Supplementary Material

Climate matching models for *Ceratapion basicorne* (Coleoptera: Apionidae), a biocontrol agent of yellow starthistle

Brittany S. Barker[1,2*]

[1]Oregon Integrated Pest Management Center, 4575 Research Way, Oregon State University, Corvallis, OR, United States

[2]Department of Horticulture, Oregon State University, 4017 Agriculture and Life Sciences Building, Oregon State University, Corvallis, OR, United States

*** Correspondence:** brittany.barker@oregonstate.edu

Appendix S1

Equations used to calculate climate "match indices" were derived from the "Match Climates" function in CLIMEX [pgs. 95−96 of the CLIMEX v. 4 manual (Kriticos et al. 2016)] and are summarized below. However, the soil moisture index (I_{sm}) was modified because CLIMEX uses relative units (0 to 1) for soil moisture whereas Simple Terrestrial Hydrosphere model, version 2 (SiTHv2) data use volumetric units (m^3 m-3). The model did not include mean temperature, humidity, or rainfall pattern indices. All variables were given a weight of 1, indicating equally important contributions to the CMI. Additional details about the equations can be found in the CLIMEX manual.

Temperature index

Maximum and minimum temperature match indices (I_{tmax} and I_{tmin}) are calculated as:

$$I_{tmax} = \exp(-k_T T_{dmax})$$

$$I_{tmin} = \exp(-k_T T_{dmin})$$

T_{dmax} and T_{dmin} are the means of the weekly absolute differences in maximum and minimum temperatures, respectively, between the home 'home' and 'away' locations. For this study, the 'home' location is Kilkis, Greece, and the 'away' locations are each grid cell in the climate rasters for the western U.S. The constant, k_T, was set to 0.1. The weights for both indices (W_1 and W_2) are 1. The combined temperature index is:

$$I_t = \frac{I_{min} \times W_1 + I_{max} \times W_2}{W_1 + W_2}$$

Moisture index

The total rainfall match index, I_{tot}, is calculated as:

$$I_{rtot} = \exp(-k_R R_d)$$

where,

$$R_d = \frac{\text{abs}(R_T - R_M)}{1 + a(R_T + R_M)}$$

R_d is the difference in annual rainfall between the 'home' and 'away' locations, adjusted so that a difference in rainfall is more significant for locations with lower rainfall. The constants a and k_R are 0.001 and 0.004, respectively.

The moisture index in CLIMEX includes a total rainfall match index (I_{tot}) and humidity index (I_{hum}). However, we did not include I_{hum} in our model, so the combined moisture index is simply:

$$I_m = \frac{I_{rtot} \times W_3}{W_3}$$

The weight (W_3) was set to 1.

Soil moisture index

The soil moisture index, I_{sm}, is calculated as:

$$I_{sm} = \exp(-k_{SM} S_d)$$

S_d is the mean of the weekly absolute differences between the 'home' and 'away' locations. The constant, k_{SM}, is set to 0.0008, which gives an index of 0.8 for a mean weekly soil moisture difference (at the first 5 cm depth) of 275 m³ m-3 and an index of 0.3 for a mean weekly soil moisture difference of 1500 m³ m-3. The index is calculated as:

$$I_{sm} = I_{sm} \times W_4$$

The weight (W_4) was set to 1.

Composite match index

The level of overall climatic similarity is given by the Composite Match Index (CMI), which is the product of the four component indices included in the analysis and is calculated as:

$$CMI = (I_t^{wt} \times I_m^3 \times I_{sm}^{w4})^{1/(wt + w3+w4)}$$

where *wt* is the maximum value of W_1 and W_2 (for the temperature index).

References

Kriticos, D. J., G. F. Maywald, T. Yonow, E. J. Zurcher, N. I. Herrmann, and R. W. Sutherst. 2016. CLIMEX version 4: exploring the effects of climate on plants, animals and diseases. CSIRO, Canberra, Australia. Available from https://www.hearne.software/getattachment/199e1f3e-460a-4ac8-8f7f-1eeee84110c7/Climex-v4-User-Guide.aspx (accessed on 15 September 2024).