In [1]:

```
# for manipulations
import numpy as np
import pandas as pd
from scipy import stats

# for data visualizations
import matplotlib.pyplot as plt
import seaborn as sns

# Algorithms
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import SVC
from sklearn.naive_bayes import GaussianNB
from sklearn.neighbors import KNeighborsClassifier


from sklearn.preprocessing import LabelEncoder

from sklearn.metrics import confusion_matrix, classification_report, accuracy_score, precis
```

In [2]:

```
# Importing data
data = pd.read_csv("Crop_Recommendation.csv")
print(data.shape)
```

```
(2200, 8)
```

In [3]:

```
data.head()
```

Out[3]:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	42	43	20.879744	NaN	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	NaN	242.864034	rice
4	78	42	42	NaN	81.604873	7.628473	262.717340	rice

Handling Missing values

In [4]:

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

Out[4]:

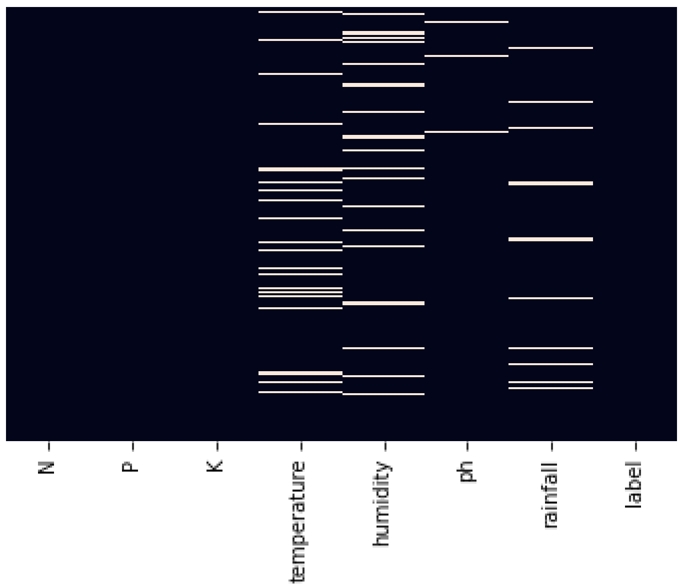
```
N                0
P                0
K                0
temperature    237
humidity       202
ph              35
rainfall       145
label            0
dtype: int64
```

In [5]:

```
sns.heatmap(data.isnull(),yticklabels=False,cbar=False)
```

Out[5]:

```
<AxesSubplot:>
```



In [6]:

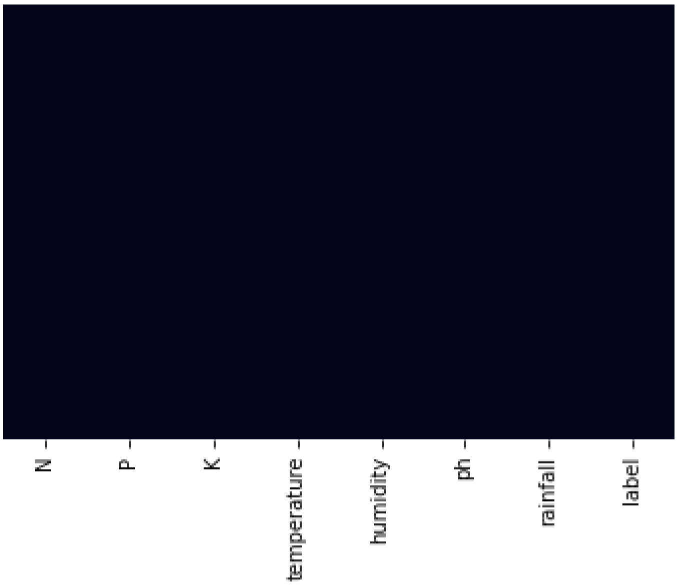
```
data['temperature'].fillna(data['temperature'].mean(), inplace=True)
data['rainfall'].fillna(data['rainfall'].mean(), inplace=True)
data['ph'].fillna(data['ph'].mean(), inplace=True)
data['humidity'].fillna(data['humidity'].mean(), inplace=True)
```

In [7]:

```
sns.heatmap(data.isnull(),yticklabels=False,cbar=False)
```

Out[7]:

<AxesSubplot:>



In [8]:

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

Out[8]:

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

In [9]:

```
df=data
```

Cheking Skewness and data distrubution of attributes

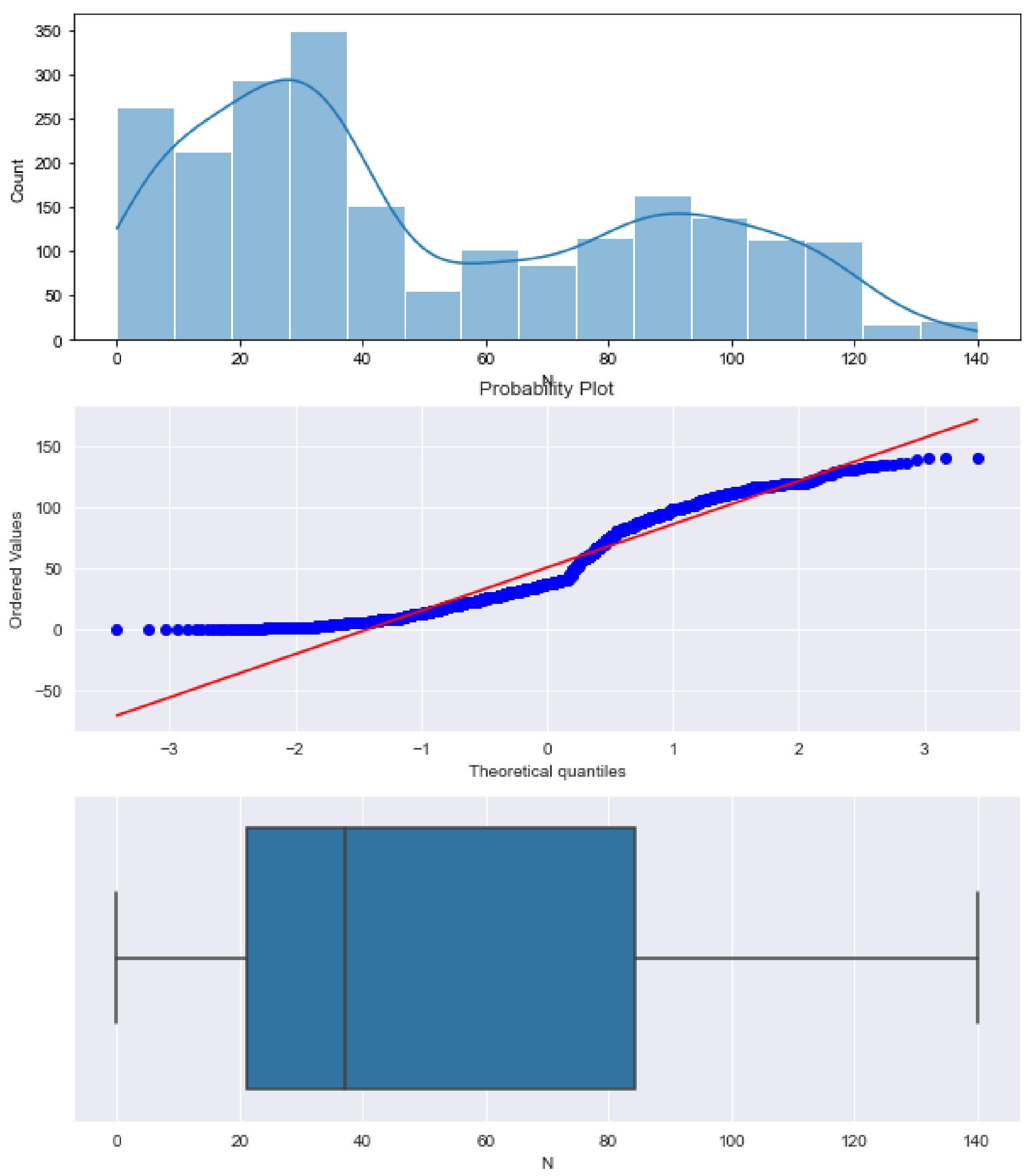
Nitrogen

In [10]:

```
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")

#histplot
sns.histplot(data.loc[:, 'N'],kde=True,ax=ax1)

#probplot
ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'N'],plot=ax2)

#boxplot
ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'N'],ax=ax3)
```

Out[10]:

```
<AxesSubplot:xlabel='N'>
```



In [11]:

```
print("Skewness of the N is", data['N'].skew())
```

Skewness of the N is 0.5097213691539147

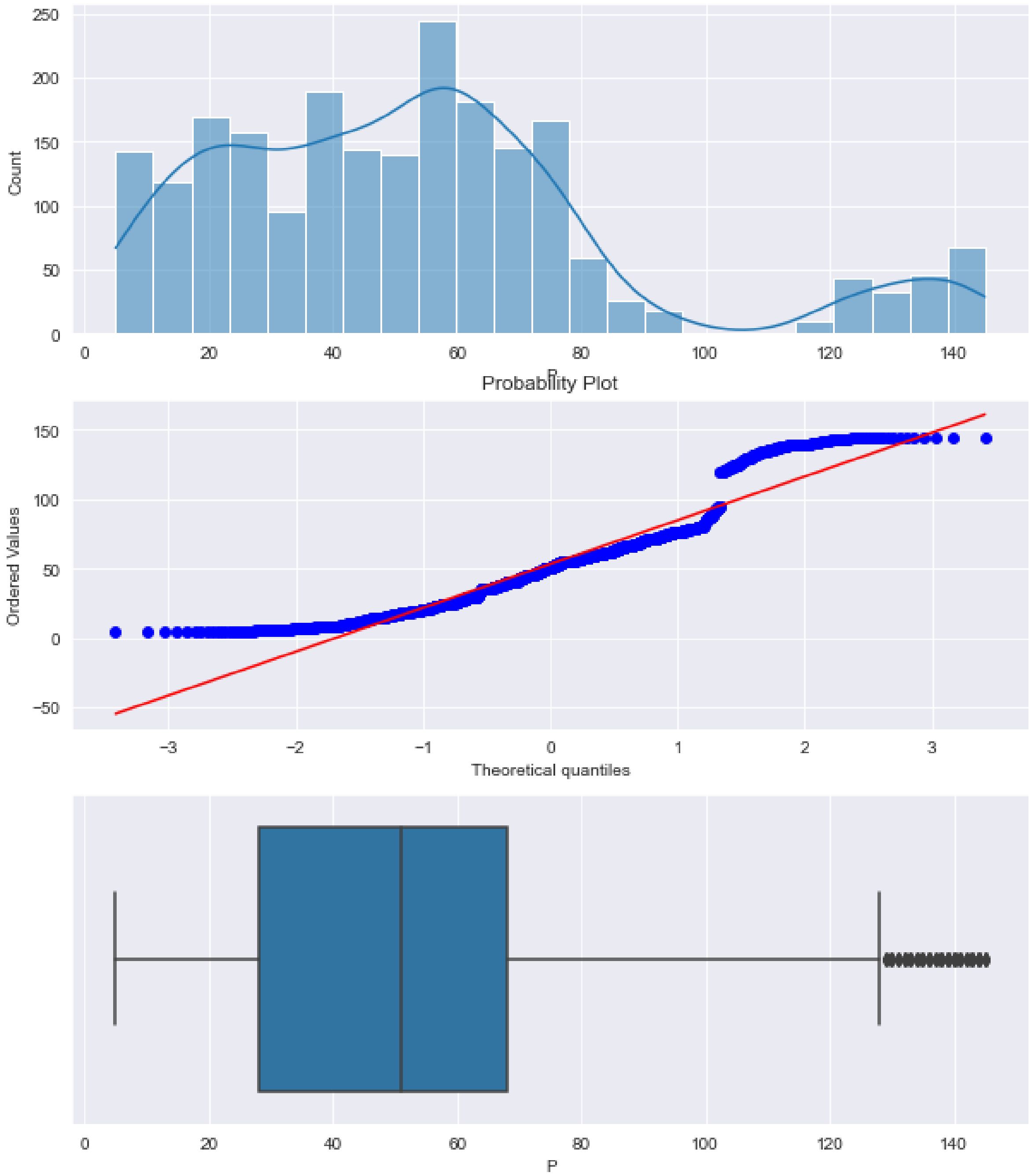
Phosphures

In [12]:

```
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")
sns.histplot(data.loc[:, 'P'],kde=True,ax=ax1)

ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'P'],plot=ax2)

ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'P'],ax=ax3)
```

Out[12]:

```
<AxesSubplot:xlabel='P'>
```



In [13]:

```
print("Skewness of the P is", data['P'].skew())
```

```
Skewness of the P is 1.0107725431372674
```

In [14]:

```
data['P'],la= stats.boxcox(data['P'])
print("Skewness of the P is", data['P'].skew())
```

```
Skewness of the P is -0.029638877554155335
```

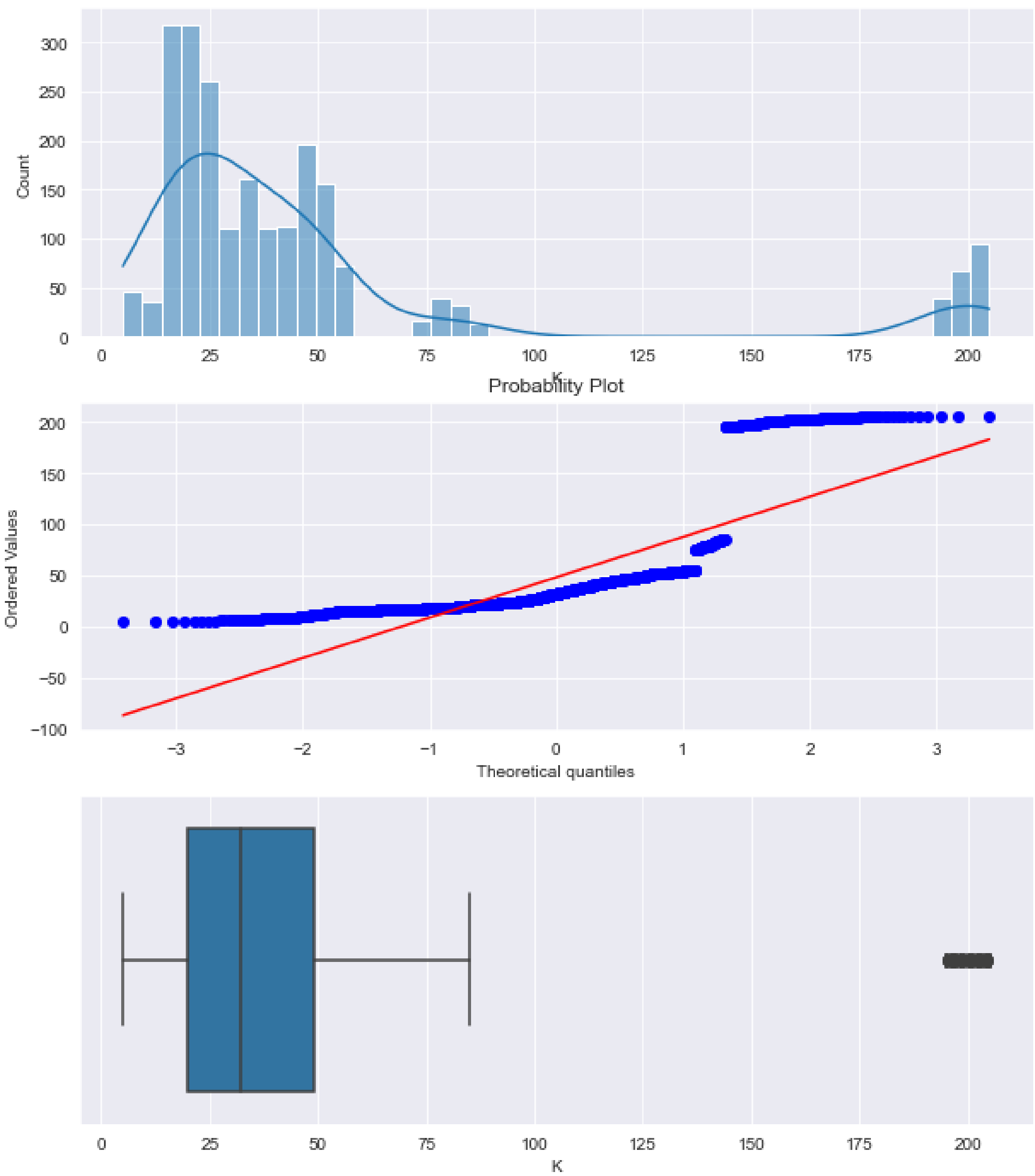
Potassium

In [15]:

```
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")
sns.histplot(data.loc[:, 'K'],kde=True,ax=ax1)

ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'K'],plot=ax2)

ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'K'],ax=ax3)
```

Out[15]:

<AxesSubplot:xlabel='K'>



In [16]:

```
print("Skewness of the K is", data['K'].skew())
```

```
Skewness of the K is 2.3751672388547
```

In [17]:

```
data['K'],la= stats.boxcox(data['K'])
print("Skewness of the K is", data['K'].skew())
```

```
Skewness of the K is -0.03015786204471948
```

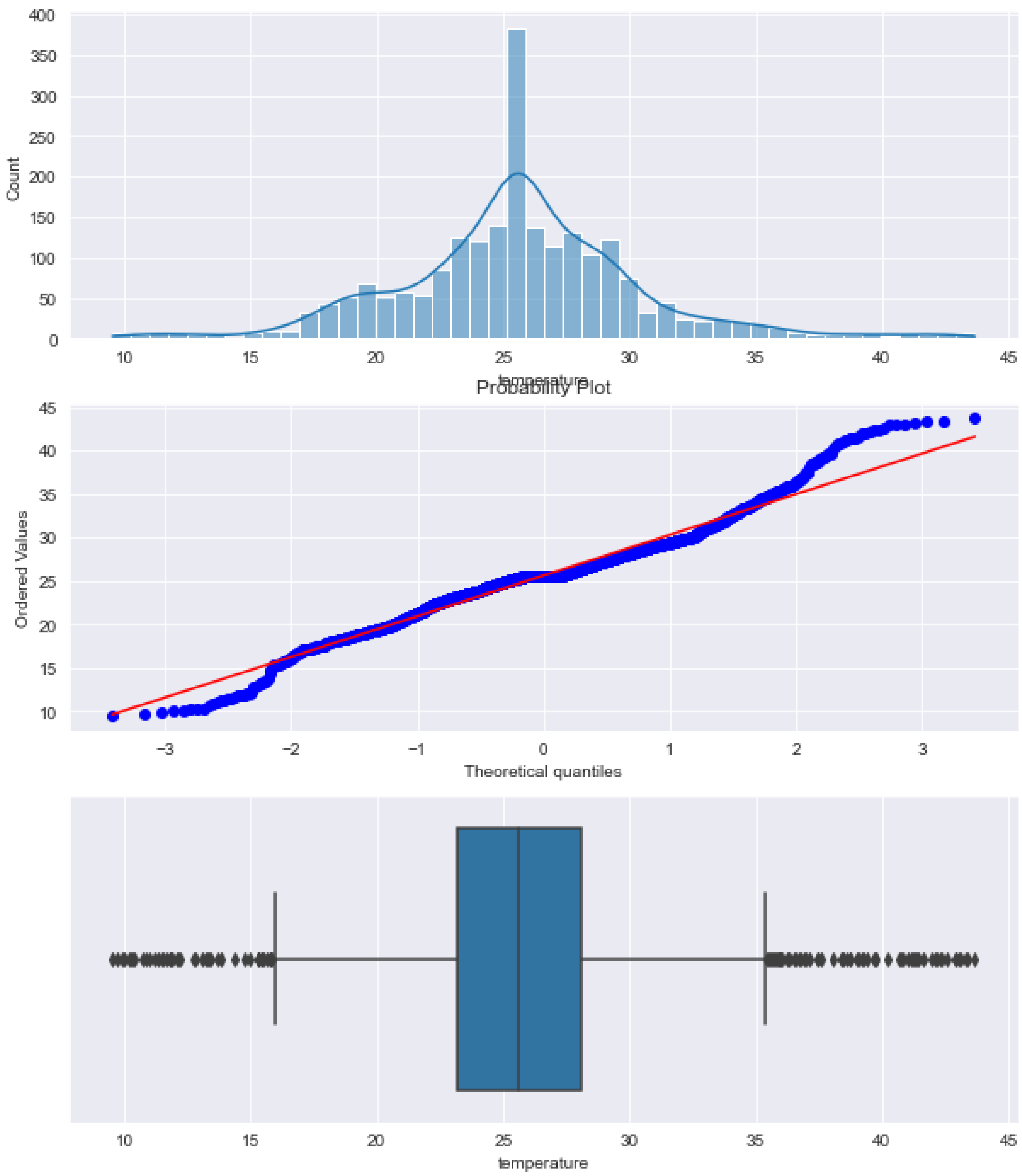
Temperature

In [18]:

```
#temperatue
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")
sns.histplot(data.loc[:, 'temperature'],kde=True,ax=ax1)

ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'temperature'],plot=ax2)

ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'temperature'],ax=ax3)
```

Out[18]:

```
<AxesSubplot:xlabel='temperature'>
```



In [19]:

```
print("Skewness of the temperature is", data['temperature'].skew())
```

```
Skewness of the temperature is 0.22922002414516282
```

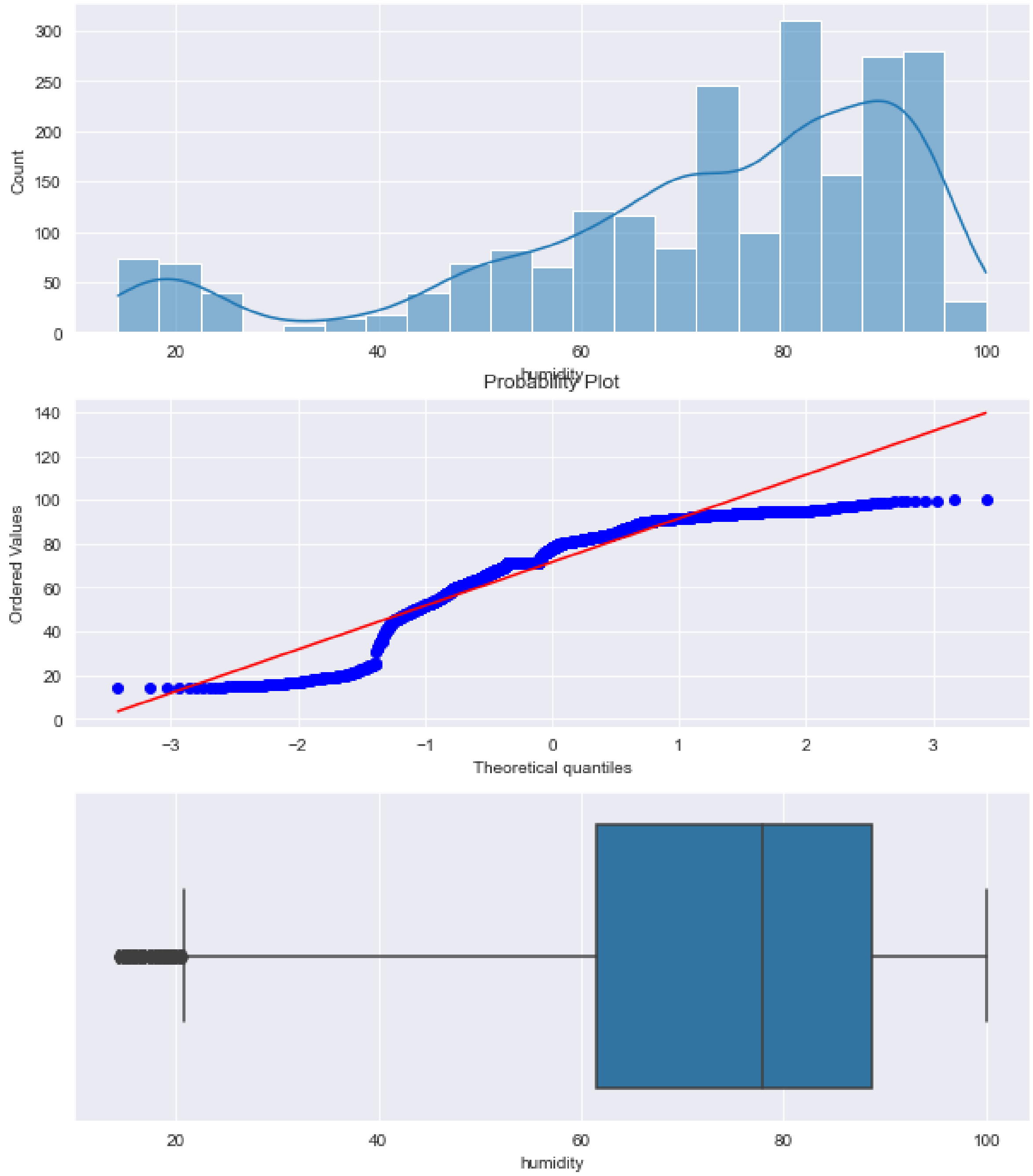
Humidity

In [20]:

```
#humidity
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")
sns.histplot(data.loc[:, 'humidity'],kde=True,ax=ax1)

ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'humidity'],plot=ax2)

ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'humidity'],ax=ax3)
```

Out[20]:

```
<AxesSubplot:xlabel='humidity'>
```



In [21]:

```
print("Skewness of the humidity is", data['humidity'].skew())
```

```
Skewness of the humidity is -1.1509111636431277
```

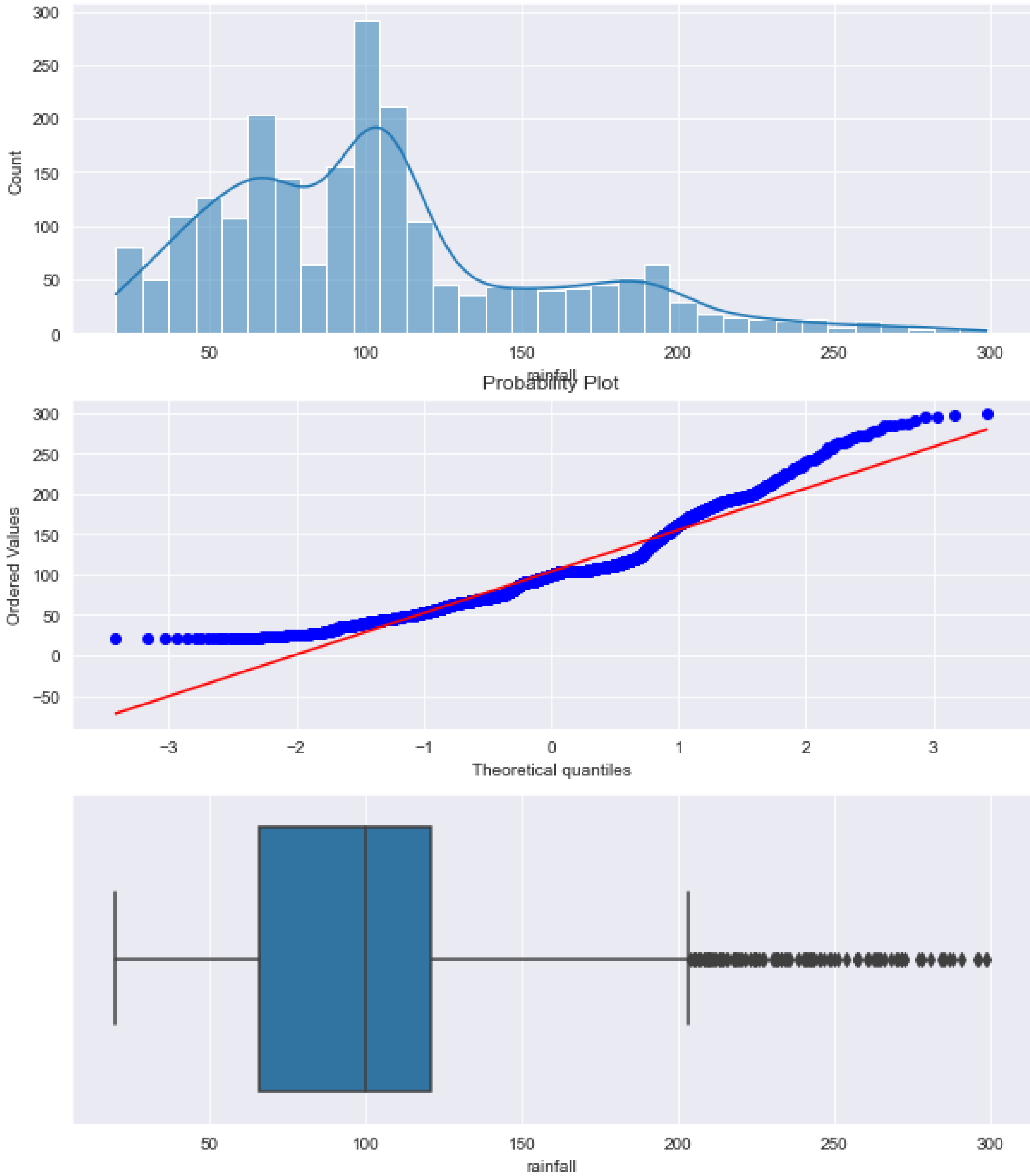
Rainfall

In [22]:

```
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")
sns.histplot(data.loc[:, 'rainfall'],kde=True,ax=ax1)

ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'rainfall'],plot=ax2)

ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'rainfall'],ax=ax3)
```

Out[22]:

<AxesSubplot:xlabel='rainfall'>



In [23]:

```
print("Skewness of the rainfall is", data['rainfall'].skew())
```

Skewness of the rainfall is 0.9741539486457941

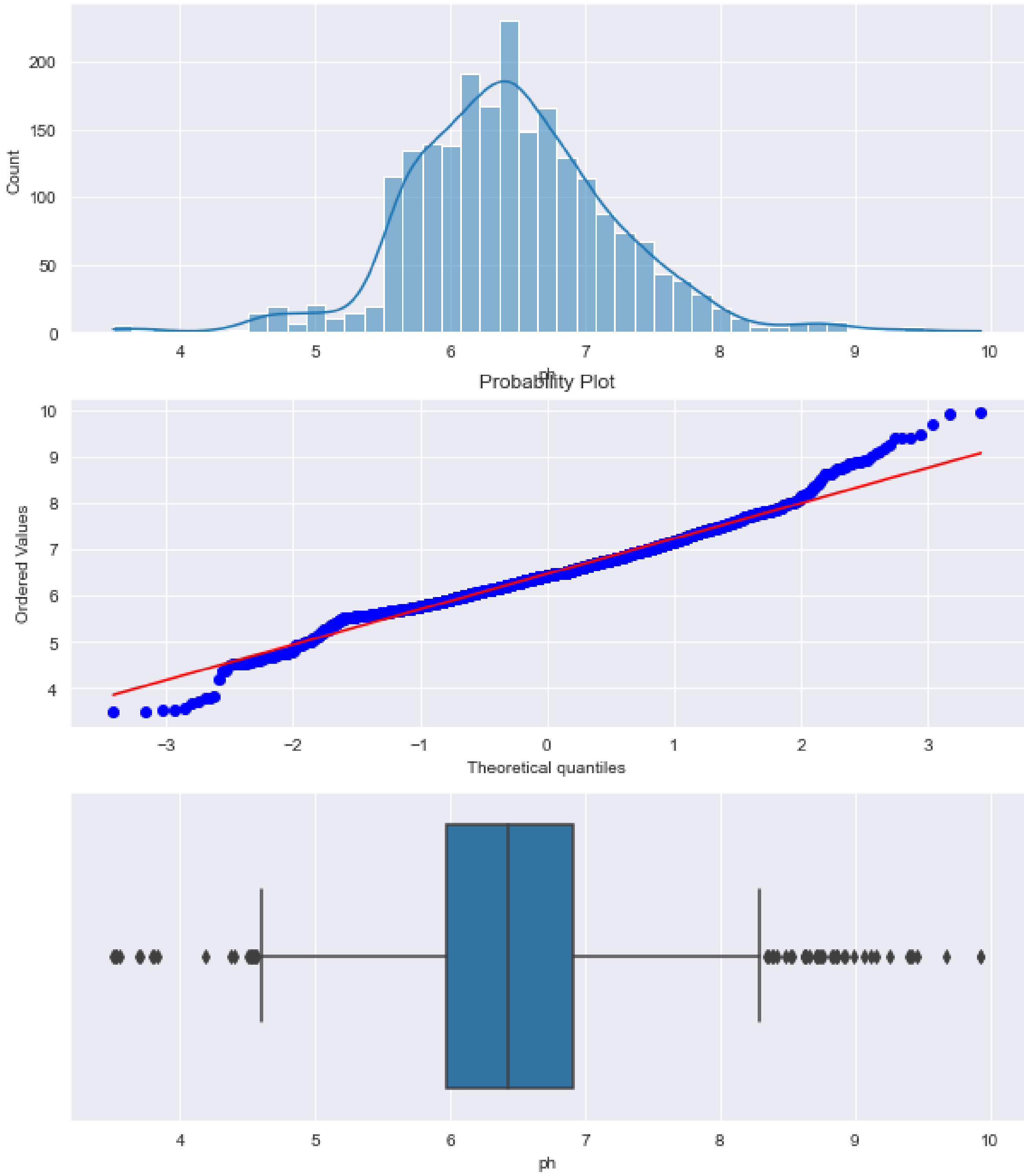
PH

In [24]:

```
#ph
fig=plt.figure(figsize=(10,12))
fig.tight_layout()
ax1 = fig.add_subplot(3, 1, 1)
sns.set_style("darkgrid")
sns.histplot(data.loc[:, 'ph'],kde=True,ax=ax1)

ax2 = fig.add_subplot(3, 1, 2)
stats.probplot(data.loc[:,'ph'],plot=ax2)

ax3 = fig.add_subplot(3, 1, 3)
sns.boxplot(x=data.loc[:, 'ph'],ax=ax3)
```

Out[24]:

<AxesSubplot:xlabel='ph'>



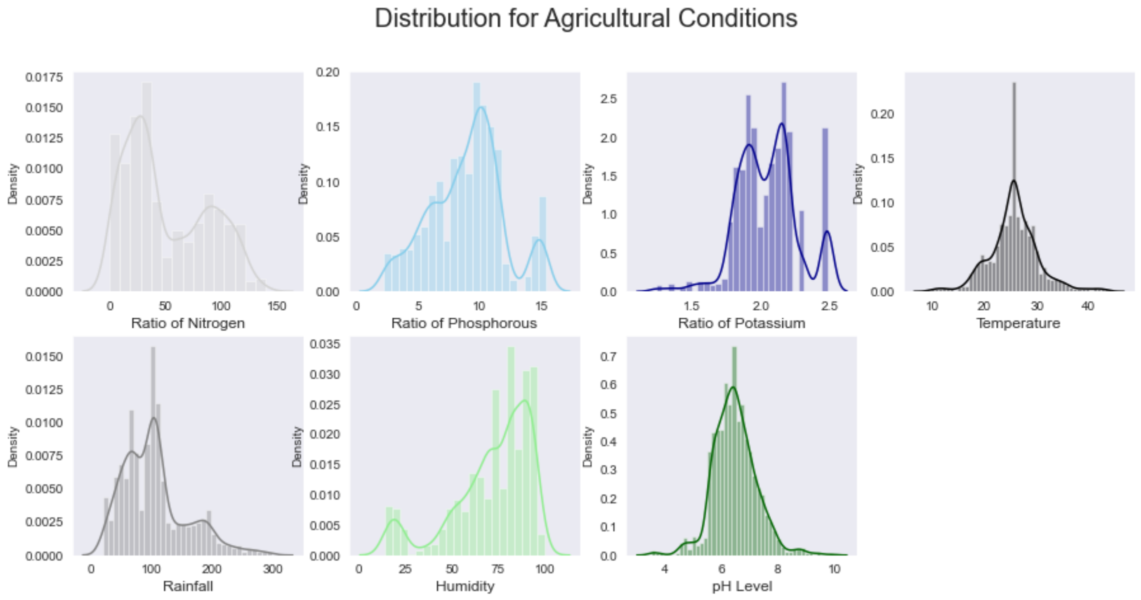
In [25]:

```
print("Skewness of the ph is", data['ph'].skew())
```

```
Skewness of the ph is 0.2956523540337813
```

In [26]:

```
### Lets check the distribution of Agricultural Conditions

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()
```



In [27]:

```
df.head()
```

Out[27]:

	N	P	K	temperature	humidity	ph	rainfall	label
0	90	8.473540	2.137693	20.879744	71.584617	6.502985	202.935536	rice
1	85	9.957805	2.124085	21.770462	80.319644	7.038096	226.655537	rice
2	60	9.700521	2.144184	23.004459	82.320763	7.840207	263.964248	rice
3	74	7.714341	2.116944	26.491096	80.158363	6.467553	242.864034	rice
4	78	8.473540	2.130997	25.633712	81.604873	7.628473	262.717340	rice

Scaling

In [28]:

```
from sklearn.preprocessing import MinMaxScaler
scaler = MinMaxScaler()

i=0
while i<df.shape[1]-1:
    x=df.columns[i]
    df[x]=scaler.fit_transform(df[[x]])
    i+=1
```

Encoding

In [29]:

```
LE = LabelEncoder()
df['label'] = LE.fit_transform(df['label'])
print(LE.classes_)
print(np.sort(df['label'].unique()))
print(20*'--')
```

```
['apple' 'banana' 'blackgram' 'chickpea' 'coconut' 'coffee' 'cotton'
 'grapes' 'jute' 'kidneybeans' 'lentil' 'maize' 'mango' 'mothbeans'
 'mungbean' 'muskmelon' 'orange' 'papaya' 'pigeonpeas' 'pomegranate'
 'rice' 'watermelon']
[ 0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 21]
----------------------------------------
```

Spliting data into training and testing

In [30]:

```
X = df[['N','P','K','temperature','humidity','ph','rainfall']]
y = df['label']

# 80% for training and 20% for testing

from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.20, random_state =
```

In [ ]:

```

```

Decision Tree

In [56]:

```
# Decision Tree
tree = DecisionTreeClassifier()
# Training
tree = tree.fit(X_train, y_train)

y_pred_tree = tree.predict(X_test)
accuracy_dt = accuracy_score(y_test, y_pred_tree)
```

In [79]:

```
accuracy_dt*100
```

Out[79]:

```
95.45454545454545
```

In [57]:

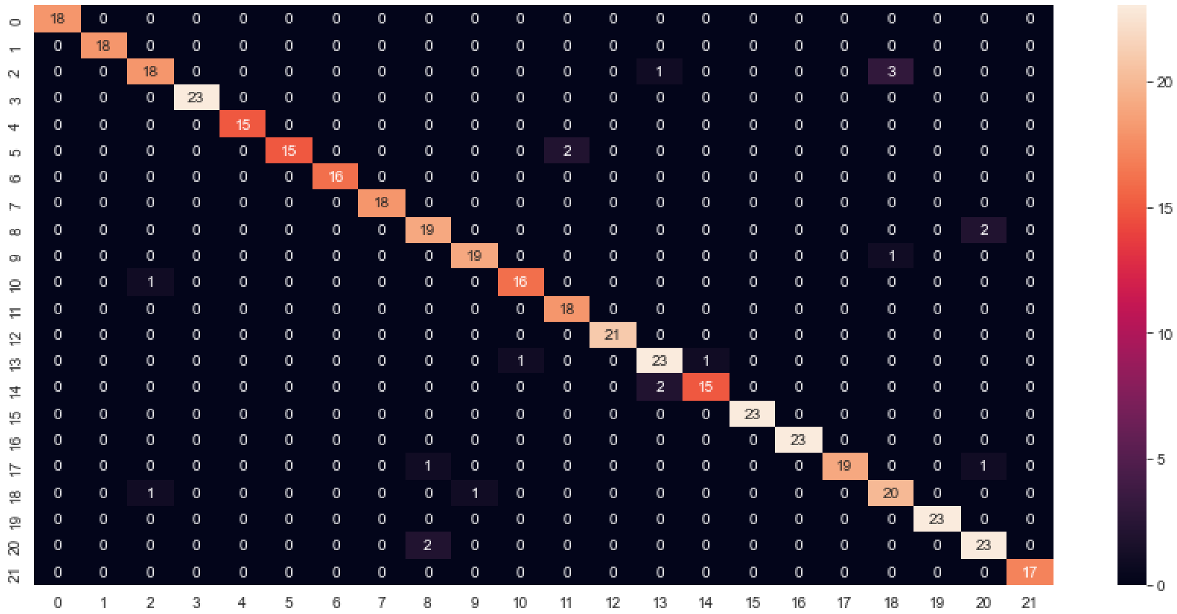
```
cm= confusion_matrix(y_test, y_pred_tree)
```

In [58]:

```
sns.heatmap(cm, annot=True)
```

Out[58]:

```
<AxesSubplot:>
```



KNN

In [59]:

```
#KNN
model = KNeighborsClassifier(n_neighbors=10)

# Training
model.fit(X_train,y_train)
```

Out[59]:

```
KNeighborsClassifier(n_neighbors=10)
```

In [60]:

```
y_pred = model.predict(X_test)
accuracy_knn = accuracy_score(y_test, y_pred)
```

In [80]:

```
accuracy_knn*100
```

Out[80]:

```
95.0
```

In [62]:

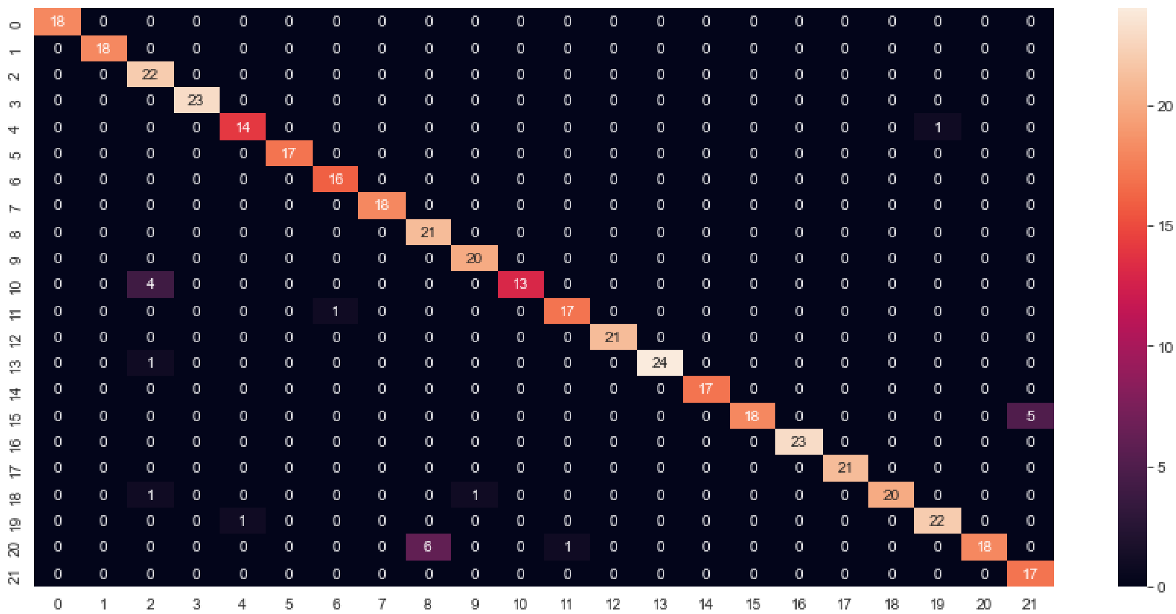
```
cpm = confusion_matrix(y_test, y_pred)
```

In [63]:

```
sns.heatmap(cpm, annot=True)
```

Out[63]:

```
<AxesSubplot:>
```



In [ ]:

```

```

Naive bayes

In [65]:

```
#naive bayes
gb = GaussianNB()

# Training
gb.fit(X_train,y_train)
```

Out[65]:

```
GaussianNB()
```

In [66]:

```
y_pred_gb = gb.predict(X_test)
accuracy_gb = accuracy_score(y_test, y_pred_gb)
```

In [81]:

```
accuracy_gb*100
```

Out[81]:

```
97.27272727272728
```

In [68]:

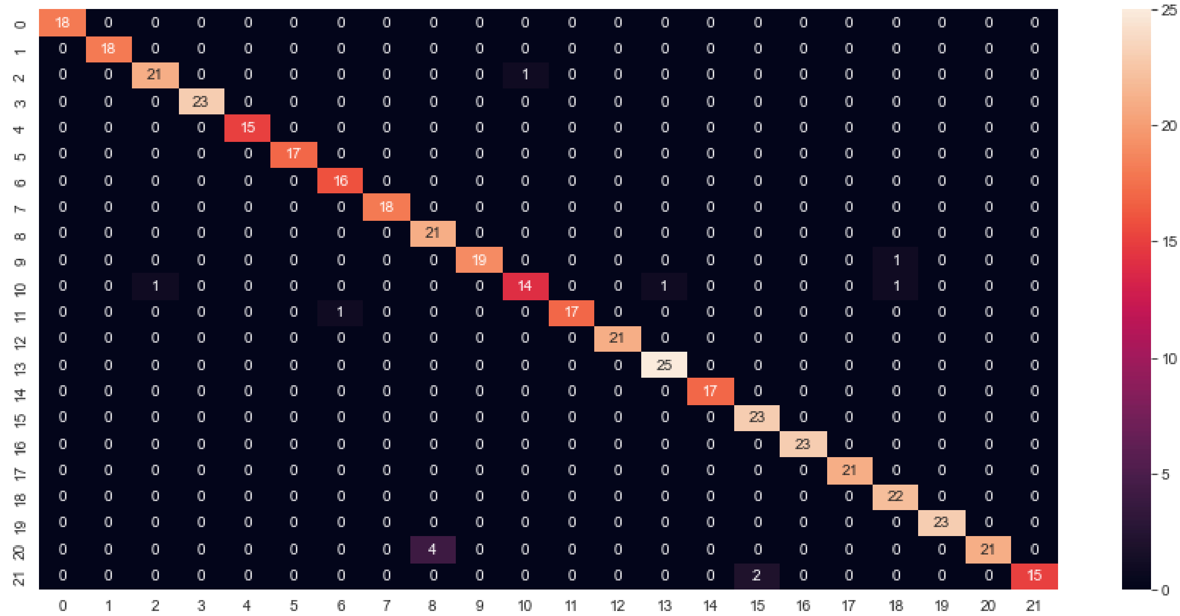
```

cm_gb = confusion_matrix(y_test, y_pred_gb)
```

In [69]:

```
sns.heatmap(cm_gb, annot=True)
```

Out[69]:

```
<AxesSubplot:>
```



SVC

In [70]:

```
clf = SVC(kernel='linear')

#Training
clf.fit(X_train, y_train)
```

Out[70]:

```
SVC(kernel='linear')
```

In [71]:

```
y_pred_svc = clf.predict(X_test)
accuracy_svc = accuracy_score(y_test, y_pred_svc)
```

In [82]:

```
accuracy_svc*100
```

Out[82]:

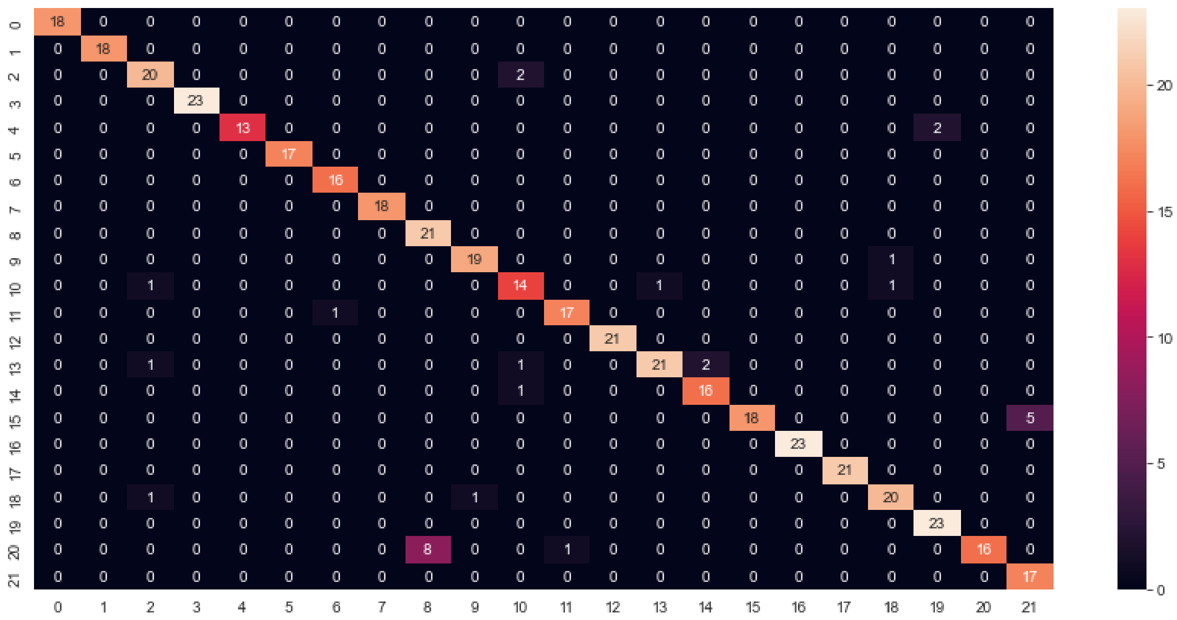
93.18181818181817

In [73]:

```
cm_svc = confusion_matrix(y_test, y_pred_svc)
sns.heatmap(cm_svc, annot=True)
```

Out[73]:

<AxesSubplot:>



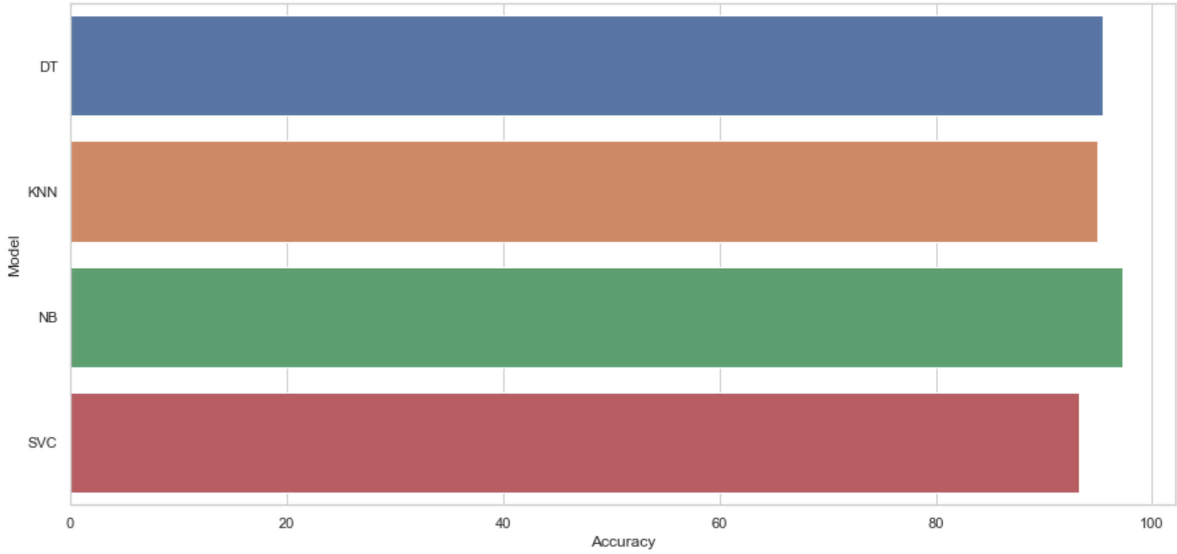
In [83]:

```
# Appending accuracies of all model to a dataframe
df=pd.DataFrame()
df['Model']=["DT","KNN","NB","SVC"]
df["Accuracy"]=[accuracy_dt*100,accuracy_knn*100,accuracy_gb*100,accuracy_svc*100]
```

Accuracy of Models

In [84]:

```
sns.set(style="whitegrid")
ax=sns.barplot(y='Model',x='Accuracy',data=df)
```



In [ ]:

```
```