

Exercise-14

November 2, 2025

```
[1]: import numpy as np  
import scipy.stats as stats
```

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[2]: np.random.seed(42)  
n_plants = 25  
growth_A = np.random.normal(loc=10, scale=2, size=n_plants)  
growth_B = np.random.normal(loc=12, scale=3, size=n_plants)  
growth_C = np.random.normal(loc=15, scale=2.5, size=n_plants)
```

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[3]: all_data = np.concatenate([growth_A, growth_B, growth_C])  
treatment_labels = ['A'] * n_plants + ['B'] * n_plants + ['C'] * n_plants
```

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[4]: f_statistic, p_value = stats.f_oneway(growth_A, growth_B, growth_C)
```

```
[5]: print("Treatment A Mean Growth:", np.mean(growth_A))  
print("Treatment B Mean Growth:", np.mean(growth_B))  
print("Treatment C Mean Growth:", np.mean(growth_C))  
print()  
print(f"F-Statistic: {f_statistic:.4f}")  
print(f"P-Value: {p_value:.4f}")
```

```
Treatment A Mean Growth: 9.672983882683818  
Treatment B Mean Growth: 11.137680744437432  
Treatment C Mean Growth: 15.265234904828972
```

```
F-Statistic: 36.1214  
P-Value: 0.0000
```

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[8]: alpha = 0.05  
if p_value<alpha:  
    print("Reject the null hypothesis: There is a significant difference in  
    ↪mean growth rates among the three treatments")  
else:  
    print("Fail to reject the null hypothesis: There is no significant  
    ↪difference in mean growth rates among the three treatments")  
if p_value<alpha:  
    from statsmodels.stats.multicomp import pairwise_tukeyhsd  
    tukey_results = pairwise_tukeyhsd(all_data, treatment_labels, alpha=0.05)
```

```
print("\nTukey's HSD Post-hoc Test:")
print(tukey_results)
```

Reject the null hypothesis: There is a significant difference in mean growth rates among the three treatments

Tukey's HSD Post-hoc Test:

Multiple Comparison of Means - Tukey HSD, FWER=0.05

```
=====
group1 group2 meandiff p-adj    lower   upper   reject
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A      B     1.4647  0.0877 -0.1683  3.0977  False
A      C     5.5923   0.0   3.9593  7.2252   True
B      C     4.1276   0.0   2.4946  5.7605   True
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```

[]: