```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.model_selection import train_test_split,GridSearchCV
from sklearn.preprocessing import StandardScaler

z=pd.read_csv('D:/KGISL MICRO COLL/Domain class/Milestone
3/Crop_recommendation.csv')
z
```

```
        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
...   ...  ..  ..          ...        ...       ...         ...     ..
.
2195  107  34  32    26.774637  66.413269  6.780064  177.774507
coffee
2196   99  15  27    27.417112  56.636362  6.086922  127.924610
coffee
2197  118  33  30    24.131797  67.225123  6.362608  173.322839
coffee
2198  117  32  34    26.272418  52.127394  6.758793  127.175293
coffee
2199  104  18  30    23.603016  60.396475  6.779833  140.937041
coffee

[2200 rows x 8 columns]
```

```
z['label'].unique()
```

```
array(['rice', 'maize', 'chickpea', 'kidneybeans', 'pigeonpeas',
       'mothbeans', 'mungbean', 'blackgram', 'lentil', 'pomegranate',
       'banana', 'mango', 'grapes', 'watermelon', 'muskmelon',
'apple',
       'orange', 'papaya', 'coconut', 'cotton', 'jute', 'coffee'],
      dtype=object)
```

```
z.isnull().sum()
```

```
N              0
P              0
```

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

```
df1=z.select_dtypes(exclude=['object'])
df1
```

	N	P	K	temperature	humidity	ph	rainfall
0	90	42	43	20.879744	82.002744	6.502985	202.935536
1	85	58	41	21.770462	80.319644	7.038096	226.655537
2	60	55	44	23.004459	82.320763	7.840207	263.964248
3	74	35	40	26.491096	80.158363	6.980401	242.864034
4	78	42	42	20.130175	81.604873	7.628473	262.717340
...	...	..	..	...	...	...	...
2195	107	34	32	26.774637	66.413269	6.780064	177.774507
2196	99	15	27	27.417112	56.636362	6.086922	127.924610
2197	118	33	30	24.131797	67.225123	6.362608	173.322839
2198	117	32	34	26.272418	52.127394	6.758793	127.175293
2199	104	18	30	23.603016	60.396475	6.779833	140.937041

[2200 rows x 7 columns]

```
q1=df1.quantile(0.25)
q3=df1.quantile(0.75)
q1
```

```
N              21.000000
P              28.000000
K              20.000000
temperature    22.769375
humidity       60.261953
ph              5.971693
rainfall       64.551686
Name: 0.25, dtype: float64
```

```
q3
```

```
N               84.250000
P               68.000000
K               49.000000
temperature     28.561654
humidity        89.948771
ph               6.923643
rainfall       124.267508
Name: 0.75, dtype: float64
```

```
iqr=q3-q1
iqr
```

```
N              63.250000
P              40.000000
K              29.000000
temperature     5.792279
humidity       29.686818
ph              0.951950
rainfall       59.715822
dtype: float64
```

```
b=(df1<(q1-1.5*iqr))|(df1>(q3+1.5*iqr))
b
```

```
          N      P      K  temperature  humidity     ph  rainfall
0     False  False  False        False     False  False     False
1     False  False  False        False     False  False      True
2     False  False  False        False     False  False      True
3     False  False  False        False     False  False      True
4     False  False  False        False     False  False      True
...     ...    ...    ...          ...       ...    ...       ...
2195  False  False  False        False     False  False     False
2196  False  False  False        False     False  False     False
2197  False  False  False        False     False  False     False
2198  False  False  False        False     False  False     False
2199  False  False  False        False     False  False     False

[2200 rows x 7 columns]
```

```
df=z[~(b).any(axis=1)]
df
```

```
        N   P   K  temperature   humidity        ph    rainfall
label
0      90  42  43    20.879744  82.002744  6.502985  202.935536
rice
13     93  56  36    24.014976  82.056872  6.984354  185.277339
rice
14     94  50  37    25.665852  80.663850  6.948020  209.586971
rice
17     91  35  39    23.793920  80.418180  6.970860  206.261186
rice
20     89  45  36    21.325042  80.474764  6.442475  185.497473
rice
...   ...  ..  ..          ...        ...       ...         ...     ..
.
2195  107  34  32    26.774637  66.413269  6.780064  177.774507
coffee
2196   99  15  27    27.417112  56.636362  6.086922  127.924610
```

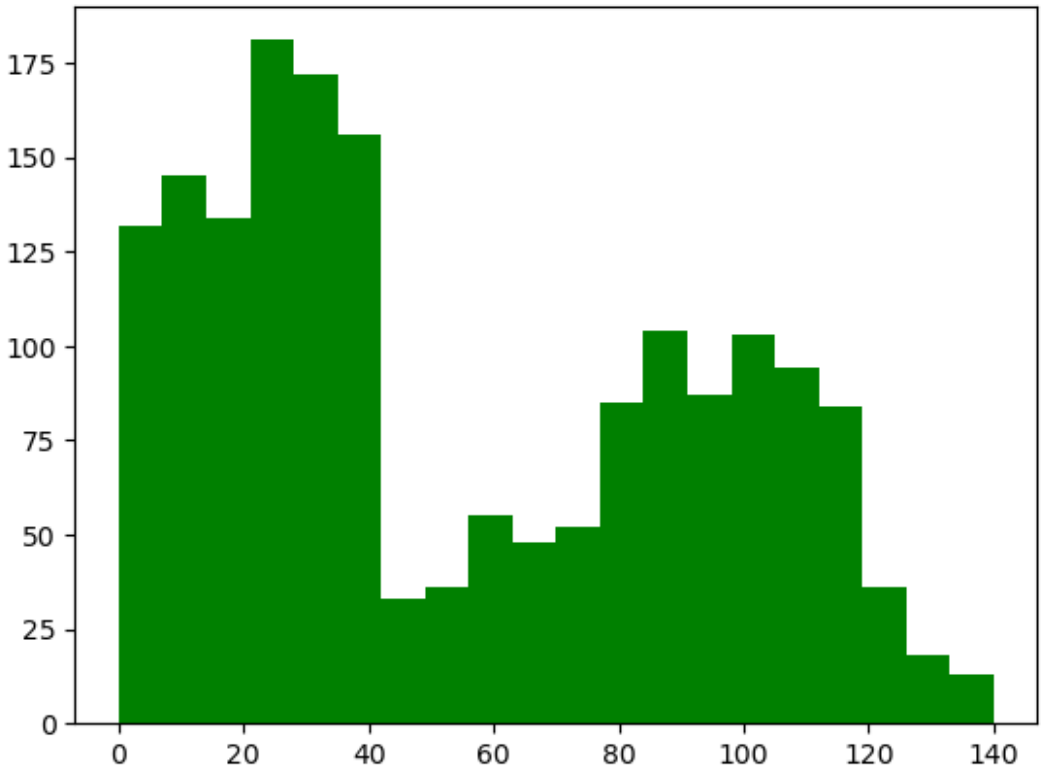
```
coffee
2197  118  33  30    24.131797  67.225123  6.362608  173.322839
coffee
2198  117  32  34    26.272418  52.127394  6.758793  127.175293
coffee
2199  104  18  30    23.603016  60.396475  6.779833  140.937041
coffee

[1768 rows x 8 columns]
```

```
z.shape,df.shape
```

```
((2200, 8), (1768, 8))
```

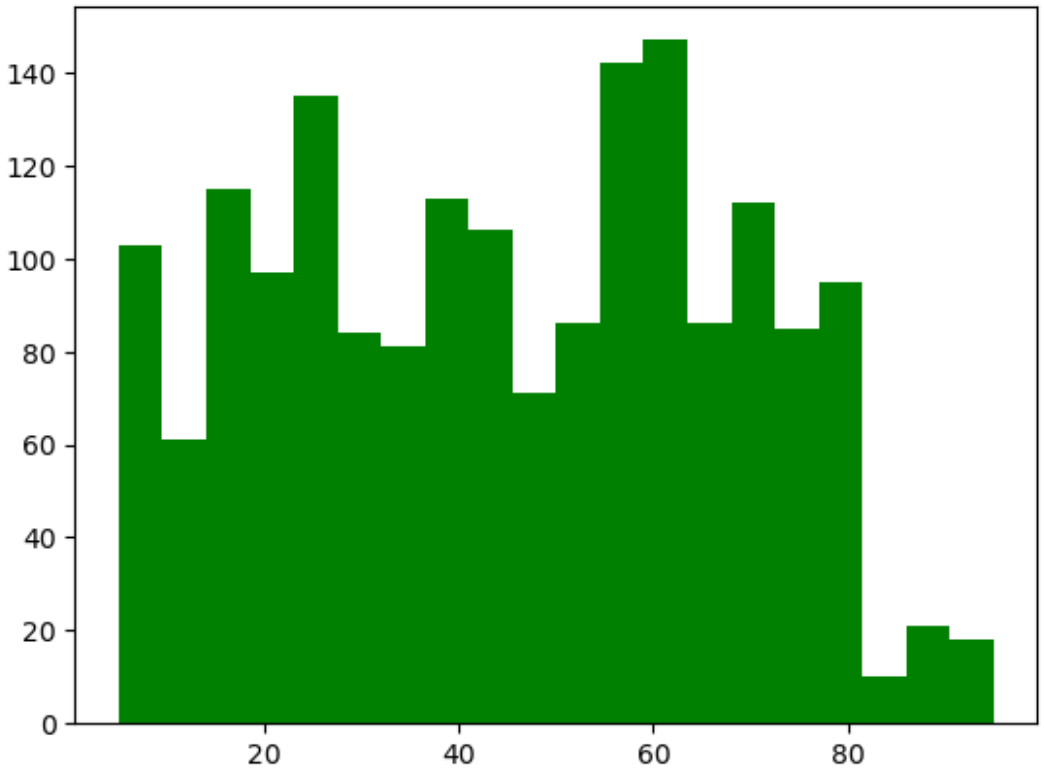
```
plt.hist(df['N'],bins=20,color='green')
```

```
(array([132., 145., 134., 181., 172., 156.,  33.,  36.,  55.,  48.,
52.,
         85., 104.,  87., 103.,  94.,  84.,  36.,  18.,  13.]),
 array([  0.,   7.,  14.,  21.,  28.,  35.,  42.,  49.,  56.,  63.,
70.,
         77.,  84.,  91.,  98., 105., 112., 119., 126., 133., 140.]),
 <BarContainer object of 20 artists>)
```



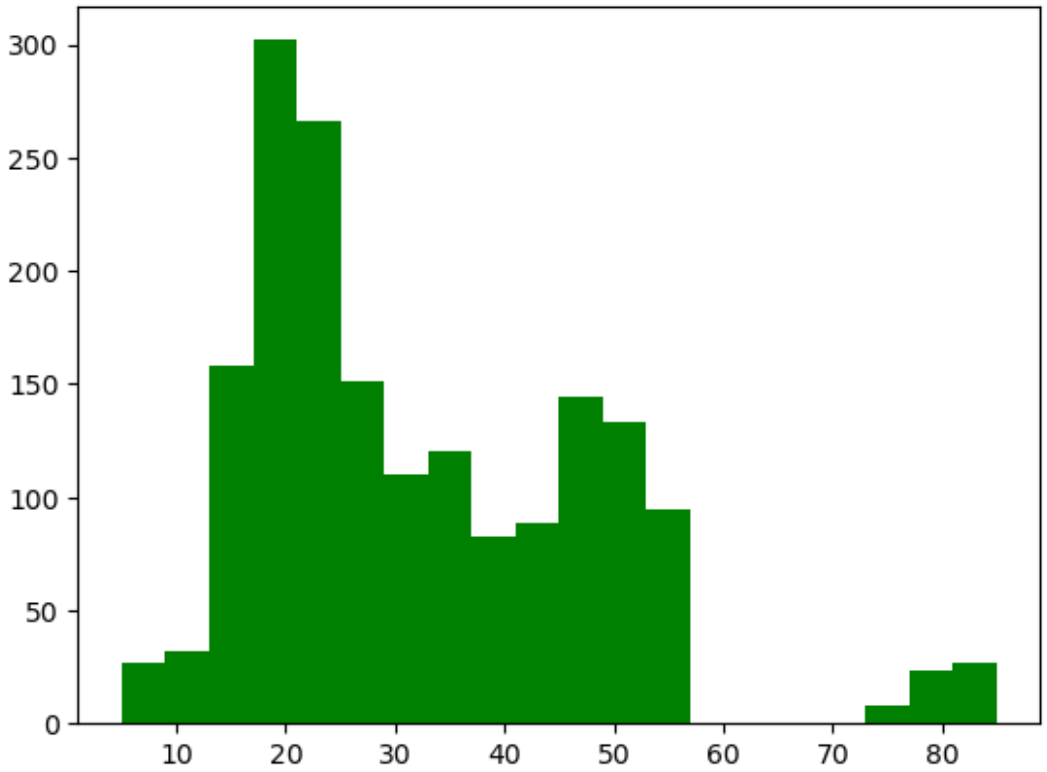

```
plt.hist(df['P'],bins=20,color='green')
```

```
(array([103.,  61., 115.,  97., 135.,  84.,  81., 113., 106.,  71.,
86.,
        142., 147.,  86., 112.,  85.,  95.,  10.,  21.,  18.]),
 array([ 5. ,  9.5, 14. , 18.5, 23. , 27.5, 32. , 36.5, 41. , 45.5,
50. ,
        54.5, 59. , 63.5, 68. , 72.5, 77. , 81.5, 86. , 90.5, 95. ]),
 <BarContainer object of 20 artists>)
```




```
plt.hist(df['K'],bins=20,color='green')
```

```
(array([ 27.,  32., 158., 302., 266., 151., 110., 120.,  83.,  89.,
144.,
        133.,  95.,   0.,   0.,   0.,   0.,   8.,  23.,  27.]),
 array([ 5.,  9., 13., 17., 21., 25., 29., 33., 37., 41., 45., 49.,
53.,
        57., 61., 65., 69., 73., 77., 81., 85.]),
 <BarContainer object of 20 artists>)
```




```
df.groupby(['label']).count()
```

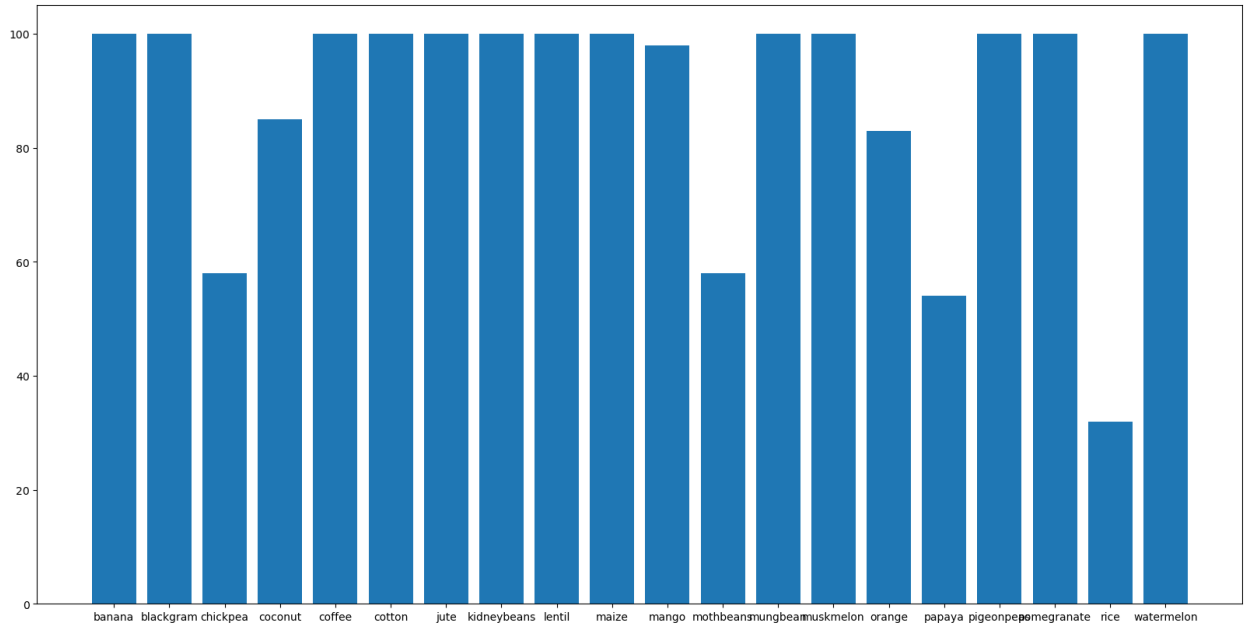
label	N	P	K	temperature	humidity	ph	rainfall
banana	100	100	100	100	100	100	100
blackgram	100	100	100	100	100	100	100
chickpea	58	58	58	58	58	58	58
coconut	85	85	85	85	85	85	85
coffee	100	100	100	100	100	100	100
cotton	100	100	100	100	100	100	100
jute	100	100	100	100	100	100	100
kidneybeans	100	100	100	100	100	100	100
lentil	100	100	100	100	100	100	100
maize	100	100	100	100	100	100	100
mango	98	98	98	98	98	98	98
mothbeans	58	58	58	58	58	58	58
mungbean	100	100	100	100	100	100	100
muskmelon	100	100	100	100	100	100	100
orange	83	83	83	83	83	83	83
papaya	54	54	54	54	54	54	54
pigeonpeas	100	100	100	100	100	100	100
pomegranate	100	100	100	100	100	100	100
rice	32	32	32	32	32	32	32
watermelon	100	100	100	100	100	100	100

```
a=df.groupby(['label']).size().reset_index(name='count').rename(columns={'Label':'Crops'})
a
```

	label	count
0	banana	100
1	blackgram	100
2	chickpea	58
3	coconut	85
4	coffee	100
5	cotton	100
6	jute	100
7	kidneybeans	100
8	lentil	100
9	maize	100
10	mango	98
11	mothbeans	58
12	mungbean	100
13	muskmelon	100
14	orange	83
15	papaya	54
16	pigeonpeas	100
17	pomegranate	100
18	rice	32
19	watermelon	100

```
plt.figure(figsize=(20,10))
plt.bar(a['label'],a['count'])
```

```
<BarContainer object of 20 artists>
```

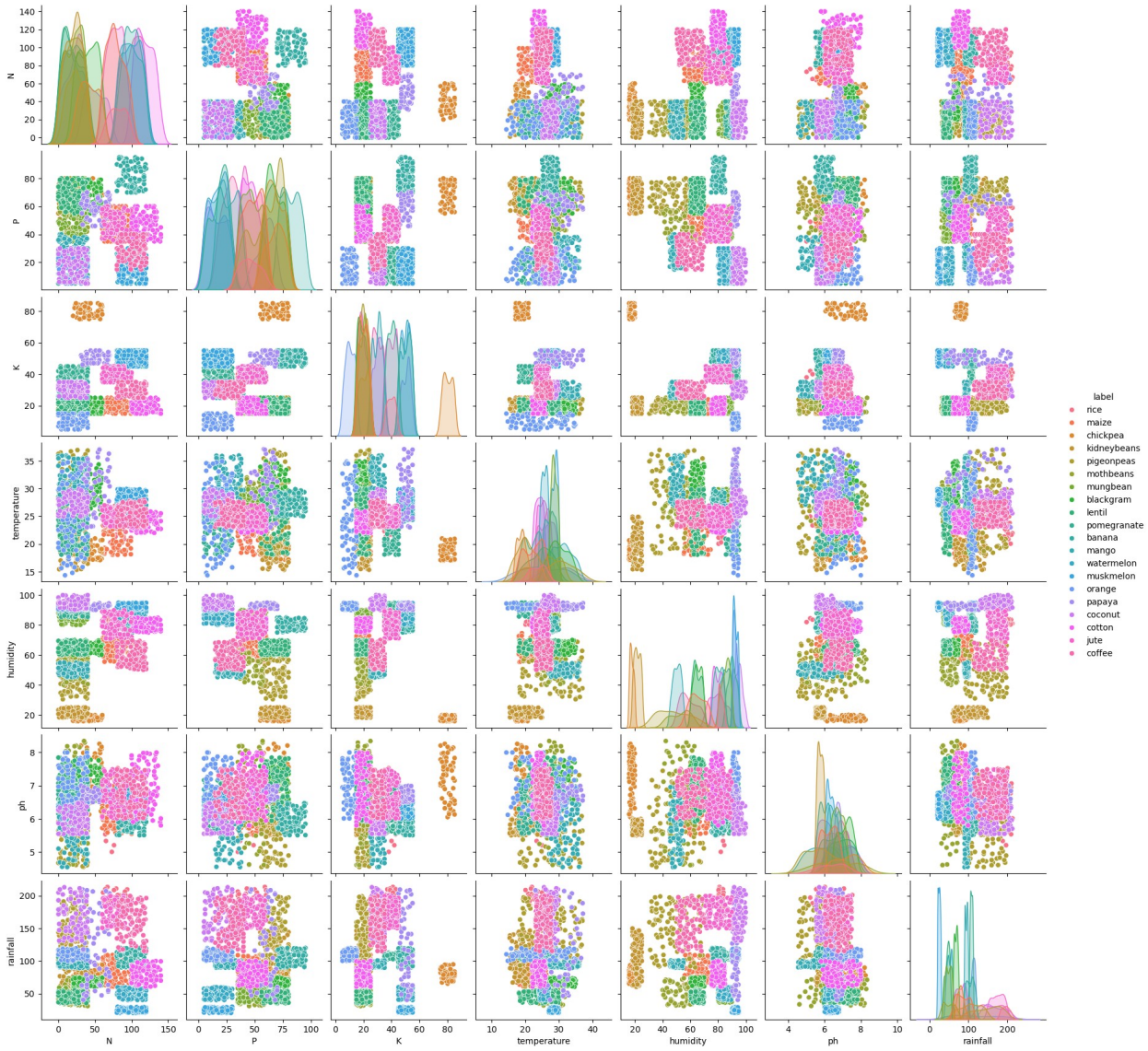


```
a['Percentage']=a['count']/sum(a['count'])*100
a
```

	label	count	Percentage
0	banana	100	5.656109
1	blackgram	100	5.656109
2	chickpea	58	3.280543
3	coconut	85	4.807692
4	coffee	100	5.656109
5	cotton	100	5.656109
6	jute	100	5.656109
7	kidneybeans	100	5.656109
8	lentil	100	5.656109
9	maize	100	5.656109
10	mango	98	5.542986
11	mothbeans	58	3.280543
12	mungbean	100	5.656109
13	muskmelon	100	5.656109
14	orange	83	4.694570
15	papaya	54	3.054299
16	pigeonpeas	100	5.656109
17	pomegranate	100	5.656109
18	rice	32	1.809955
19	watermelon	100	5.656109

```
sns.pairplot(df,hue='label')
```

```
<seaborn.axisgrid.PairGrid at 0x1aaa5bc5d90>
```




```
df1=df.drop(columns=['label'])
df1
```

	N	P	K	temperature	humidity	ph	rainfall
0	90	42	43	20.879744	82.002744	6.502985	202.935536
13	93	56	36	24.014976	82.056872	6.984354	185.277339
14	94	50	37	25.665852	80.663850	6.948020	209.586971
17	91	35	39	23.793920	80.418180	6.970860	206.261186
20	89	45	36	21.325042	80.474764	6.442475	185.497473
...	...	..	..	...	...	...	...
2195	107	34	32	26.774637	66.413269	6.780064	177.774507
2196	99	15	27	27.417112	56.636362	6.086922	127.924610
2197	118	33	30	24.131797	67.225123	6.362608	173.322839
2198	117	32	34	26.272418	52.127394	6.758793	127.175293
2199	104	18	30	23.603016	60.396475	6.779833	140.937041

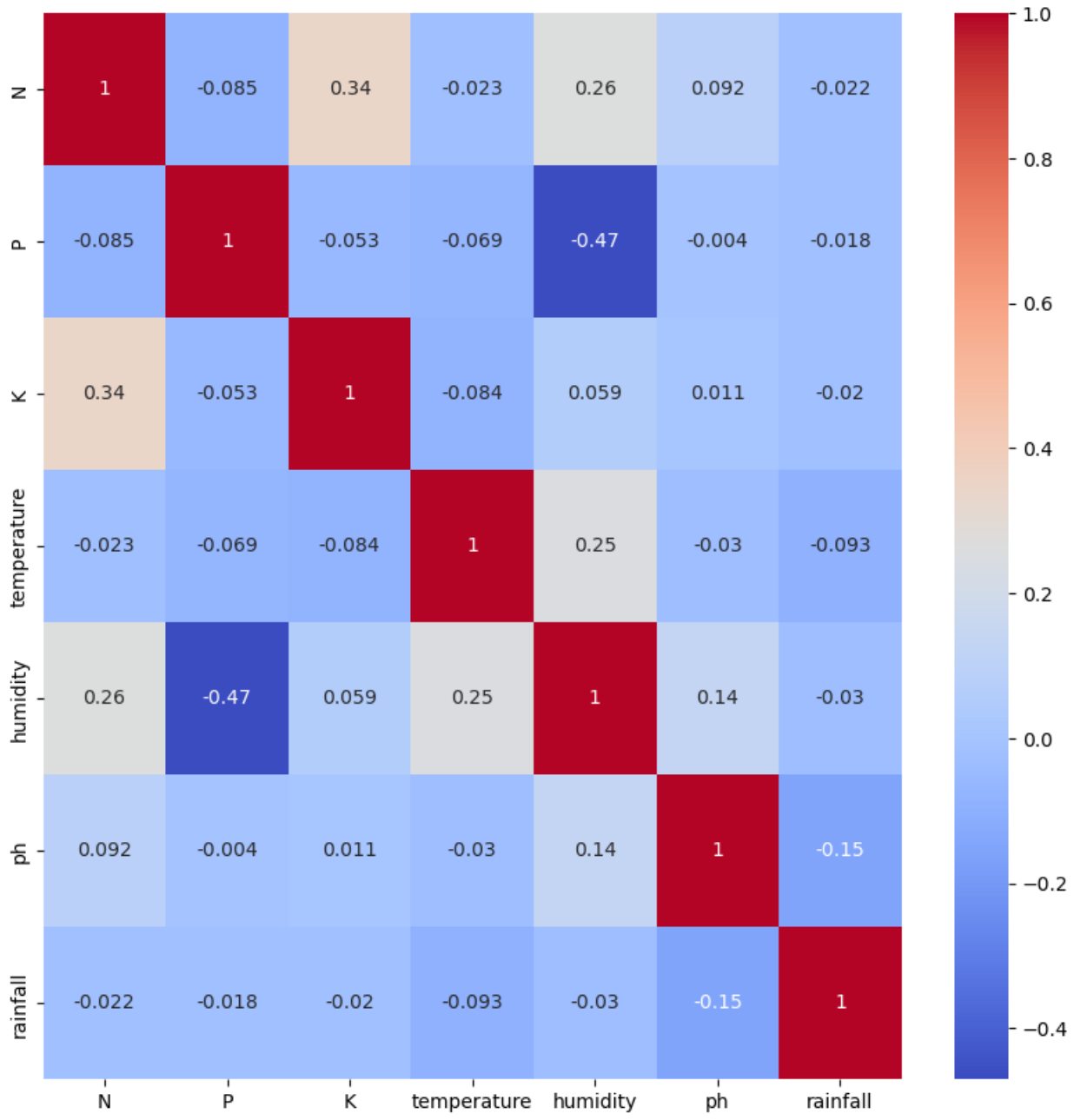
```
[1768 rows x 7 columns]
```

```
df1.corr()
```

```
                    N         P         K  temperature  humidity
ph  \
N            1.000000 -0.084996  0.343172    -0.022925  0.263791
0.091578
P           -0.084996  1.000000 -0.052944    -0.068690 -0.470329 -
0.003966
K            0.343172 -0.052944  1.000000    -0.084430  0.059263
0.010826
temperature -0.022925 -0.068690 -0.084430     1.000000  0.247642 -
0.030254
humidity     0.263791 -0.470329  0.059263     0.247642  1.000000
0.138226
ph           0.091578 -0.003966  0.010826    -0.030254  0.138226
1.000000
rainfall    -0.021797 -0.017827 -0.020435    -0.093072 -0.030023 -
0.152062

              rainfall
N           -0.021797
P           -0.017827
K           -0.020435
temperature -0.093072
humidity    -0.030023
ph          -0.152062
rainfall     1.000000
```

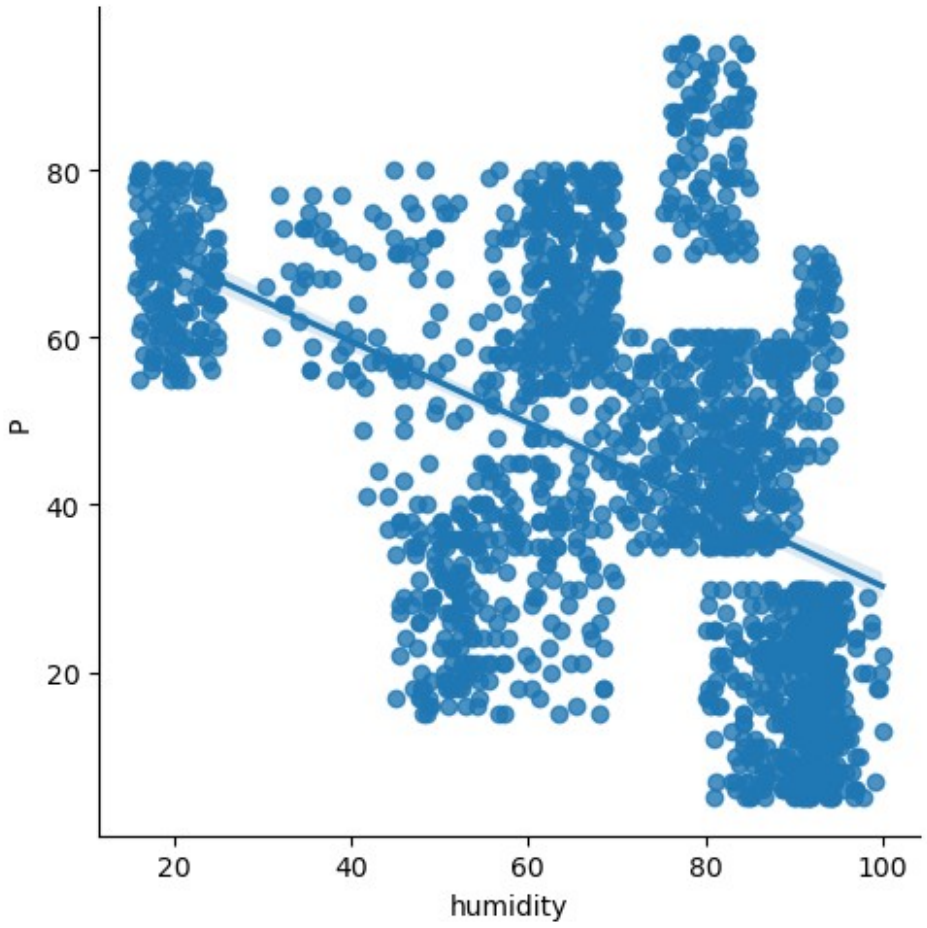
```
plt.figure(figsize=(10,10))
sns.heatmap(df1.corr(),annot=True,cmap='coolwarm')
```

```
<Axes: >
```




```
sns.lmplot(x='humidity',y='P',data=df)
```

```
<seaborn.axisgrid.FacetGrid at 0x1aaab37e890>
```




```
x=df.drop(columns=['label'])
y=df['label']
x
```

	N	P	K	temperature	humidity	ph	rainfall
0	90	42	43	20.879744	82.002744	6.502985	202.935536
13	93	56	36	24.014976	82.056872	6.984354	185.277339
14	94	50	37	25.665852	80.663850	6.948020	209.586971
17	91	35	39	23.793920	80.418180	6.970860	206.261186
20	89	45	36	21.325042	80.474764	6.442475	185.497473
...	...	..	..	...	...	...	...
2195	107	34	32	26.774637	66.413269	6.780064	177.774507
2196	99	15	27	27.417112	56.636362	6.086922	127.924610
2197	118	33	30	24.131797	67.225123	6.362608	173.322839
2198	117	32	34	26.272418	52.127394	6.758793	127.175293
2199	104	18	30	23.603016	60.396475	6.779833	140.937041

[1768 rows x 7 columns]

```
y
```

```
0         rice
13        rice
14        rice
17        rice
20        rice
         ...
2195    coffee
2196    coffee
2197    coffee
2198    coffee
2199    coffee
Name: label, Length: 1768, dtype: object
```

```
from sklearn.feature_selection import f_classif
a=f_classif(x,y)
a
```

```
(array([ 879.87735413,  742.26069725, 2266.90559447,  127.16376955,
        2315.85411065,   74.08361738,  592.36868665]),
 array([0.00000000e+000, 0.00000000e+000, 0.00000000e+000,
2.87413059e-312,
        0.00000000e+000, 5.70550659e-208, 0.00000000e+000]))
```

```
a=pd.Series(a[1])
a.index=x.columns
a
```

```
N               0.000000e+00
P               0.000000e+00
K               0.000000e+00
temperature    2.874131e-312
humidity        0.000000e+00
ph             5.705507e-208
rainfall        0.000000e+00
dtype: float64
```

```
df
```

```
        N   P   K  temperature   humidity        ph    rainfall
label
0      90  42  43    20.879744  82.002744  6.502985  202.935536
rice
13     93  56  36    24.014976  82.056872  6.984354  185.277339
rice
14     94  50  37    25.665852  80.663850  6.948020  209.586971
rice
17     91  35  39    23.793920  80.418180  6.970860  206.261186
rice
20     89  45  36    21.325042  80.474764  6.442475  185.497473
rice
...   ...  ..  ..          ...        ...       ...         ...     ..
```

```
.
2195  107  34  32    26.774637  66.413269  6.780064  177.774507
coffee
2196   99  15  27    27.417112  56.636362  6.086922  127.924610
coffee
2197  118  33  30    24.131797  67.225123  6.362608  173.322839
coffee
2198  117  32  34    26.272418  52.127394  6.758793  127.175293
coffee
2199  104  18  30    23.603016  60.396475  6.779833  140.937041
coffee

[1768 rows x 8 columns]
```

```
from sklearn.model_selection import train_test_split,GridSearchCV
from sklearn.ensemble import RandomForestClassifier
from sklearn.metrics import
confusion_matrix,classification_report,accuracy_score

x=df.drop(columns=['label'])
y=df['label']
x
```

```
        N   P   K  temperature   humidity        ph    rainfall
0      90  42  43    20.879744  82.002744  6.502985  202.935536
13     93  56  36    24.014976  82.056872  6.984354  185.277339
14     94  50  37    25.665852  80.663850  6.948020  209.586971
17     91  35  39    23.793920  80.418180  6.970860  206.261186
20     89  45  36    21.325042  80.474764  6.442475  185.497473
...   ...  ..  ..          ...        ...       ...         ...
2195  107  34  32    26.774637  66.413269  6.780064  177.774507
2196   99  15  27    27.417112  56.636362  6.086922  127.924610
2197  118  33  30    24.131797  67.225123  6.362608  173.322839
2198  117  32  34    26.272418  52.127394  6.758793  127.175293
2199  104  18  30    23.603016  60.396475  6.779833  140.937041

[1768 rows x 7 columns]
```

```
y
```

```
0         rice
13        rice
14        rice
17        rice
20        rice
         ...
2195    coffee
2196    coffee
2197    coffee
2198    coffee
```

```
2199    coffee
Name: label, Length: 1768, dtype: object
```

```
x_train,x_test,y_train,y_test=train_test_split(x,y,test_size=0.33,rand
om_state=42)
```

```
rf=RandomForestClassifier()
param_grid = {
    'n_estimators': [500,1000,2000],
    'max_depth': [15,20,25],
    'min_samples_split': [5,7,8]
}
```

```
grid_search=GridSearchCV(estimator=rf,param_grid=param_grid,cv=5,scori
ng='accuracy')
```

```
grid_search.fit(x_train,y_train)
```

```
GridSearchCV(cv=5, estimator=RandomForestClassifier(),
             param_grid={'max_depth': [15, 20, 25],
                         'min_samples_split': [5, 7, 8],
                         'n_estimators': [500, 1000, 2000]},
             scoring='accuracy')
```

```
grid_search.best_params_
```

```
{'max_depth': 15, 'min_samples_split': 5, 'n_estimators': 500}
```

```
grid_search.best_estimator_
```

```
RandomForestClassifier(max_depth=15, min_samples_split=5,
n_estimators=500)
```

```
pr=grid_search.best_estimator_.predict(x_test)
print(f"The accuracy of our model is:{accuracy_score(pr,y_test)}")
```

```
The accuracy of our model is:0.9897260273972602
```

```
print(classification_report(pr,y_test))
```

```
              precision    recall  f1-score   support

      banana       1.00      1.00      1.00        31
   blackgram       0.97      1.00      0.99        37
    chickpea       1.00      1.00      1.00        14
     coconut       1.00      1.00      1.00        33
      coffee       1.00      1.00      1.00        37
      cotton       1.00      0.96      0.98        27
        jute       1.00      0.88      0.94        33
 kidneybeans       1.00      1.00      1.00        37
      lentil       1.00      1.00      1.00        31
       maize       0.97      0.97      0.97        33
```

```
              precision    recall  f1-score   support

       mango       1.00      1.00      1.00        31
   mothbeans       1.00      1.00      1.00        21
    mungbean       1.00      1.00      1.00        34
   muskmelon       1.00      1.00      1.00        31
      orange       1.00      1.00      1.00        29
      papaya       1.00      1.00      1.00        25
  pigeonpeas       1.00      1.00      1.00        34
 pomegranate       1.00      1.00      1.00        34
        rice       0.33      1.00      0.50         2
  watermelon       1.00      1.00      1.00        30

    accuracy                           0.99       584
   macro avg       0.96      0.99      0.97       584
weighted avg       0.99      0.99      0.99       584
```