Developing a Reliable Growing Degree Day Model for *Anthemis Cotula* (Mayweed)

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Regional Approaches to Climate Change – PACIFIC NORTHWEST AGRICULTURE

Background

- Mayweed, originally endemic to the Mediterranean region, can be found in all 50 states[2]
- Mayweed is a significant crop pest in the cereal production systems of the Pacific Northwest
- An annual herb that almost exclusively outcrosses, mayweed can produce anywhere from 5000 to 17000 seeds[5]

2) "Plants Profile for Anthemis Cotula (stinking Chamomile)." Plants Profile for Anthemis Cotula (stinking Chamomile). Web. 5 Aug. 2015. <http://plants.usda.gov/core/profile?symbol=ANCO2>.
5) "Wheat and Small Grains." Mayweed Chamomile -. Web. 5 Aug. 2015. <http://smallgrains.wsu.edu/mayweed-chamomile/>.

- Grows 15 to 60 cm tall
- The inflorescence “flower” actually consists of:
  - -small yellow disk florets
  - -11 to 22 white sterile ray florets[1]
- ALS inhibiting herbicide resistant

1) "HPIPM:Mayweed Chamomile." - Bugwoodwiki. University of Georgia. Web. 5 Aug. 2015.


Establishment
= severe
decrease crop
yields

Central Hypothesis

- Growing Degree Days (GDD) can be used to better predict important developmental stages in mayweed growth (i.e time to flowering, transition from vegetative to reproductive stage)

Growing Degree Days

- a measure of accumulated heat energy at a certain base temperature
- used to predict life cycles, growth patterns, and developmental stages of crops and crop pests[3]

$$GDD = \sum_{i=m}^{n} \left(\frac{T_{max} - T_{min}}{2} \right) - T_b$$

3) "Research and Extension." Growing Degree Days -. Web. 5 Aug. 2015. <http://wine.wsu.edu/research-extension/weather/growing-degree-days/>.

Methods

- Field measurements occurred at the WSU Cook Agronomy Research Farm in Pullman, WA
- Growth Stages were assessed across a GDD gradient from North to South
- Growth chamber experiments were set up to observe early stages of mayweed growth

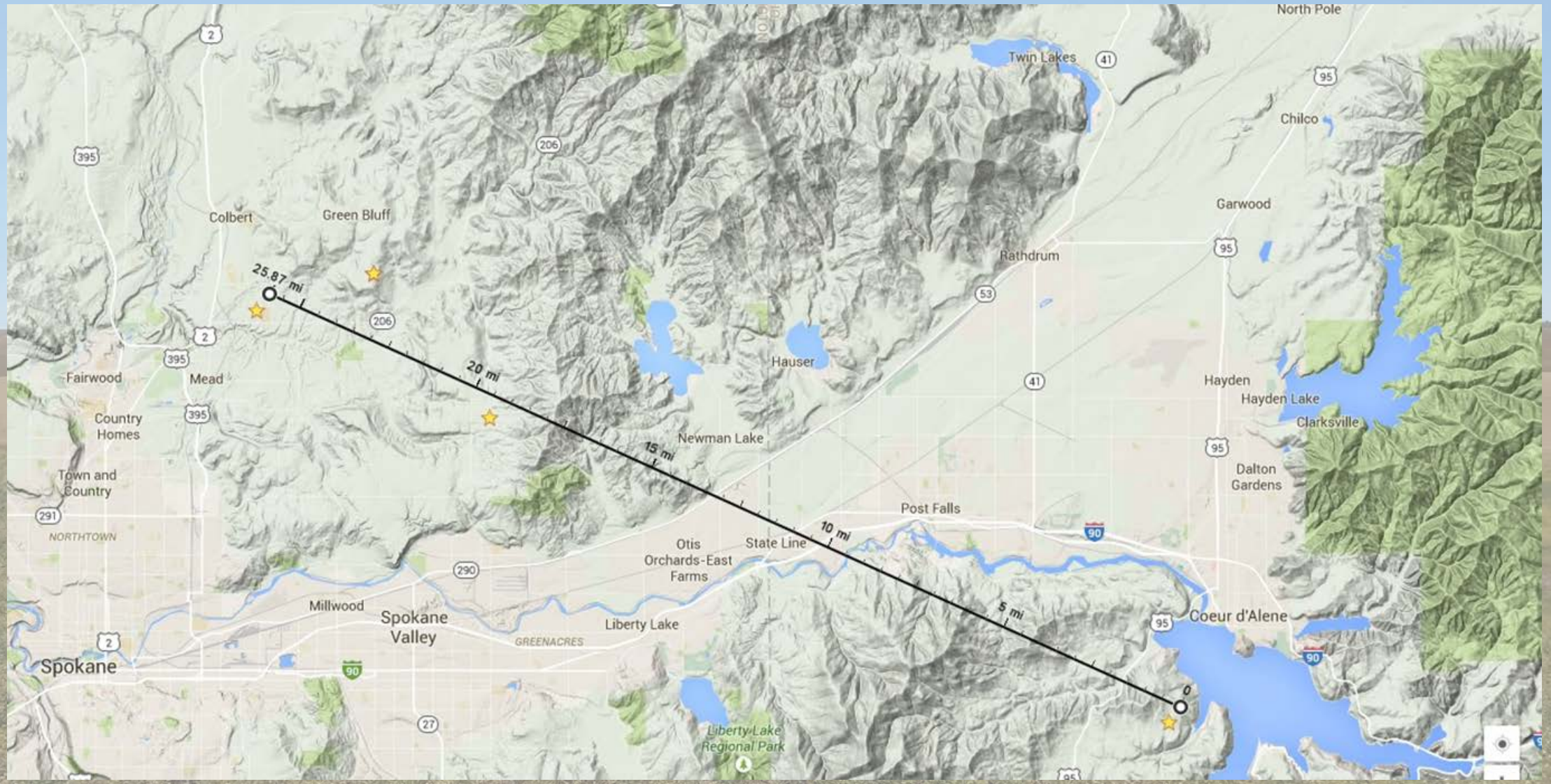
Experimental Parameters

- Plots 116, 201, 312, and 414 were the non-treated control plots in a study investigating the utility of LOROX (herbicide) for mayweed chamomile control in chickpeas
- Two meter squared quadrats were placed randomly into each plot and marked with flagging
- Basic observations on plant maturity were recorded for 15 individuals randomly selected from within each quadrat

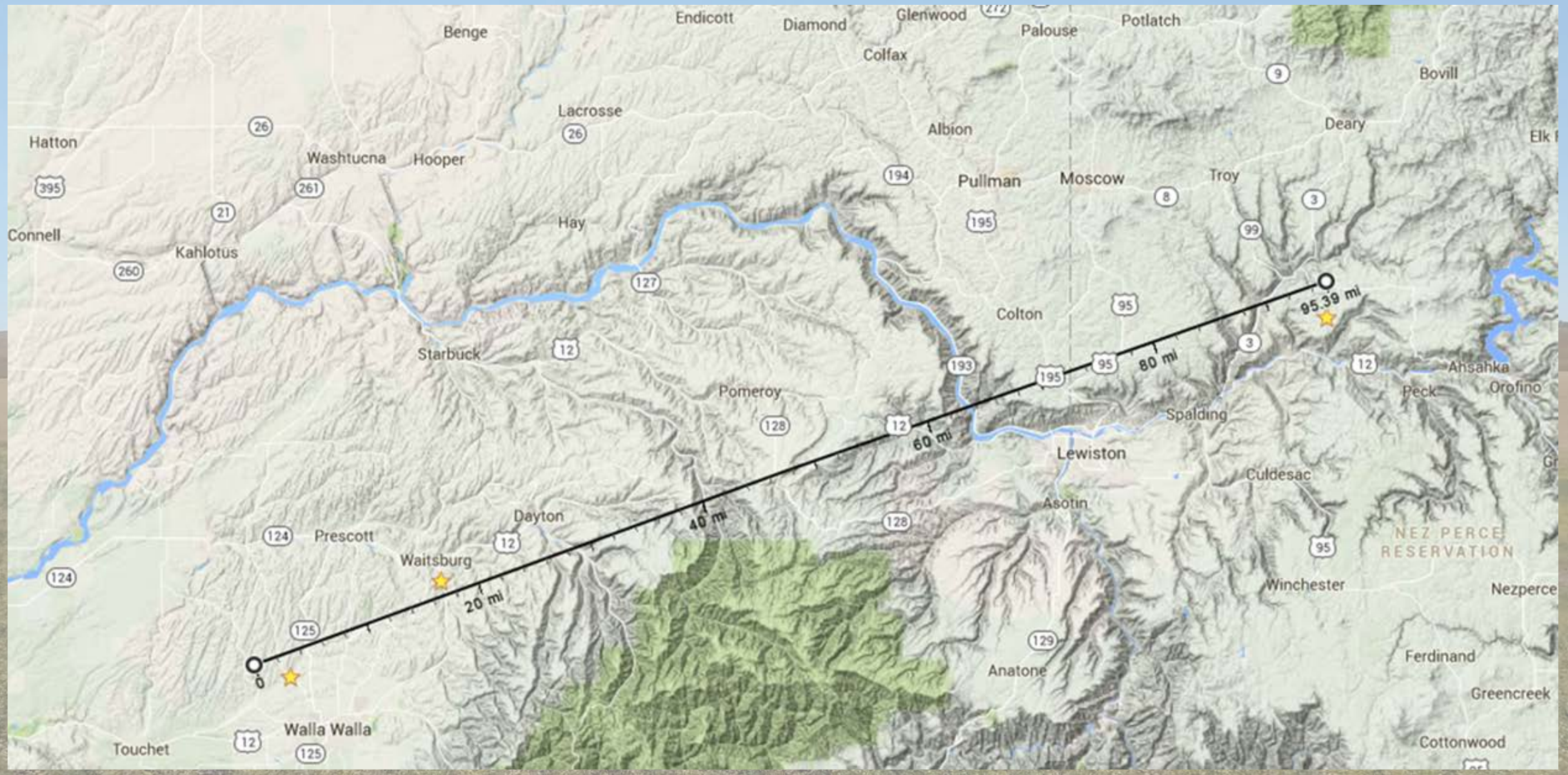
North to South Mayweed Observations

- Sites in Green Bluff, WA, Coeur D'Alene, ID, and Spokane Valley, WA were visited on 6/30/2015
- Sites in Walla Walla, WA, Waitsburg, WA, and Leland, ID were visited on 7/2/2015 and 7/8/2015 respectively

Northern Sites



Southern Sites



Growth Chamber Experiments

- Seeds were planted in two flats of 36 individual cells in Sunshine© professional growing mix
- One was placed in a 16 hr day growth chamber the other in a 12 hr chamber
- Three different sources of seeds were used, one with a 50% germination rate and the other two came from samples collected in 2013 with an unknown germination rate

Left: 12 hr growth chamber
Right: 16 hr growth chamber

Results

- Preliminary observations of mayweed germination in response to daylight hours 12hr = higher germination rate; stored seeds did not germinate
- GDD proved to be a good indicator of plant growth stage
- From observations collected on Cook Farm, a classification system for the different stages of mayweed growth was developed
- The height measurements collected at Cook Farm fit well into a sigmoidal regression model

Mayweed Growth Stage Classification

Stage	Description [4]
VE	Seedling has emerged, cotyledons present
V1	First two true leaves form, cotyledons still present
V2	Less than 3cm in height short, squat, more true leaves begin to form
V3	Plant starts to grow vertically and branch out as well
R1	Primary buds begin to form at top of main stem
R2	Primary buds begins to open and immature disk flowers become visible
R3.1	Immature ray flowers begin to become visible and disk flowers more defined
R3.2	Ray florets begin elongating on primary bud secondary buds continue to open up
R3.3	Ray florets open completely and disk florets are completely visible, not conical yet
R3.4	Pollen grains start to form on disk florets, disk florets become more conical
R3.5	Disk flower head is now conical
R3.6	Ray florets are wilting, older flowers have reached maturity, stems still green
R4	Stems begin to turn yellow. Dry seeds become visible

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Stages of Mayweed Chamomile Development

Vegetative Stages

Figure VE

Figure V1

Figure V2

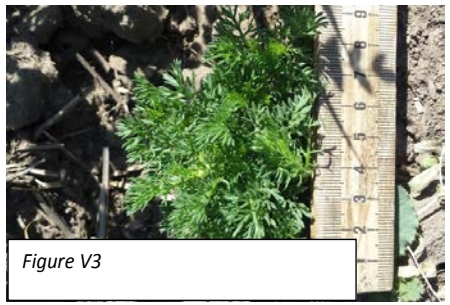


Figure V3

Reproductive Stages

Figure R1

Figure R2

Figure R3.1

Reproductive Stages Continued

Figure R3.2

Figure R3.3

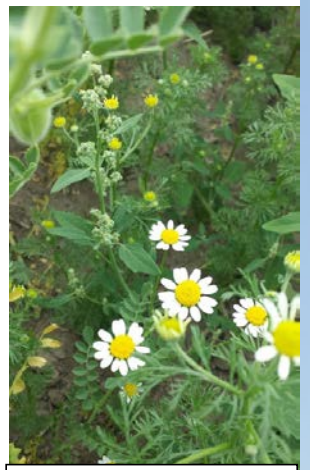


Figure 3.4

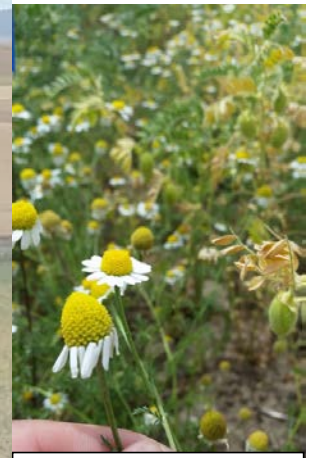


Figure R3.5

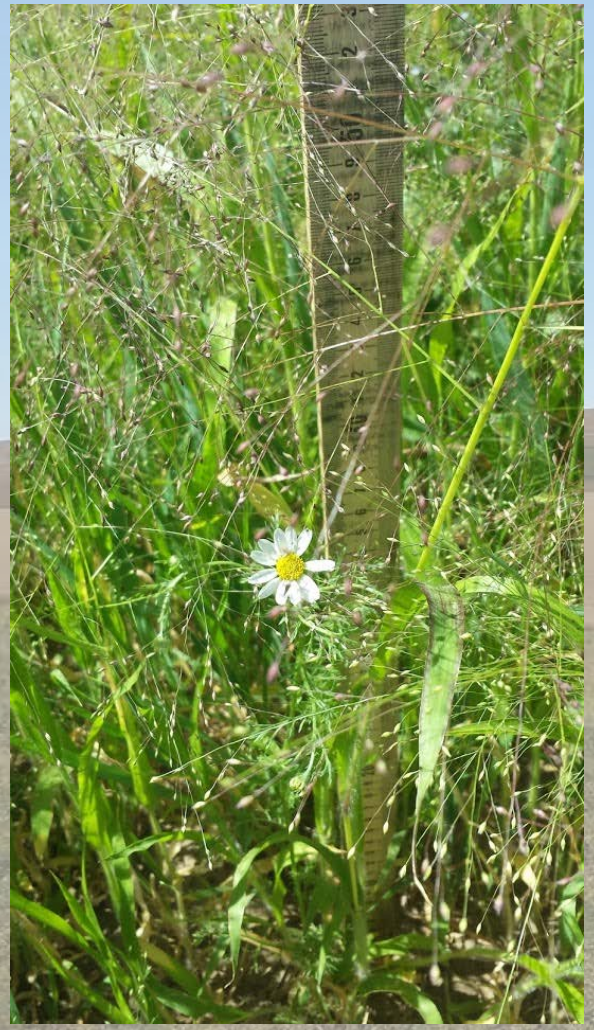
Figure R3.6

Figure R4

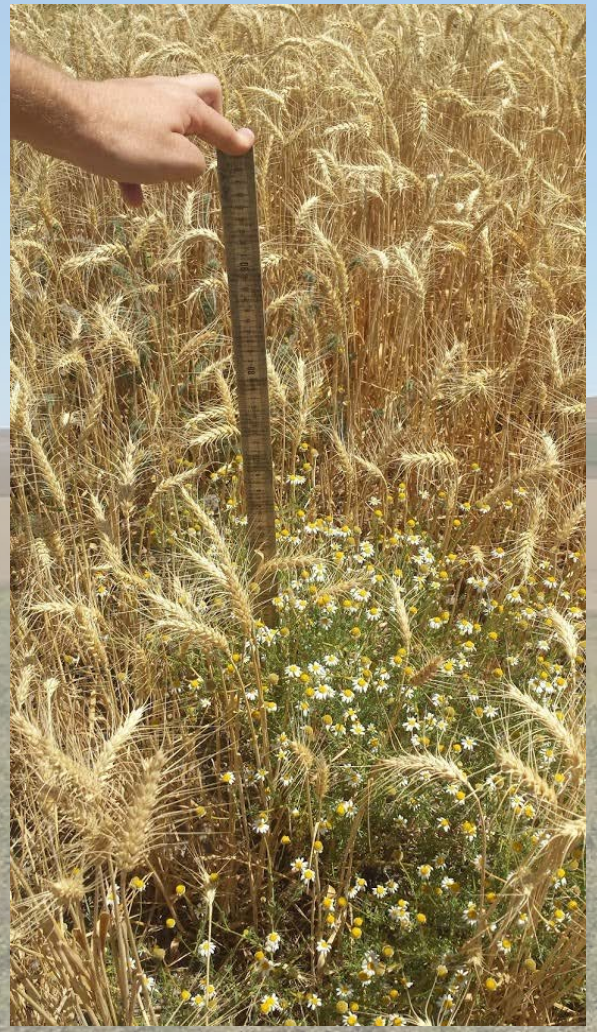
North to South Results

- Areas that had accumulated more GDD = later stages of development
- Areas that had accumulated less GDD = earlier stages of development

Green Bluff Site 1 Stage R 3.3 GDD: 1175

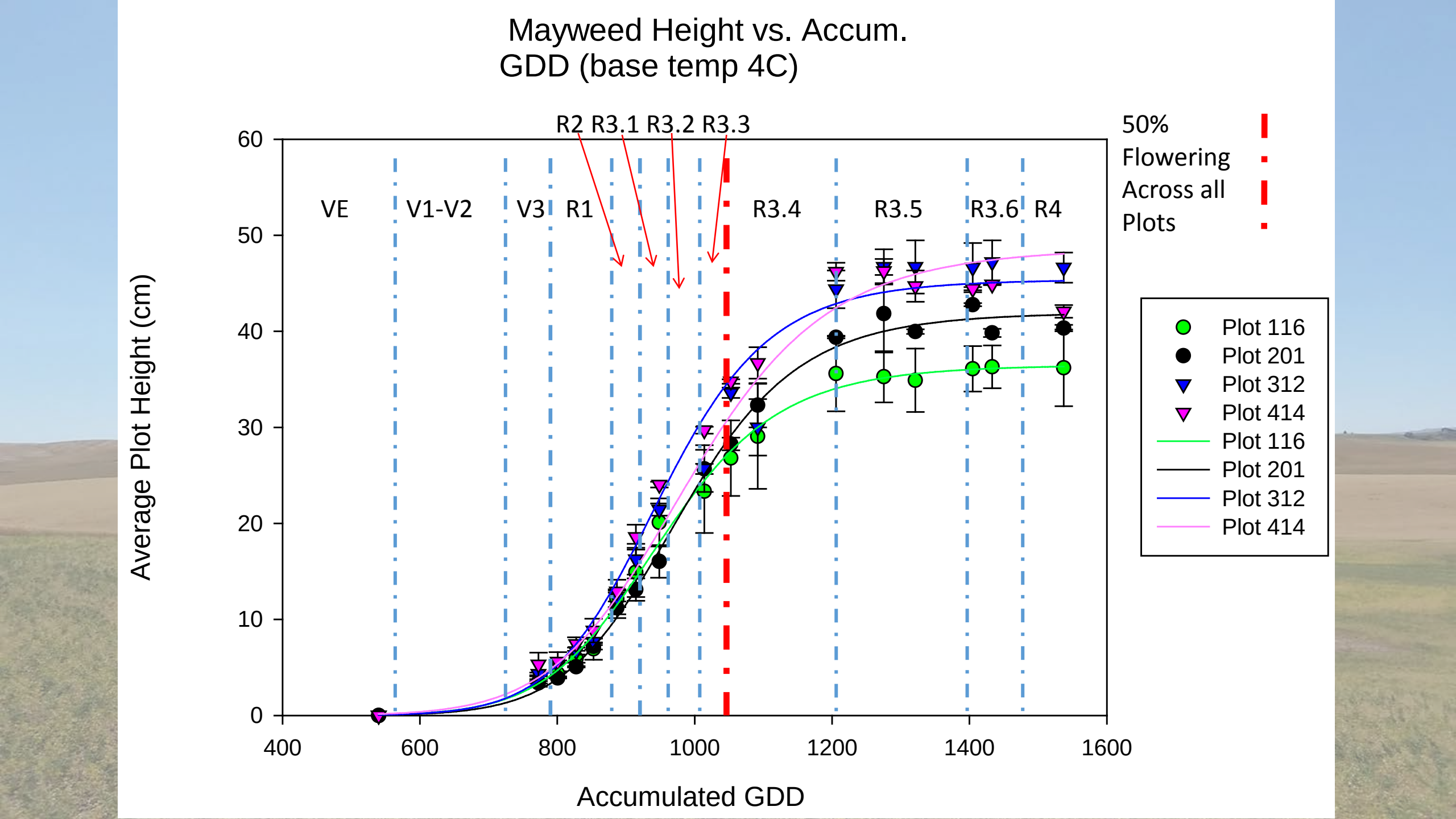


Walla Walla Site 1 Stage: R3.6-R4 GDD: 1570




Cook Farm Results

- By plotting the average heights against accumulated growing degree days a clear pattern was present on the following graph
- Observations from the field coupled with growth classifications led to a specific point where the mayweed transitioned from mostly vegetative growth to flowering
- Very high (>95%) R value for each regression curve


Mayweed Height vs. Accum. GDD (base temp 4C)
R2 R3.1 R3.2 R3.3
VE
V1-V2
V3
R1
R3.4
R3.5
R3.6
R4
50% Flowering Across all Plots
Plot 116
Plot 201
Plot 312
Plot 414
Plot 116
Plot 201
Plot 312
Plot 414
Average Plot Height (cm)
0
10
20
30
40
50
60
400
600
800
1000
1200
1400
1600
Accumulated GDD

Conclusions: What does it all mean?

- The growth patterns illustrated in the previous graph fit a sigmoidal regression line which could be used as a baseline for the mayweed developmental model
- If future experiments validate the mayweed developmental model it may be used to predict developmental stage based on GDD accumulation
- A validated model could also be coupled with climate change modeling to project mayweed growth under future climate scenarios

Future Goals/Extension Uses

- Farmers and other stake holders would be able to use this information to better plan herbicide application timing
- Possibly predict how mayweed might behave in the changing PNW climate
- Informational pamphlet on mayweed could be developed with the new pictures and updated information gathered by this project

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- Jonathan A.R. Witkop

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Sources

- 1) "HPIPM:Mayweed Chamomile." - Bugwoodwiki. University of Georgia. Web. 5 Aug. 2015.
- 2) "Plants Profile for Anthemis Cotula (stinking Chamomile)." Plants Profile for Anthemis Cotula (stinking Chamomile). Web. 5 Aug. 2015. <http://plants.usda.gov/core/profile?symbol=ANCO2>.
- 3) "Research and Extension." Growing Degree Days -. Web. 5 Aug. 2015. <http://wine.wsu.edu/research-extension/weather/growing-degree-days/>.
- 4) Schneiter, A.A, and J.F. Miller. "Stages of Sunflower Development." NDSU, 1 May 2013. Web. 5 Aug. 2015. <https://www.ag.ndsu.edu/pubs/plantsci/crops/a1145.pdf>.
- 5) "Wheat and Small Grains." Mayweed Chamomile -. Web. 5 Aug. 2015. <http://smallgrains.wsu.edu/mayweed-chamomile/>.

Questions?