Validation of A New Western Bean Cutworm Flight Completion Estimation Method in New York State

Project Leaders

Olmstead, D.[1], Wise, K.[1], Zuefle, M.[1], and Cummings, J.[1]

[1] NYS IPM Program, Cornell AgriTech, Geneva, NY

Introduction

Western bean cutworm (WBC), *Striacosta albicosta* (Smith) (Lepidoptera: Noctuidae) is a single-generation pest of corn and dry beans in North America. WBC is native to the Midwest United States but has moved steadily eastward in recent years, and is now considered to be a regionally-invasive pest in the eastern US, including New York State. The New York State Vegetable Research Advisory Council funded a project to develop a decision support model on NEWA (http://newa.cornell.edu) in 2017 using a new method for WBC flight prediction published by Hanson et al (2015). Model coding is complete and stakeholders, including vegetable and field crop Extension specialists, would like to utilize the NEWA WBC Flight Prediction model starting in 2020. The purpose of this project was to evaluate the underlying model that generates NEWA WBC flight predictions for precision and accuracy in NY. And, if necessary, make minor adjustments to best predict WBC flight completion for this region.

Materials and Methods

Moth Flight Monitoring

Thirty-six different NY locations (Table 1) were monitored for male WBC populations between 2016 and 2019, using universal moth traps (Great Lakes IPM, Vestaburg, MI, part GL/IP-2351-X) baited with pheromone lures changed every two weeks (Great Lakes IPM, Vestaburg, MI part GL/TR-3406-X). These were checked on a weekly basis by collaborators (Table 1).

Weather Data

Daily maximum and minimum temperatures (°F, 5km resolution) from January 1 to September 30 for each location were acquired from the Applied Climate Information System using coordinates provided in table 1 (Northeast Regional Climate Center, Cornell University). Temperature data were converted to °C before analysis [1].

$$T_{(°C)} = (T_{(°F)} - 32) * 5/9 \quad [1]$$

Actual Flight Completion Dates

Twenty-five percent flight completion values were derived by regressing weekly cumulative trap catch to find the best fit model for each location. Each instance was then utilized to solve for the corresponding day of year (DOY) for 25% flight completion (Table 2).

Simulated Flight Completion Dates

Daily degree day accumulation was calculated from weather data using the optimized WBC flight model described in Hanson et al (2015), with a lower threshold of 3.3°C and an upper threshold of 23.9°C beginning March 1 or DOY 61 (DOY 62 in 2016). A horizontal cutoff method, where the area above the upper threshold is subtracted from the area above the lower threshold, was applied when daily maximum temperature exceeded 23.9°C. Accumulated degree day values were used with equation [2], provided by Hanson et al (2015), to calculate daily % flight completion (D = accumulated degree-days, $\mu = 7.315$, and $s = 0.044$) and corresponding DOY values.

$$\%\,flight\ completion\ = \frac{100}{1+e^{-\left(\frac{ln(D)-\mu}{s}\right)}} \qquad [2]$$

Evaluation of Actual vs Predicted 25% Flight Completion

Residual analysis confirmed DOY (actual and predicted) data were normally distributed and transformation was not necessary. DOY was assigned as the response variable and method of 25% flight calculation (actual vs predicted) was assigned as the factor in a one-way ANOVA (JMP 13.0, SAS Institute, Cary South Carolina).

Results

Actual (203 ± 1) and predicted (213 ± 1) DOY, using the published Hanson method, for WBC 25% flight completion were significantly different (ANOVA, df=1, F=51.13, p<0.0001). To achieve a better fit, a lower development threshold of 2.0°C was substituted for Hanson's published value of 3.3°C. A second evaluation of actual (203 ± 1), predicted (213 ± 1), and predicted adjustment (204 ± 1) DOY showed no significant differences between actual and predicted adjustment means (ANOVA, df=2, F=32.77, p<0001) (Figure 1).

Discussion

A slight adjustment of the lower development threshold to 2.0°C, from 3.3°C, best compensated for the mean 10-day delay in predicted 25% flight completion. Adjustments to model start date and upper development threshold did not produce an adequate fit of predicted with actual flight completion dates. Further work is needed to understand the reasons why, but this adjustment method coincides with the same approach used by Hansen et al. to iterate for a best fit model in the Midwest US, at a much smaller scale.

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References Cited

Hanson, A. A., Moon, R. D., Wright, R. J., Hunt, T. E., and Hutchison, W. D. 2015. Degree-Day Prediction Models for the Flight Phenology of Western Bean Cutworm (Lepidoptera: Noctuidae) Assessed with the Concordance Correlation Coefficient. J. Econ. Entomol. 108: 1728-1738; DOI: 10.1093/jee/tov110

Tables and Figures

Table 1. Locations at which male western bean cutworm flights were monitored in 2016 (n=7), 2017 (n=14), 2018 (n=7), and 2019 (n=7), using pheromone lure traps and zero catch values before and after emergence were confirmed.

City	Year	Latitude	Longitude	Total Catch	Collaborator	Email
Amenia	2018	41.847523	-73.605681	59	Jennifer Fimbel	jlf20@cornell.edu
Amsterdam	2019	42.975005	-74.275824	92	Kevin Ganoe	khg2@cornell.edu
Aurora	2016	42.732757	-76.654991	63	Paul Stachowski	pjs16@cornell.edu
Avon	2017	42.919092	-77.683615	531	Jodi Letham	jll347@cornell.edu
Camillus	2019	43.0505591	-76.364436	106	Cassidy Fletcher	cfletcher@seedway.com
Canajoharie	2019	42.845556	-74.674079	53	Kevin Ganoe	khg2@cornell.edu
Chaumont	2016	44.091845	-76.043310	140	Mike Hunter	meh27@cornell.edu
Chazy	2017	44.885946	-73.471527	169	Mike Davis	mhd11@cornell.edu
Clayton	2017	44.159941	-76.220088	564	Mike Hunter	meh27@cornell.edu
Colton	2017	44.509327	-74.893804	124	Kitty O'Neil	kao32@cornell.edu
Croghan	2018	43.898809	-75.460894	623	Mike Hunter	meh27@cornell.edu
Edwards	2016	44.35553	-75.219600	137	Kitty O'Neil	kao32@cornell.edu
Ellisburg	2018	43.758165	-76.143120	564	Mike Hunter	meh27@cornell.edu
Hammond	2018	44.529431	-75.586010	461	Kitty O'Neil	kao32@cornell.edu
Hopewell	2017	42.900068	-77.152548	690	Jodi Letham	jll347@cornell.edu
Huevelton	2018	44.577140	-75.440753	227	Kitty O'Neil	kao32@cornell.edu
Kinderkook	2018	42.376038	-73.726077	66	Ken Wise	klw24@cornell.edu
Madrid	2016	44.743790	-75.172113	499	Kitty O'Neil	kao32@cornell.edu
Manheim	2019	43.114509	-74.840405	81	Kevin Ganoe	khg2@cornell.edu
Martinsburg	2016	43.766660	-75.483330	647	Joe Lawrence	jrl65@cornell.edu
Mooers	2019	44.939597	-73.537430	234	Sarah Bull	slk95@cornell.edu
Munnsville	2017	42.985000	-75.531000	316	Kristen Bossard	kristen-bossard@oneidaswcd.org
New Bremen	2017	43.856265	-75.423109	575	Mike Hunter	meh27@cornell.edu
Pamelia	2017	44.132027	-75.847515	1541	Mike Hunter	meh27@cornell.edu
Peru	2019	44.606530	-73.541914	606	Sarah Bull	slk95@cornell.edu
Philadelphia	2017	44.147443	-75.683304	432	Mike Hunter	meh27@cornell.edu
Plessis	2016	44.287208	-75.860135	146	Mike Hunter	meh27@cornell.edu
Rutland	2017	43.964184	-75.760802	2464	Mike Hunter	meh27@cornell.edu
Saratoga	2018	43.158190	-73.612225	186	Ken Wise	klw24@cornell.edu
Scott	2017	42.705640	-76.234780	404	Janice Degni	jgd3@cornell.edu
Tully	2017	42.791013	-76.118262	159	Paul Stachowski	pjs16@cornell.edu
Turin	2018	43.627956	-75.393755	1203	Mike Hunter	meh27@cornell.edu
Valatie	2017	42.433640	-73.605600	158	Ken Wise	klw24@cornell.edu
Valois	2016	42.521831	-76.848924	102	Jeff Gardner	jg48@cornell.edu
Walton	2019	42.440168	-74.939160	116	Paul Cerosaletti	pec6@cornell.edu
Willsboro	2017	44.379596	-73.393725	151	Mike Davis	mhd11@cornell.edu

Table 2. Actual 25% flight completion DOY values derived from best-fit regression models using actual WBC cumulative flight emergence at NY locations from 2016 to 2019. Predicted day of 25% flight completion using are also provided. DOY='Day of Year' (not calendar date).

City	Year	R_2	Best-fit flight model	Actual 25% DOY[a]	Hanson 25% DOY[b]	Adj. Hanson 25% DOY[c]
Amenia	2018	0.84	-641.13 + 3.47 * DOY	192	215	205
Amsterdam	2019	0.86	-586.65 + 2.91 * DOY	210	208	200
Aurora	2016	0.94	-450.13 + 2.41 * DOY	197	207	199
Avon	2017	0.90	-425.97 + 2.31 * DOY	195	207	198
Camillus	2019	0.89	-474.33 + 2.50 * DOY	200	209	187
Canajoharie	2019	0.86	-552.98 + 2.74 * DOY	211	212	204
Chaumont	2016	0.90	-438.11 + 2.38 * DOY	195	213	205
Chazy	2017	0.92	-436,24 + 2.23 * DOY	207	213	203
Clayton	2017	0.91	-545.11 + 2.77 * DOY	206	217	207
Colton	2017	0.96	-623.74 + 3.13 * DOY	207	222	212
Croghan	2018	0.89	-486.39 + 2.60 * DOY	197	214	206
Edwards	2016	0.94	-654.81 + 3.28 * DOY	207	214	206
Ellisburg	2018	0.90	-456.22 + 2.46 * DOY	196	213	205
Hammond	2018	0.92	-811.15 + 4.10 * DOY	204	215	207
Hopewell	2017	0.89	-439.64 + 2.39 * DOY	194	206	198
Huevelton	2018	0.90	-773.30 + 3.96 * DOY	202	213	192
Kinderhook	2018	0.92	-367.51 + 2.09 * DOY	188	205	198
Madrid	2016	0.91	-775.25 + 3.92 * DOY	204	213	205
Manheim	2019	0.90	-895.99 + 4.25 * DOY	217	222	212
Martinsburg	2016	0.88	-590.68 + 3.00 * DOY	205	217	209
Mooers	2019	0.91	-696.31 + 3.41 * DOY	212	216	208
Munnsville	2017	0.87	-432.59 + 2.27 * DOY	202	210	201
New Bremen	2017	0.88	-495.61 + 2.57 * DOY	203	218	208

City	Year	R_2	Best-fit flight model	Actual 25% DOY[a]	Hanson 25% DOY[b]	Adj. Hanson 25% DOY[c]
Pamelia	2017	0.88	-510.25 + 2.59 * DOY	207	212	202
Peru	2019	0.95	-578.15 + 2.83 * DOY	213	216	208
Philadelphia	2017	0.90	-502.68 + 2.57 * DOY	205	215	205
Plessis	2016	0.91	-409.60 + 2.18 * DOY	199	212	205
Rutland	2017	0.87	-680.66 + 3.34 * DOY	211	213	203
Saratoga	2018	0.86	-686.88 + 3.59 * DOY	198	204	197
Scott	2017	0.96	-634.07 + 3.29 * DOY	200	219	209
Tully	2017	0.82	-346.24 + 1.91 * DOY	194	217	208
Turin	2018	0.95	-628.25 + 3.21 * DOY	204	213	206
Valatie	2017	0.94	-513.17 + 2.75 * DOY	196	203	195
Valois	2016	0.90	-548.30 + 2.91 * DOY	197	212	204
Walton	2019	0.97	-344.92 + 1.70 * DOY	218	224	214
Willsboro	2017	0.93	-403.96 + 2.12 * DOY	202	208	199

[a] Derived from best-fit regression models of actual WBC flight emergence.
[b] Derived using the Hanson et al (2015) method.
[c] Derived by substituting a lower threshold of 2.0°C in the Hanson et al (2015) method.

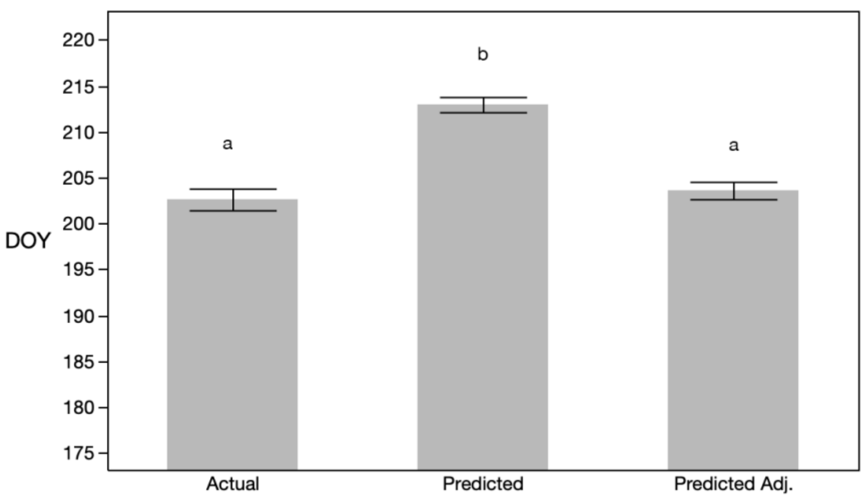

Figure 1. Actual (203 ± 1), predicted (213 ± 1) DOY for WBC 25% flight completion using the published Hanson method, and predicted adjustment (204 ± 1) using a lower threshold of 2.0°C instead of 3.3°C (ANOVA, df=2, F=32.77, p<0.0001). Different letters indicate a statistical difference between means.