Temperature and Radiation

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Contents

Necessary libraries

```
library(knitr)
library(ggplot2)
theme_set(theme_bw())
library(emmeans)
library(multcomp)
library(PLS205)
library(lme4)
library(lmerTest)
library(multcompView)
library(car)
library(Rmisc)
library(dplyr) #https://r4ds.had.co.nz/ (Chapter 3, Chapter 5, look at filter and select)
# https://bookdown.org/ansellbr/WEHI_tidyR_course_book/
library(stringr)
library(data.table)
library(GGally)
library(formatR)
library(readxl)
library(paletteer )
library(ggpubr)
```

Monthly

Read from excel

```
#read directly from the directory where I generated the files from
monthly <- read_excel("C:/Users/zhang/Documents/GitHub/FallowRice_ContinuousRice_AgronomicPerformance/T
```

```
## New names:
## * `qc` -> `qc...6`
## * `qc` -> `qc...8`
## * `qc` -> `qc...10`
## * `qc` -> `qc...12`
## * `qc` -> `qc...14`
## * `qc` -> `qc...16`
## * `qc` -> `qc...18`
## * `qc` -> `qc...20`
## * `qc` -> `qc...22`
## * `qc` -> `qc...24`
## * `qc` -> `qc...26`
## * `qc` -> `qc...28`
## * `qc` -> `qc...30`
```

```
monthly$Solar_Rad <- monthly$"Avg Sol Rad (W/sq.m)"
monthly$Min_Temp <- monthly$"Avg Min Air Temp (C)"
monthly$Max_Temp <- monthly$"Avg Max Air Temp (C)"
monthly$Avg_Temp <- monthly$"Avg Air Temp (C)"

monthly$Month_Year <- monthly$"Month Year"




monthly <- monthly %>%
  mutate(Year = format(Month_Year, "%Y")) %>%
  mutate(Month = format(Month_Year, "%b"))

data_2021 <- monthly %>% filter(Year == "2021")
data_2022 <- monthly %>% filter(Year == "2022")
data_2023 <- monthly %>% filter(Year == "2023")


str(monthly)
```

```
## tibble [19 x 37] (S3: tbl_df/tbl/data.frame)
##  $ Stn Id              : num [1:19] 244 244 244 244 244 244 244 244 244 244 ...
##  $ Stn Name            : chr [1:19] "Biggs" "Biggs" "Biggs" "Biggs" ...
##  $ CIMIS Region        : chr [1:19] "Sacramento Valley" "Sacramento Valley" "Sacramento Valley" "Saci
##  $ Month Year          : POSIXct[1:19], format: "2021-05-01" "2021-06-01" ...
##  $ Total ETo (mm)      : num [1:19] 202 203 203 168 138 ...
##  $ qc...6              : chr [1:19] NA NA NA "K" ...
##  $ Total Precip (mm)   : num [1:19] 0.1 0 0 0 2.1 ...
```

```
##  $ qc...8              : chr [1:19] NA NA NA "K" ...
##  $ Avg Sol Rad (W/sq.m): num [1:19] 334 346 328 270 242 151 315 332 327 295 ...
##  $ qc...10             : chr [1:19] "K" "K" "K" "K" ...
##  $ Avg Vap Pres (kPa)  : num [1:19] 1.2 1.6 1.7 1.6 1.3 1.1 1.1 1.4 1.6 1.7 ...
##  $ qc...12             : chr [1:19] "K" NA NA "K" ...
##  $ Avg Max Air Temp (C): num [1:19] 29.6 33.5 35.1 34.3 32.5 23.5 27.7 32.3 34.1 35.4 ...
##  $ qc...14             : chr [1:19] "K" "K" "K" "K" ...
##  $ Avg Min Air Temp (C): num [1:19] 12.7 15.7 16 14.6 11.9 8.8 11.6 15 15.6 15.7 ...
##  $ qc...16             : chr [1:19] "K" NA "L" NA ...
##  $ Avg Air Temp (C)    : num [1:19] 21.2 24.5 25.9 24 21.7 15.5 19.6 24 25 25.3 ...
##  $ qc...18             : chr [1:19] NA NA "K" "K" ...
##  $ Avg Max Rel Hum (%) : num [1:19] 75 80 83 86 82 86 77 80 83 88 ...
##  $ qc...20             : chr [1:19] NA NA NA "K" ...
##  $ Avg Min Rel Hum (%) : num [1:19] 27 30 31 31 27 42 28 27 32 29 ...
##  $ qc...22             : chr [1:19] NA NA NA "K" ...
##  $ Avg Rel Hum (%)     : num [1:19] 46 50 50 53 50 62 47 47 52 52 ...
##  $ qc...24             : chr [1:19] "K" NA "L" "K" ...
##  $ Avg Dew Point (C)   : num [1:19] 8.8 13.3 14.5 13.7 10.5 7.6 7.6 11.9 14.3 14.6 ...
##  $ qc...26             : chr [1:19] "K" NA "L" "K" ...
##  $ Avg Wind Speed (m/s): num [1:19] 2.4 1.8 1.6 1.5 1.8 2.1 2.5 2 1.7 1.5 ...
##  $ qc...28             : chr [1:19] "K" NA NA "K" ...
##  $ Avg Soil Temp (C)   : num [1:19] 20.1 22.9 24.7 23.8 20.8 15.5 17.6 21.5 23.9 24.3 ...
##  $ qc...30             : chr [1:19] NA NA NA "K" ...
##  $ Solar_Rad           : num [1:19] 334 346 328 270 242 151 315 332 327 295 ...
##  $ Min_Temp            : num [1:19] 12.7 15.7 16 14.6 11.9 8.8 11.6 15 15.6 15.7 ...
##  $ Max_Temp            : num [1:19] 29.6 33.5 35.1 34.3 32.5 23.5 27.7 32.3 34.1 35.4 ...
##  $ Avg_Temp            : num [1:19] 21.2 24.5 25.9 24 21.7 15.5 19.6 24 25 25.3 ...
##  $ Month_Year          : POSIXct[1:19], format: "2021-05-01" "2021-06-01" ...
##  $ Year                : chr [1:19] "2021" "2021" "2021" "2021" ...
##  $ Month               : chr [1:19] "May" "Jun" "Jul" "Aug" ...
```

```r
which.max(monthly$Solar_Rad)
```

```
## [1] 2
```

2021 graph

```r
graph_2021 <-
ggplot(data_2021, aes(x = Month_Year)) +
  geom_bar(stat = "identity", aes(y = Solar_Rad, fill = "Solar_Rad"), fill = "#808080FF",  alpha = 0.8)
  geom_line(aes(y = Avg_Temp * 10, color = "Avg_Temp"), color = "Black", size = 0.7) +
  geom_point(aes(y = Avg_Temp * 10), color = "Black", size = 2) +
  geom_line(aes(y = Min_Temp * 10, color = "Min_Temp"), color = "Black", size = 0.7, linetype = "twodash
  geom_point(aes(y = Min_Temp * 10), color = "Black", size = 2) +
  geom_line(aes(y = Max_Temp * 10, color = "Max_Temp"), color = "Black", size = 0.7, linetype = "twodash
  geom_point(aes(y = Max_Temp * 10), color = "Black", size = 2) +
  scale_x_datetime(
    name = "",
    date_breaks = "1 month",  # Breaks at every month
    date_labels = "%b",  # Format as abbreviated month names
    expand = c(0.05, 0)
```

```
  ) +
  scale_y_continuous(
    expression("Daily Solar Radiation (W/m"^{2}*")"),
    sec.axis = sec_axis(~ ./10, name = expression("Temperature " (degree*C))),
    expand = c(0, 0),
    breaks = seq(0, 400, by = 50),
    limits = c(0, 400)
  ) +
  theme_classic() +
  ggtitle("2021") +
  theme(
    text = element_text(size = 10),
    axis.text.x = element_text(size = 12, angle = 50, hjust = 1.5, vjust = 1.4),
    axis.text.y = element_text(size = 13),
    axis.title = element_text(size =15),
    plot.title = element_text(hjust = 0.5, size = 15, face = "bold")
  )  # Darken legend text
```

```
## Warning: Using 'size' aesthetic for lines was deprecated in ggplot2 3.4.0.
## i Please use 'linewidth' instead.
## This warning is displayed once every 8 hours.
## Call 'lifecycle::last_lifecycle_warnings()' to see where this warning was
## generated.
```

```
#ggsave(graph_2021, filename = "climate_graph_LowRes.png", height = 15, width = 15, units = "cm", dpi =
```

2022 graph

```
graph_2022 <-
ggplot(data_2022, aes(x = Month_Year)) +
  geom_bar(stat = "identity", aes(y = Solar_Rad, fill = "Solar_Rad"), fill = "#808080FF",  alpha = 0.8)
  geom_line(aes(y = Avg_Temp * 10, color = "Avg_Temp"), color = "Black", size = 0.7) +
  geom_point(aes(y = Avg_Temp * 10), color = "Black", size = 2) +
  geom_line(aes(y = Min_Temp * 10, color = "Min_Temp"), color = "Black", size = 0.7, linetype = "twodash
  geom_point(aes(y = Min_Temp * 10), color = "Black", size = 2) +
  geom_line(aes(y = Max_Temp * 10, color = "Max_Temp"), color = "Black", size = 0.7, linetype = "twodash
  geom_point(aes(y = Max_Temp * 10), color = "Black", size = 2) +
  scale_x_datetime(
    name = "",
    date_breaks = "1 month",  # Breaks at every month
    date_labels = "%b",  # Format as abbreviated month names
    expand = c(0.05, 0)
  ) +
  scale_y_continuous(
    expression("Daily Solar Radiation (W/m"^{2}*")"),
    sec.axis = sec_axis(~ ./10, name = expression("Temperature " (degree*C))),
    expand = c(0, 0),
    breaks = seq(0, 400, by = 50),
    limits = c(0, 400)
  ) +
```

```
  theme_classic() +
  ggtitle("2022") +
  theme(
    text = element_text(size = 10),
    axis.text.x = element_text(size = 12, angle = 50, hjust = 1.5, vjust = 1.4),
    axis.text.y = element_text(size = 13),
    axis.title = element_text(size =15),
    plot.title = element_text(hjust = 0.5, size = 15, face = "bold")
  )  # Darken legend text
#ggsave(graph_2022, filename = "climate_graph_LowRes.png", height = 15, width = 15, units = "cm", dpi =
```

2023 graph

```
graph_2023 <-
ggplot(data_2023, aes(x = Month_Year)) +
  geom_bar(stat = "identity", aes(y = Solar_Rad, fill = "Solar_Rad"), fill = "#808080FF",  alpha = 0.8)
  geom_line(aes(y = Avg_Temp * 10, color = "Avg_Temp"), color = "Black", size = 0.7) +
  geom_point(aes(y = Avg_Temp * 10), color = "Black", size = 2) +
  geom_line(aes(y = Min_Temp * 10, color = "Min_Temp"), color = "Black", size = 0.7, linetype = "twodash
  geom_point(aes(y = Min_Temp * 10), color = "Black", size = 2) +
  geom_line(aes(y = Max_Temp * 10, color = "Max_Temp"), color = "Black", size = 0.7, linetype = "twodash
  geom_point(aes(y = Max_Temp * 10), color = "Black", size = 2) +
  scale_x_datetime(
    name = "",
    date_breaks = "1 month",  # Breaks at every month
    date_labels = "%b",  # Format as abbreviated month names
    expand = c(0.05, 0)
  ) +
  scale_y_continuous(
    expression("Daily Solar Radiation (W/m"^{2}*")"),
    sec.axis = sec_axis(~ ./10, name = expression("Temperature " (degree*C))),
    expand = c(0, 0),
    breaks = seq(0, 400, by = 50),
    limits = c(0, 400)
  ) +
  theme_classic() +
  ggtitle("2023") +
  theme(
    text = element_text(size = 10),
    axis.text.x = element_text(size = 12, angle = 50, hjust = 1.5, vjust = 1.4),
    axis.text.y = element_text(size = 13),
    axis.title = element_text(size =15),
    plot.title = element_text(hjust = 0.5, size = 15, face = "bold")
  )  # Darken legend text
#ggsave(graph_2023, filename = "climate_graph_LowRes.png", height = 15, width = 15, units = "cm", dpi =
```

Combine into one graph

```
all_climate <- ggarrange(graph_2021,
                    graph_2022,
                    graph_2023,
                              nrow = 3,
                              ncol = 1,
                              common.legend = TRUE,
                              #legend.grob = get_legend(N_response_curve_average),
                              legend= "bottom")

ggsave(filename = "Climate.jpg",  # Include the file extension here
       plot = all_climate,              # Specify the plot
       path = "C:/Users/zhang/Documents/GitHub/FallowRice_ContinuousRice_AgronomicPerformance/Figures",
       dpi = 400,
       height = 30, width = 12, units = "cm")
```