In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:
```
df = pd.read_csv("wine.txt", sep=" ")
```

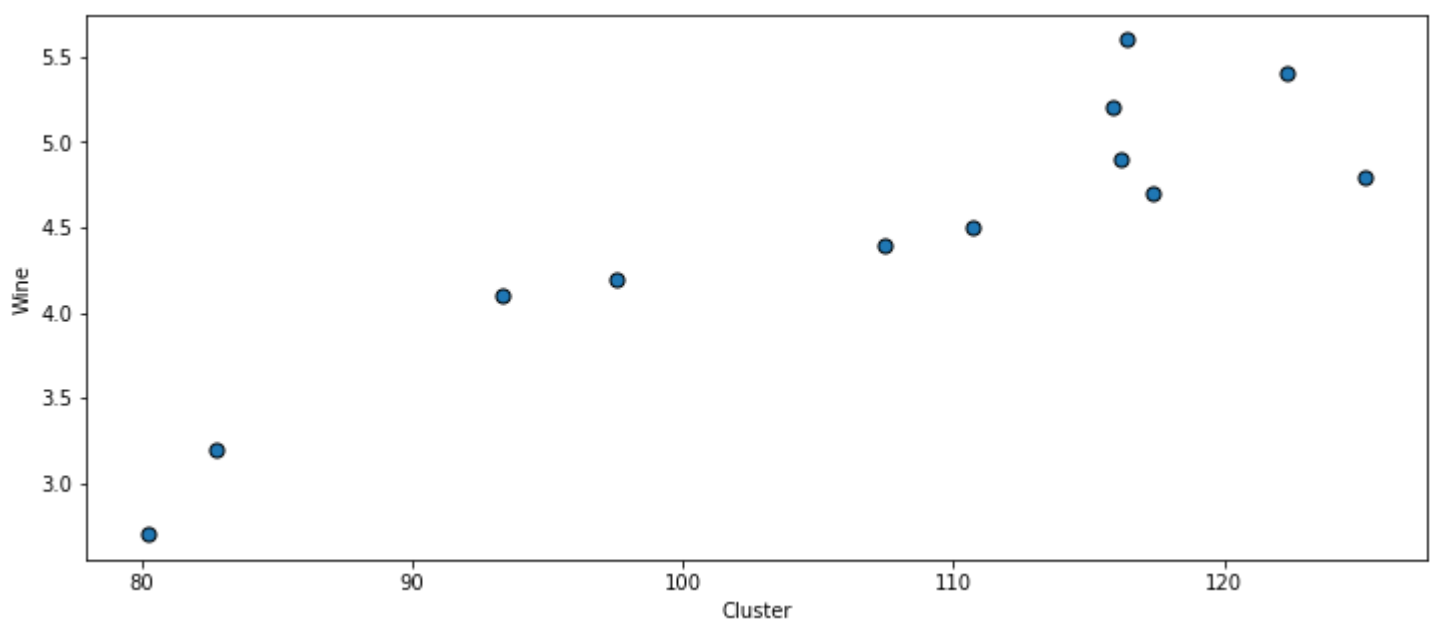
In [3]:
```
df
```

Out[3]:

	Year	Wine	Cluster
0	1971	5.6	116.37
1	1973	3.2	82.77
2	1974	4.5	110.68
3	1975	4.2	97.50
4	1976	5.2	115.88
5	1977	2.7	80.19
6	1978	4.8	125.24
7	1979	4.9	116.15
8	1980	4.7	117.36
9	1981	4.1	93.31
10	1982	4.4	107.46
11	1983	5.4	122.30

In [4]:
```
df.plot.scatter(x='Cluster', y='Wine', figsize=(12, 5), s=50, linewidths=1, edgecolor='black')
```

Out[4]: <AxesSubplot:xlabel='Cluster', ylabel='Wine'>



In [5]:
```
x = df['Cluster']
y = df['Wine']
```

Find $\hat{\beta}_0$ and $\hat{\beta}_1$ in [1]

$$\hat{\beta}_1 = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum(X_i - \bar{X})^2}$$

$$\hat{\beta}_0 = \bar{Y} - \hat{\beta}_1 \bar{X}$$

[1] https://towardsdatascience.com/simple-linear-regression-in-python-numpy-only-130a988c0212

In [6]:
```
def linear_regression(x, y):
    x_mean = x.mean()
    y_mean = y.mean()

    B1_num = ((x - x_mean) * (y - y_mean)).sum()
    B1_den = ((x - x_mean)**2).sum()
    B1 = B1_num / B1_den

    B0 = y_mean - (B1*x_mean)

    reg_line = 'y = {} + {}β'.format(round(B0, 3), round(B1, 3))

    return (B0, B1, reg_line)
```

In [7]:
```
B0, B1, line = linear_regression(x, y)
```

In [8]:
```
print(B0, B1, line)
print("Value of $\hat{\beta}_0$ is: ", round(B0, 3))
print("Value of $\hat{\beta}_1$ is: ", round(B1, 3))
print("The line equation: ", line)
```

```
-1.027902709556801 0.051380577893637314 y = -1.028 + 0.051β
Value of $\hat{□eta}_0$ is:  -1.028
Value of $\hat{□eta}_1$ is:  0.051
The line equation:  y = -1.028 + 0.051β
```

In [9]:
```
plt.figure(figsize=(12,5))
plt.scatter(x, y, s=50, linewidths=1, edgecolor='black')
plt.xlabel('Cluster')
plt.ylabel('Wine Production')
plt.plot(x, B0 + B1 * x, c="green")
```

Out[9]: [<matplotlib.lines.Line2D at 0x1fd6f56c4f0>]

In [10]:
```
def predict(B0, B1, new_x):
    y = B0 + B1 * new_x
    return y
```

In [11]:
```
new_cluster = 100

predict_wine = round(predict(B0, B1, new_cluster), 3)
print(predict_wine)
```

```
4.11
```

When the the number of berries in a bunch of grapes is 100 then the yearly production of wine will be 4.11

In [12]:
```
plt.figure(figsize=(12,5))
plt.scatter(x, y, s=50, linewidths=1, edgecolor='black')
plt.xlabel('Cluster')
plt.ylabel('Wine Production')
plt.grid()
plt.plot(x, B0 + B1 * x, c="green")
plt.plot(new_cluster, predict_wine, marker="*", markersize=20, markeredgecolor="black", markerfacecolor="red")
plt.show()
```