Analysis of Flowering Timing and Duration in Two Populations

Introduction

This analysis examines the timing and duration of flowering in two populations: PC and CojoHQ. We will analyze whether there are differences between these populations in terms of:

1. Timing of flowering (when flowers open and close)
2. Duration of flowering (how long flowers remain open)
3. Variation in these parameters

Data Preparation

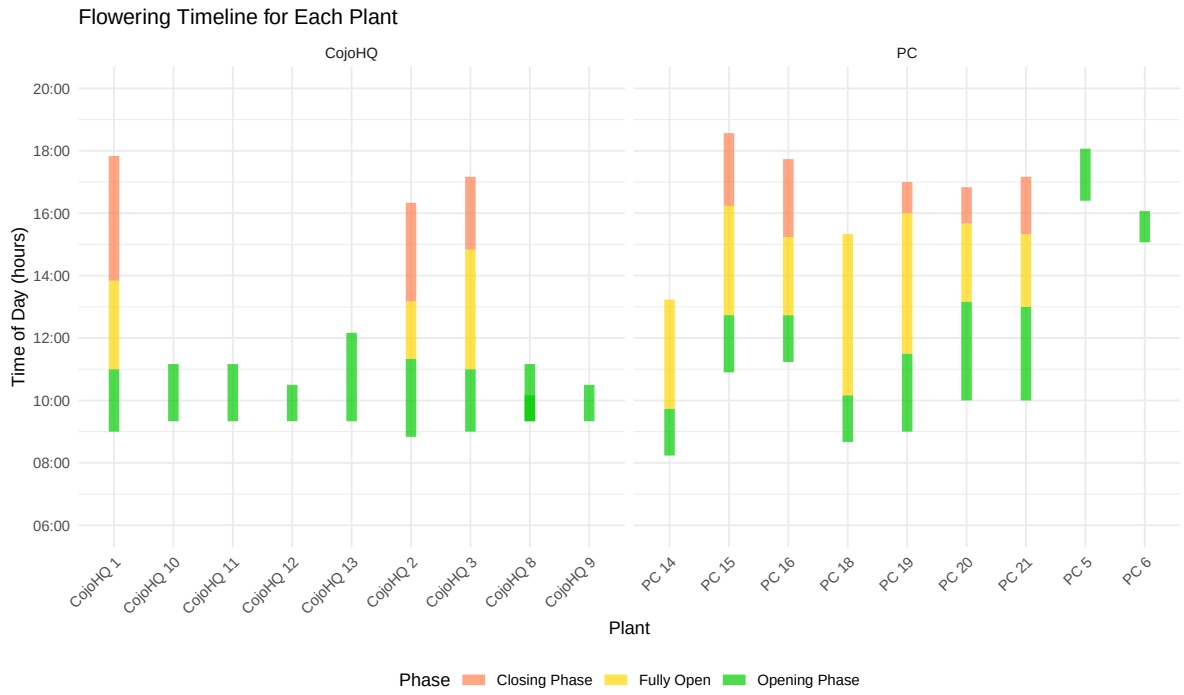
Create a structured dataframe:

```
  Locality Plant       Date open_start open_finish close_start close_finish
1   CojoHQ     1 2025-03-10      09:00       11:00       13:50        17:50
2   CojoHQ     2 2025-03-10      08:50       11:20       13:10        16:20
3   CojoHQ     3 2025-03-10      09:00       11:00       14:50        17:10
4   CojoHQ     4 2025-03-11      14:54        <NA>        <NA>         <NA>
5       PC     5 2025-03-11      16:24       18:04        <NA>         <NA>
6       PC     6 2025-03-11      15:04       16:04        <NA>         <NA>
  time_to_open time_to_close time_fully_available time_available
1        02:00         04:00                02:50          08:50
2        02:30         03:10                01:50          07:30
3        02:00         02:20                03:50          08:10
4         <NA>          <NA>                 <NA>           <NA>
5        01:40          <NA>                 <NA>          18:04
6        01:00          <NA>                 <NA>           <NA>
  open_start_hours open_finish_hours close_start_hours close_finish_hours
```

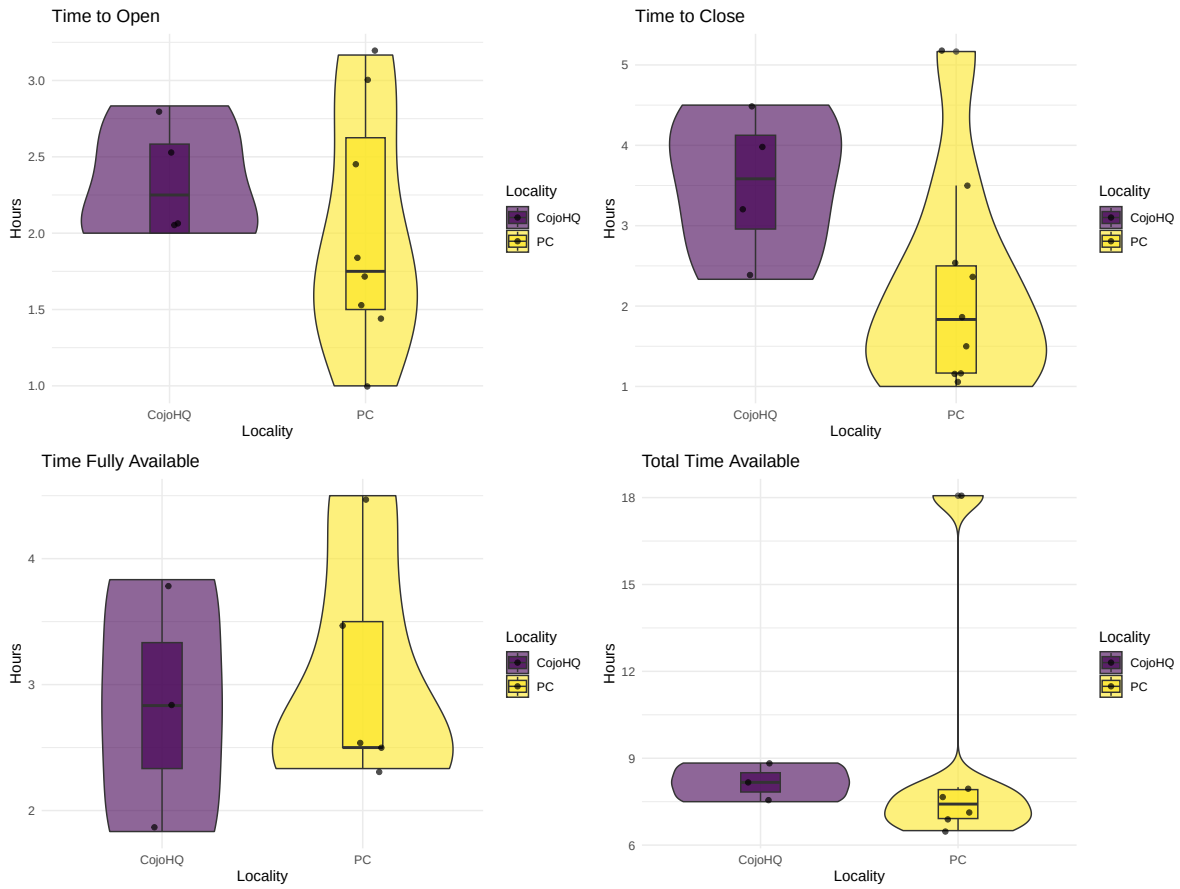
```
1         9.000000          11.00000          13.83333           17.83333
2         8.833333          11.33333          13.16667           16.33333
3         9.000000          11.00000          14.83333           17.16667
4        14.900000                NA                NA                 NA
5        16.400000          18.06667                NA                 NA
6        15.066667          16.06667                NA                 NA
  time_to_open_hours time_to_close_hours time_fully_available_hours
1           2.000000            4.000000                   2.833333
2           2.500000            3.166667                   1.833333
3           2.000000            2.333333                   3.833333
4                 NA                  NA                         NA
5           1.666667                  NA                         NA
6           1.000000                  NA                         NA
  time_available_hours
1             8.833333
2             7.500000
3             8.166667
4                   NA
5            18.066667
6                   NA

# A tibble: 2 x 18
  Locality     n mean_time_to_open sd_time_to_open mean_time_to_close
  <chr>    <int>             <dbl>           <dbl>              <dbl>
1 CojoHQ      11              2.33           0.408               3.5
2 PC          13              2.02           0.779               2.24
# i 13 more variables: sd_time_to_close <dbl>, mean_time_fully_available <dbl>,
#   sd_time_fully_available <dbl>, mean_time_available <dbl>,
#   sd_time_available <dbl>, mean_open_start <dbl>, sd_open_start <dbl>,
#   mean_open_finish <dbl>, sd_open_finish <dbl>, mean_close_start <dbl>,
#   sd_close_start <dbl>, mean_close_finish <dbl>, sd_close_finish <dbl>
```

Visualizing Flowering Timing and Duration

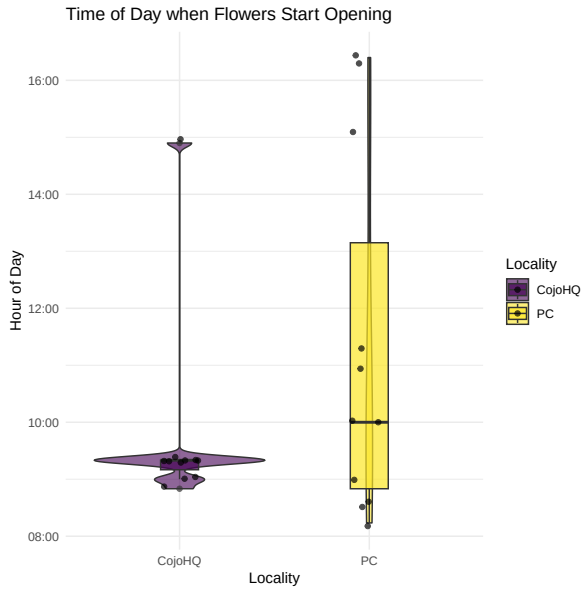
Let's visualize the key aspects of flowering timing and duration for both populations:

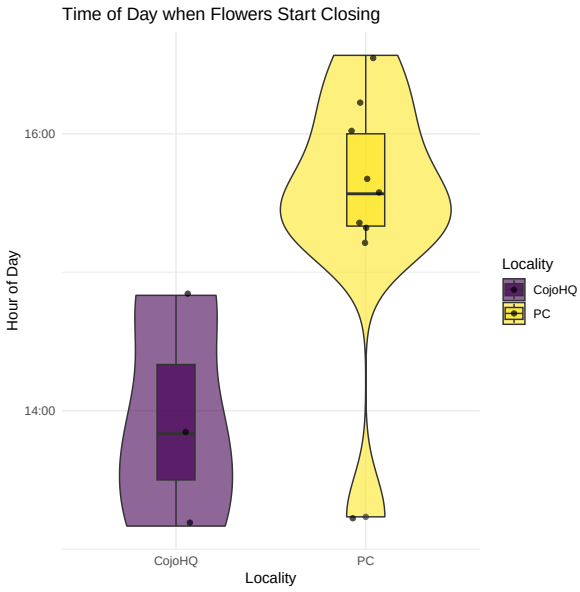


Now, let's look at the distributions of key timing variables:



Let's also look at when flowers start opening and when they start closing:





Statistical Analysis

Let's perform statistical tests to determine if there are significant differences between the two populations:

	Variable	t_statistic	p_value	Significant	Mean_CojoHQ	Mean_PC	SD_CojoHQ	SD_PC	n_CojoHQ	n_PC	Effect_Size	Var_Equal_p
t	time_to_open	0.9116658	0.38369257	FALSE	2.333333	2.020833	0.4082483	0.7788754	4	8	0.4535885	0.34561506
t1	time_to_close	1.9154930	0.09030407	FALSE	3.500000	2.240741	0.9525793	1.3594094	4	9	0.9981961	0.69340382
t2	time_fully_available	-0.3285263	0.75881060	FALSE	2.833333	3.066667	1.0000000	0.9249625	3	5	-0.2454504	0.95547060
t3	time_available	-0.4690833	0.65724440	FALSE	8.166667	9.038889	0.6666667	4.4559781	3	6	-0.2305752	0.50076567
t4	open_start	-1.4509863	0.16662914	FALSE	9.733333	11.293939	1.7233688	3.1232753	11	11	-0.6187027	0.06665979
t5	open_finish	-2.2229626	0.05455398	FALSE	11.016667	13.018519	0.5524916	2.6502679	10	9	-1.0751191	0.03134738
t6	close_start	-2.6247560	0.06011729	FALSE	13.944444	15.462963	0.8388705	0.9493337	3	9	-1.6358177	0.93677481
t7	close_finish	-1.3070280	0.26665730	FALSE	16.500000	17.442857	1.3676148	0.6078847	4	7	-1.0109617	0.17411902

Interpretation of Results

	Variable	Interpretation	Direction	Variance_Difference	Mean_Cojo_HQ	Mean_PC	SD_Cojo_HQ	SD_PC	p-value
t	time_to_open	No significant difference	CojoHQ > PC	No significant variance difference	2.333	2.021	0.408	0.779	0.384
t1	time_to_close	Marginally significant difference	CojoHQ > PC	No significant variance difference	3.500	2.241	0.953	1.359	0.090
t2	time_fully_available	No significant difference	CojoHQ < PC	No significant variance difference	2.833	3.067	1.000	0.925	0.759
t3	time_available	No significant difference	CojoHQ < PC	No significant variance difference	8.167	9.039	0.667	4.456	0.657
t4	open_start	No significant difference	CojoHQ < PC	No significant variance difference	9.733	11.294	1.723	3.123	0.167
t5	open_finish	Marginally significant difference	CojoHQ < PC	Significant variance difference	11.017	13.019	0.552	2.650	0.055
t6	close_start	Marginally significant difference	CojoHQ < PC	No significant variance difference	13.944	15.463	0.839	0.949	0.060
t7	close_finish	No significant difference	CojoHQ < PC	No significant variance difference	16.500	17.443	1.368	0.608	0.267

Conclusions

1. **Timing of Flowering**:
    - The time of day when flowers start opening appears to differ between populations, with CojoHQ flowers generally opening earlier in the day compared to PC flowers.
    - The time when flowers start closing also shows differences, with PC flowers generally beginning to close later in the day.
2. **Duration of Flowering**:
    - The time it takes for flowers to fully open ("time_to_open") shows differences between populations, with PC flowers taking slightly longer to open on average.

- The time it takes for flowers to close ("time_to_close") shows notable differences, with CojoHQ flowers taking longer to close.
- The total time flowers are available ("time_available") is longer in CojoHQ population compared to PC.

3. **Variation in Timing**:
    - There are differences in the variability of flowering timing between populations, as indicated by the standard deviations and variance tests.
    - The CojoHQ population generally shows more consistency in opening times, while the PC population shows more consistency in closing times.

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Summary of Key Findings

Let's explore one more comparative visualization to better understand the overall flowering patterns: