python
data.isnull().sum()
```

Out[5]:

```
N              0
P              0
K              0
temperature    0
humidity       0
ph             0
rainfall       0
label          0
dtype: int64
```

In [6]:

```python
data['label'].value_counts()
```

Out[6]:

```
coffee         100
muskmelon      100
mango          100
pigeonpeas     100
mungbean       100
coconut        100
orange         100
jute           100
kidneybeans    100
papaya         100
maize          100
blackgram      100
grapes         100
rice           100
apple          100
watermelon     100
cotton         100
pomegranate    100
banana         100
mothbeans      100
chickpea       100
lentil         100
Name: label, dtype: int64
```

In [7]:

```python
print("Average Ratio of Nitrogen in the Soil : {0:.2f}".format(data['N'].mean()))
print("Average Ratio of Phosphorous in the Soil : {0:.2f}".format(data['P'].mean()))
print("Average Ratio of Potassium in the Soil : {0:.2f}".format(data['K'].mean()))
print("Average Tempature in Celsius : {0:.2f}".format(data['temperature'].mean()))
print("Average Relative Humidity in % : {0:.2f}".format(data['humidity'].mean()))
print("Average PH Value of the soil : {0:.2f}".format(data['ph'].mean()))
print("Average Rainfall in mm : {0:.2f}".format(data['rainfall'].mean()))
```

```
Average Ratio of Nitrogen in the Soil : 50.55
Average Ratio of Phosphorous in the Soil : 53.36
Average Ratio of Potassium in the Soil : 48.15
Average Tempature in Celsius : 25.62
Average Relative Humidity in % : 71.48
Average PH Value of the soil : 6.47
Average Rainfall in mm : 103.46
```

In [8]:

```python
@interact
def summary(crops = list(data['label'].value_counts().index)):
    x = data[data['label'] == crops]
    print("---------------------------------------------")
    print("Statistics for Nitrogen")
    print("Minimum Nitrigen required :", x['N'].min())
    print("Average Nitrogen required :", x['N'].mean())
    print("Maximum Nitrogen required :", x['N'].max())
    print("---------------------------------------------")
    print("Statistics for Phosphorous")
    print("Minimum Phosphorous required :", x['P'].min())
    print("Average Phosphorous required :", x['P'].mean())
    print("Maximum Phosphorous required :", x['P'].max())
    print("---------------------------------------------")
    print("Statistics for Potassium")
    print("Minimum Potassium required :", x['K'].min())
    print("Average Potassium required :", x['K'].mean())
    print("Maximum Potassium required :", x['K'].max())
    print("---------------------------------------------")
    print("Statistics for Temperature")
    print("Minimum Temperature required : {0:.2f}".format(x['temperature'].min()))
    print("Average Temperature required : {0:.2f}".format(x['temperature'].mean()))
    print("Maximum Temperature required : {0:.2f}".format(x['temperature'].max()))
    print("---------------------------------------------")
    print("Statistics for Humidity")
    print("Minimum Humidity required : {0:.2f}".format(x['humidity'].min()))
    print("Average Humidity required : {0:.2f}".format(x['humidity'].mean()))
    print("Maximum Humidity required : {0:.2f}".format(x['humidity'].max()))
    print("---------------------------------------------")
    print("Statistics for PH")
    print("Minimum PH required : {0:.2f}".format(x['ph'].min()))
    print("Average PH required : {0:.2f}".format(x['ph'].mean()))
    print("Maximum PH required : {0:.2f}".format(x['ph'].max()))
    print("---------------------------------------------")
    print("Statistics for Rainfall")
    print("Minimum Rainfall required : {0:.2f}".format(x['rainfall'].min()))
    print("Average Rainfall required : {0:.2f}".format(x['rainfall'].mean()))
    print("Maximum Rainfall required : {0:.2f}".format(x['rainfall'].max()))
```

In [9]:

```python
@interact
def compare(conditions = ['N','P','K','temperature','ph','humidity','rainfall']):
    print("Average Value for", conditions,"is {0:.2f}".format(data[conditions].mean()))
    print("---------------------------------------------")
    print("Rice : {0:.2f}".format(data[(data['label'] == 'rice')][conditions].mean()))
    print("Black Grams : {0:.2f}".format(data[data['label'] == 'blackgram'][conditions].mean()))
    print("Banana : {0:.2f}".format(data[(data['label'] == 'banana')][conditions].mean()))
    print("Jute : {0:.2f}".format(data[data['label'] == 'jute'][conditions].mean()))
    print("Coconut : {0:.2f}".format(data[(data['label'] == 'coconut')][conditions].mean()))
    print("Apple : {0:.2f}".format(data[data['label'] == 'apple'][conditions].mean()))
    print("Papaya : {0:.2f}".format(data[(data['label'] == 'papaya')][conditions].mean()))
    print("Muskmelon : {0:.2f}".format(data[data['label'] == 'muskmelon'][conditions].mean()))
    print("Grapes : {0:.2f}".format(data[(data['label'] == 'grapes')][conditions].mean()))
    print("Watermelon : {0:.2f}".format(data[data['label'] == 'watermelon'][conditions].mean()))
    print("Kidney Beans: {0:.2f}".format(data[(data['label'] == 'kidneybeans')][conditions].mean()))
    print("Mung Beans : {0:.2f}".format(data[data['label'] == 'mungbean'][conditions].mean()))
    print("Oranges : {0:.2f}".format(data[(data['label'] == 'orange')][conditions].mean()))
    print("Chick Peas : {0:.2f}".format(data[data['label'] == 'chickpea'][conditions].mean()))
    print("Lentils : {0:.2f}".format(data[(data['label'] == 'lentil')][conditions].mean()))
    print("Cotton : {0:.2f}".format(data[data['label'] == 'cotton'][conditions].mean()))
    print("Maize : {0:.2f}".format(data[(data['label'] == 'maize')][conditions].mean()))
    print("Moth Beans : {0:.2f}".format(data[data['label'] == 'mothbeans'][conditions].mean()))
    print("Pigeon Peas : {0:.2f}".format(data[(data['label'] == 'pigeonpeas')][conditions].mean()))
    print("Mango : {0:.2f}".format(data[data['label'] == 'mango'][conditions].mean()))
    print("Pomegranate : {0:.2f}".format(data[(data['label'] == 'pomegranate')][conditions].mean()))
    print("Coffee : {0:.2f}".format(data[data['label'] == 'coffee'][conditions].mean()))
```

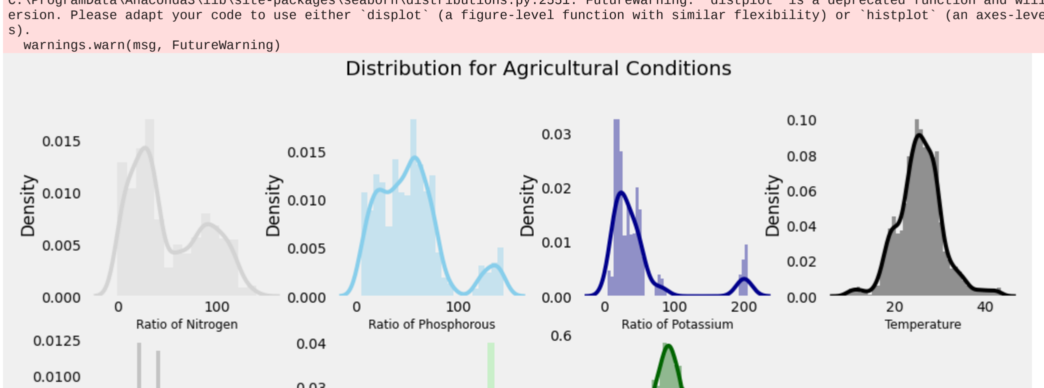
In [10]:

```python
@interact
def compare(conditions = ['N','P','K','temperature','ph','humidity','rainfall']):
    print("Crops which require greater than average", conditions,'\n')
    print(data[data[conditions] > data[conditions].mean()]['label'].unique())
    print("---------------------------------------------")
    print("Crops which require less than average", conditions,'\n')
    print(data[data[conditions] <= data[conditions].mean()]['label'].unique())
```

In [11]:

```python
plt.rcParams['figure.figsize'] = (15, 7)

plt.subplot(2, 4, 1)
sns.distplot(data['N'], color = 'lightgrey')
plt.xlabel('Ratio of Nitrogen', fontsize = 12)
plt.grid()

plt.subplot(2, 4, 2)
sns.distplot(data['P'], color = 'skyblue')
plt.xlabel('Ratio of Phosphorous', fontsize = 12)
plt.grid()

plt.subplot(2, 4, 3)
sns.distplot(data['K'], color ='darkblue')
plt.xlabel('Ratio of Potassium', fontsize = 12)
plt.grid()

plt.subplot(2, 4, 4)
sns.distplot(data['temperature'], color = 'black')
plt.xlabel('Temperature', fontsize = 12)
plt.grid()

plt.subplot(2, 4, 5)
sns.distplot(data['rainfall'], color = 'grey')
plt.xlabel('Rainfall', fontsize = 12)
plt.grid()

plt.subplot(2, 4, 6)
sns.distplot(data['humidity'], color = 'lightgreen')
plt.xlabel('Humidity', fontsize = 12)
plt.grid()

plt.subplot(2, 4, 7)
sns.distplot(data['ph'], color = 'darkgreen')
plt.xlabel('pH Level', fontsize = 12)
plt.grid()

plt.suptitle('Distribution for Agricultural Conditions', fontsize = 20)
plt.show()
```

```
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
C:\ProgramData\Anaconda3\lib\site-packages\seaborn\distributions.py:2551: FutureWarning: `distplot` is a deprecated function and will be removed in a future version. Please adapt your code to use either `displot` (a figure-level function with similar flexibility) or `histplot` (an axes-level function for histograms).
  warnings.warn(msg, FutureWarning)
```



In [12]:

```python
print("Some Interesting Patterns")
print("---------------------------------")
print("Crops which requires very High Ratio of Nitrogen Content in Soil:", data[data['N'] > 120]['label'].unique())
print("Crops which requires very High Ratio of Phosphorous Content in Soil:", data[data['P'] > 100]['label'].unique())
print("Crops which requires very High Ratio of Potassium Content in Soil:", data[data['K'] > 200]['label'].unique())
print("Crops which requires very High Rainfall:", data[data['rainfall'] > 200]['label'].unique())
print("Crops which requires very Low Temperature :", data[data['temperature'] < 10]['label'].unique())
print("Crops which requires very High Temperature :", data[data['temperature'] > 40]['label'].unique())
print("Crops which requires very Low Humidity:", data[data['humidity'] < 20]['label'].unique())
print("Crops which requires very Low pH:", data[data['ph'] < 4]['label'].unique())
print("Crops which requires very High pH:", data[data['ph'] > 9]['label'].unique())
```

```
Some Interesting Patterns
---------------------------------
Crops which requires very High Ratio of Nitrogen Content in Soil: ['cotton']
Crops which requires very High Ratio of Phosphorous Content in Soil: ['grapes' 'apple']
Crops which requires very High Ratio of Potassium Content in Soil: ['grapes' 'apple']
Crops which requires very High Rainfall: ['rice' 'papaya' 'coconut']
Crops which requires very Low Temperature : ['grapes']
Crops which requires very High Temperature : ['grapes' 'papaya']
Crops which requires very Low Humidity: ['chickpea' 'kidneybeans']
Crops which requires very Low pH: ['mothbeans']
Crops which requires very High pH: ['mothbeans']
```

In [13]:

```python
print("Summer Crops")
print(data[(data['temperature'] > 30) & (data['humidity'] > 50)]['label'].unique())
print("-----------------------------------")
print("Winter Crops")
print(data[(data['temperature'] < 20) & (data['humidity'] > 30)]['label'].unique())
print("-----------------------------------")
print("Rainy Crops")
print(data[(data['rainfall'] > 200) & (data['humidity'] > 30)]['label'].unique())
```

```
Summer Crops
['pigeonpeas' 'mothbeans' 'blackgram' 'mango' 'grapes' 'orange' 'papaya']
-----------------------------------
Winter Crops
['maize' 'pigeonpeas' 'lentil' 'pomegranate' 'grapes' 'orange']
-----------------------------------
Rainy Crops
['rice' 'papaya' 'coconut']
```

In [14]:

```python
import warnings
warnings.filterwarnings('ignore')

x = data.loc[:, ['N','P','K','temperature','ph','humidity','rainfall']].values

print(x.shape)

x_data  = pd.DataFrame(x)
x_data.head()
```

```
(2200, 7)
```

Out[14]:

	0	1	2	3	4	5	6
0	90.0	42.0	43.0	20.879744	6.502985	82.002744	202.935536
1	85.0	58.0	41.0	21.770462	7.038096	80.319644	226.655537
2	60.0	55.0	44.0	23.004459	7.840207	82.320763	263.964248
3	74.0	35.0	40.0	26.491096	6.980401	80.158363	242.864034
4	78.0	42.0	42.0	20.130175	7.628473	81.604873	262.717340

In [15]:

```python
from sklearn.cluster import KMeans
plt.rcParams['figure.figsize'] = (10, 4)

wcss = []
for i in range(1, 11):
    km = KMeans(n_clusters = i, init = 'k-means++', max_iter = 300, n_init = 10, random_state = 0)
    km.fit(x)
    wcss.append(km.inertia_)


plt.plot(range(1, 11), wcss)
plt.title('The Elbow Method', fontsize = 20)
plt.xlabel('No. of Clusters')
plt.ylabel('wcss')
plt.show()
```

In [16]:

```python
km = KMeans(n_clusters = 4, init = 'k-means++', max_iter = 300, n_init = 10, random_state = 0)
y_means = km.fit_predict(x)

a = data['label']
y_means = pd.DataFrame(y_means)
z = pd.concat([y_means, a], axis = 1)
z = z.rename(columns = {0: 'cluster'})

print("Lets check the Results After Applying the K Means Clustering Analysis \n")
print("Crops in First Cluster:", z[z['cluster'] == 0]['label'].unique())
print("---------------------------------------------------------------")
print("Crops in Second Cluster:", z[z['cluster'] == 1]['label'].unique())
print("---------------------------------------------------------------")
print("Crops in Third Cluster:", z[z['cluster'] == 2]['label'].unique())
print("---------------------------------------------------------------")
print("Crops in Forth Cluster:", z[z['cluster'] == 3]['label'].unique())
```

```
Lets check the Results After Applying the K Means Clustering Analysis 

Crops in First Cluster: ['rice' 'pigeonpeas' 'papaya' 'coconut' 'jute' 'coffee']
---------------------------------------------------------------
Crops in Second Cluster: ['maize' 'chickpea' 'kidneybeans' 'pigeonpeas' 'mothbeans' 'mungbean'
 'blackgram' 'lentil' 'pomegranate' 'mango' 'orange' 'papaya' 'coconut']
---------------------------------------------------------------
Crops in Third Cluster: ['grapes' 'apple']
---------------------------------------------------------------
Crops in Forth Cluster: ['maize' 'banana' 'watermelon' 'muskmelon' 'papaya' 'cotton' 'coffee']
```

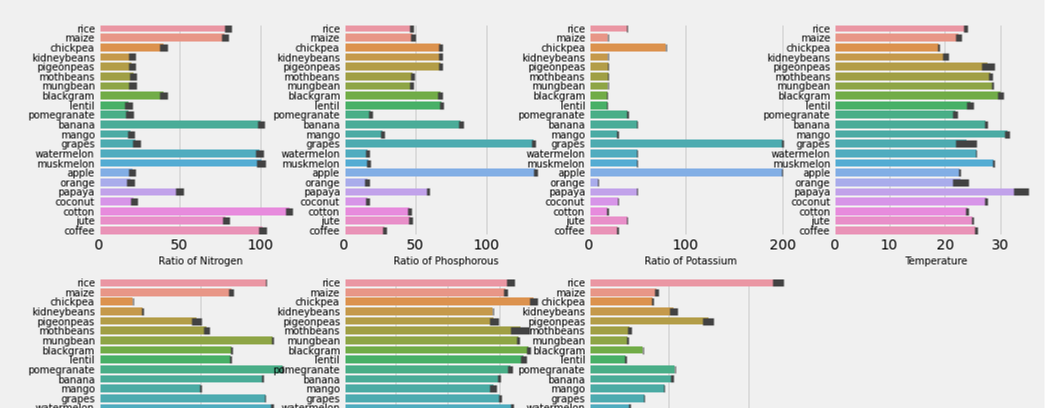
In [17]:

```python
print("Results for Hard Clustering\n")
counts = z[z['cluster'] == 0]['label'].value_counts()
d = z.loc[z['label'].isin(counts.index[counts >= 50])]
d = d['label'].value_counts()
print("Crops in Cluster 1:", list(d.index))
print("--------------------------------------------------")
counts = z[z['cluster'] == 1]['label'].value_counts()
d = z.loc[z['label'].isin(counts.index[counts >= 50])]
d = d['label'].value_counts()
print("Crops in Cluster 2:", list(d.index))
print("--------------------------------------------------")
counts = z[z['cluster'] == 2]['label'].value_counts()
d = z.loc[z['label'].isin(counts.index[counts >= 50])]
d = d['label'].value_counts()
print("Crops in Cluster 3:", list(d.index))
print("--------------------------------------------------")
counts = z[z['cluster'] == 3]['label'].value_counts()
d = z.loc[z['label'].isin(counts.index[counts >= 50])]
d = d['label'].value_counts()
print("Crops in Cluster 4:", list(d.index))
```

```
Results for Hard Clustering

Crops in Cluster 1: ['coffee', 'jute', 'coconut', 'rice', 'pigeonpeas', 'papaya']
--------------------------------------------------
Crops in Cluster 2: ['chickpea', 'mothbeans', 'kidneybeans', 'pomegranate', 'orange', 'mungbean', 'mango', 'blackgram', 'lentil']
--------------------------------------------------
Crops in Cluster 3: ['grapes', 'apple']
--------------------------------------------------
Crops in Cluster 4: ['muskmelon', 'cotton', 'maize', 'watermelon', 'banana']
```

In [18]:

```python
plt.rcParams['figure.figsize'] = (15, 8)

plt.subplot(2, 4, 1)
sns.barplot(data['N'], data['label'])
plt.ylabel(' ')
plt.xlabel('Ratio of Nitrogen', fontsize = 10)
plt.yticks(fontsize = 10)

plt.subplot(2, 4, 2)
sns.barplot(data['P'], data['label'])
plt.ylabel(' ')
plt.xlabel('Ratio of Phosphorous', fontsize = 10)
plt.yticks(fontsize = 10)

plt.subplot(2, 4, 3)
sns.barplot(data['K'], data['label'])
plt.ylabel(' ')
plt.xlabel('Ratio of Potassium', fontsize = 10)
plt.yticks(fontsize = 10)

plt.subplot(2, 4, 4)
sns.barplot(data['temperature'], data['label'])
plt.ylabel(' ')
plt.xlabel('Temperature', fontsize = 10)
plt.yticks(fontsize = 10)

plt.subplot(2, 4, 5)
sns.barplot(data['humidity'], data['label'])
plt.ylabel(' ')
plt.xlabel('Humidity', fontsize = 10)
plt.yticks(fontsize = 10)

plt.subplot(2, 4, 6)
sns.barplot(data['ph'], data['label'])
plt.ylabel(' ')
plt.xlabel('pH of Soil', fontsize = 10)
plt.yticks(fontsize = 10)

plt.subplot(2, 4, 7)
sns.barplot(data['rainfall'], data['label'])
plt.ylabel(' ')
plt.xlabel('Rainfall', fontsize = 10)
plt.yticks(fontsize = 10)

plt.suptitle('Visualizing the Impact of Different Conditions on Crops', fontsize = 15)
plt.show()
```



In [19]:

```python
y = data['label']
x = data.drop(['label'], axis = 1)

print("Shape of x:", x.shape)
print("Shape of y:", y.shape)
```

```
Shape of x: (2200, 7)
Shape of y: (2200,)
```

In [20]:

```python
from sklearn.model_selection import train_test_split

x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.2, random_state = 0)

print("The Shape of x train:", x_train.shape)
print("The Shape of x test:", x_test.shape)
print("The Shape of y train:", y_train.shape)
print("The Shape of y test:", y_test.shape)
```

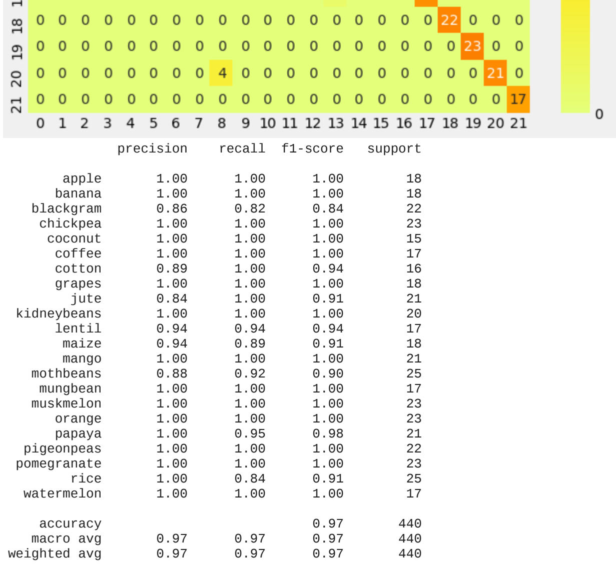
```
The Shape of x train: (1760, 7)
The Shape of x test: (440, 7)
The Shape of y train: (1760,)
The Shape of y test: (440,)
```

In [21]:

```python
from sklearn.linear_model import LogisticRegression

model = LogisticRegression()
model.fit(x_train, y_train)
y_pred = model.predict(x_test)
```

In [22]:

```python
from sklearn.metrics import classification_report, confusion_matrix
plt.rcParams['figure.figsize'] = (10, 10)
cm = confusion_matrix(y_test, y_pred)
sns.heatmap(cm, annot = True, cmap = 'Wistia')
plt.title('Confusion Matrix for Logistic Regression', fontsize = 15)
plt.show()

cr = classification_report(y_test, y_pred)
print(cr)
```




```
              precision    recall  f1-score   support

       apple       1.00      1.00      1.00        18
      banana       1.00      1.00      1.00        18
   blackgram       0.86      0.82      0.84        22
    chickpea       1.00      1.00      1.00        23
     coconut       1.00      1.00      1.00        15
      coffee       1.00      1.00      1.00        17
      cotton       0.89      1.00      0.94        16
      grapes       1.00      1.00      1.00        18
        jute       0.84      1.00      0.91        21
 kidneybeans       1.00      1.00      1.00        20
      lentil       0.94      0.94      0.94        17
       maize       0.94      0.89      0.91        18
       mango       1.00      1.00      1.00        21
   mothbeans       0.88      0.92      0.90        25
    mungbean       1.00      1.00      1.00        17
   muskmelon       1.00      1.00      1.00        23
      orange       1.00      1.00      1.00        23
      papaya       1.00      0.95      0.98        21
  pigeonpeas       1.00      1.00      1.00        22
 pomegranate       1.00      1.00      1.00        23
        rice       1.00      0.84      0.91        25
  watermelon       1.00      1.00      1.00        17

    accuracy                           0.97       440
   macro avg       0.97      0.97      0.97       440
weighted avg       0.97      0.97      0.97       440
```

In [23]:

```python
data.head()
```

Out[23]:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	82.002744	6.502985	202.935536	rice
1	85	58	41	21.770462	80.319644	7.038096	226.655537	rice
2	60	55	44	23.004459	82.320763	7.840207	263.964248	rice
3	74	35	40	26.491096	80.158363	6.980401	242.864034	rice
4	78	42	42	20.130175	81.604873	7.628473	262.717340	rice

In [24]:

```python
prediction = model.predict((np.array([[90,
                                       40,
                                       40,
                                       20,
                                       80,
                                       7,
                                       200]])))
print("The Suggested Crop for Given Climatic Condition is :", prediction)
```

```
The Suggested Crop for Given Climatic Condition is : ['rice']
```

In [25]:

```python
data[data['label'] == 'orange'].head()
```

Out[25]:

	N	P	K	temperature	humidity	ph	rainfall	label
1600	22	30	12	15.781442	92.510777	6.354007	119.035002	orange
1601	37	6	13	26.030973	91.508193	7.511755	101.284774	orange
1602	27	13	6	13.360506	91.356082	7.335158	111.226688	orange
1603	7	16	9	18.879577	92.043045	7.813917	114.665951	orange
1604	20	7	9	29.477417	91.578029	7.129137	111.172750	orange

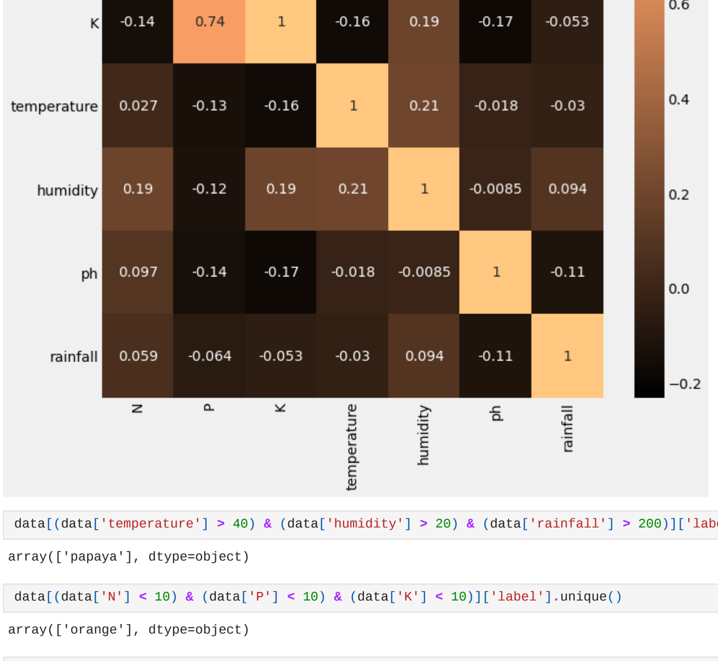
In [26]:

```python
prediction = model.predict((np.array([[20,
                                       30,
                                       10,
                                       15,
                                       90,
                                       7.5,
                                       100]])))
print("The Suggested Crop for Given Climatic Condition is :", prediction)
```

```
The Suggested Crop for Given Climatic Condition is : ['orange']
```

In [27]:

```python
sns.heatmap(data.corr(),
            annot = True,
            cmap = 'copper')
plt.title('Correlation Heatmap')
plt.show()
```



In [28]:

```python
data[(data['temperature'] > 40) & (data['humidity'] > 20) & (data['rainfall'] > 200)]['label'].unique()
```

Out[28]:

```
array(['papaya'], dtype=object)
```

In [29]:

```python
data[(data['N'] < 10) & (data['P'] < 10) & (data['K'] < 10)]['label'].unique()
```

Out[29]:

```
array(['orange'], dtype=object)
```

In [ ]: