Impacts of climatic and landscape factors on cereal aphid populations in the inland Pacific Northwest USA

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Abstract

Direct and indirect damages from aphids to cereal crops are limiting factors for cereal crops in the Pacific North West United States (PNW-USA), as well as worldwide. At least ten aphid species have been known to occur in cereal crops and on perennial and annual grasses within the region. The development of sustainable integrated pest management programs are needed to inform ecosystem management approaches across spatial large scales. This study aimed to evaluate climatic factors and landscape use patterns on four main cereal aphids in the PNW-USA. Aphid samples were collected weekly by sweep net in 108 REACCH sites from May to July 2011-2014. Statistical analyses to evaluate correlation structure between climate variables and aphid densities were conducted using SAS (9.4). Correlation coefficients between aphid species densities, climatic factors, and cropland cover type were calculated for annuli of three distances from collecting sites (0-500, 500-1000, 1000-1500 m.). We found a trend of significant positive association between daily temperature of collecting sites with densities of individual aphid species, as well as total aphid densities. Conversely, a significant trend of negative association was observed between daily relative humidity and aphid densities. Concerning landscape effects, positive correlations between aphid density and climate metrics are more apparent in the second radiation distance (500-1000 m) compared to the other distances, and more common in *M. festucae cerealium* than other aphid species. We also concluded that there were potential correlations between climate metrics and aphid densities in 2012 in comparison to the other years, and that this association was greater for grasses compared to cereal crops. The significant positive association between aphid densities and grasses are mainly related to *M. festucae cerealium.*

Introduction

Understanding the relative influence of density-dependent and density-independent processes affecting population growth and abundance of fluctuating populations over time is crucial for the application of ecology to pest management and also to understand the broad-scale community structure.

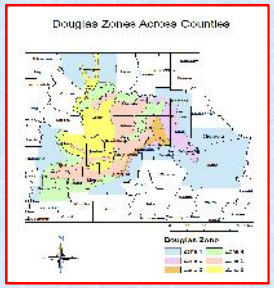
Characteristics of aphids such as short generation times, multiple modes of reproduction, low developmental threshold temperature s and efficient dispersal capabilities enable them to readily respond and adapt to climate stress (Finlay and Luck, 2011). Landscape ecology approaches can provide tools to manage agro-ecosystems in terms of sustainable crop protection against insect pests (Estevez et al., 2000), and epidemiology of viral diseases (Fabre et al., 2005).

At least ten aphid species including; *Rhopalosiphum padi, Sitobion avenae, Schizaphis graminum* ,*Metopolophim dirhodum* , *R. maidis, R. insertum, Sipha elegans, Aphis middletonii, Diuraphis noxia, M. festucae cerealium* occur in cereal crops as well as on perennial and annual grasses in Pacific North West of USA. The five first species are also primary vectors of BYD viruses (Halbert et al., 2013; Davis et al.,.

The development of sustainable integrated pest management programs for cereal aphids are needed to inform ecosystem management approaches across spatial large scales. This study aimed to evaluate the hypothesize that population densities of each of four dominant aphid species and total sum of all species are associated with climatic factors, surface area covered with cereal crops and/or perennial grasses and/or Poaceae plantes.

Materials and Methods

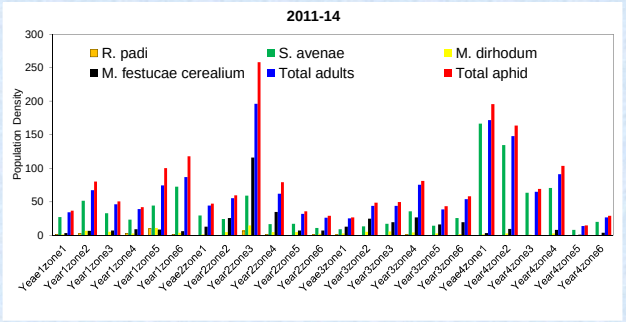
Aphid samples were collected weekly by sweep net in 108 Regional Approaches to Climate Change (REACCH) sites from May to July 2011-2014.

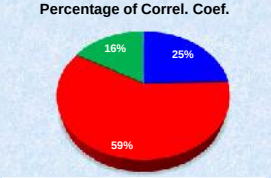


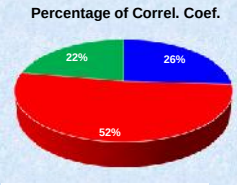
Winged and wingless individuals of ten aphid species were identified based on morphological characteristics using a stereomicroscope. Number of individual aphid species was registered separately for each collecting site and date. Collecting site's coordinates (latitude and longitude) were recorded using GPS. Daily climatic metrics and cropland cover types for each of the collecting sites were delivered by collaborators and staff.

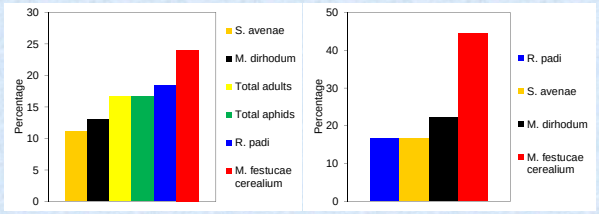
Statistical analyses to evaluate the correlation structure between climatic variables and aphid densities were conducted using SAS (9.4). The analyses were carried out only for four aphid species, *Rhopalosiphum padi, Sitobion avenae,Metopolophim dirhodum*, and *M. festucae cerealium,* having higher population densities and continuity of data. Pearson's correlation coefficients among aphid species densities, climatic factors, and cropland cover types were computed for annuli of three distances from collecting sites (0-500, 500-1000, and 1000-1500 m.).

Results

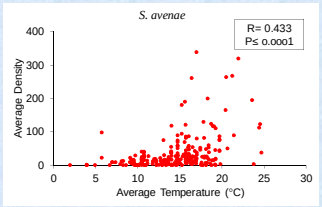


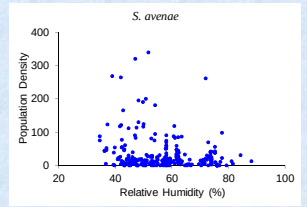


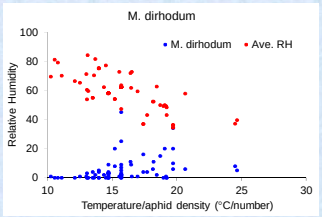


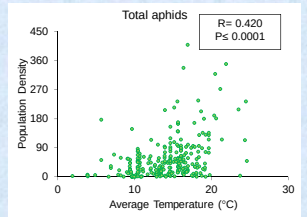


- density-dependence of *M. festucae cerealium* (MFC) to cereal crops, Poaceae and especially perennial grasses is more apparent comparing with the other three studied aphid species, and also with the total adults densities.
- Percentage of significant correlation coefficient cases between aphid densities and cropland cover type calculated for the 500-1000 m radiation from collecting sites are more apparent compared to the two other selected ranges.









Conclusions

- The contributions of density dependence and climate to aphid population dynamics are species-specific in spite of similar ecological niches. Although the results express a tendency between aphid densities and daily climatic factors of collecting sites, but it is our future work to understand correlations between aphid densities and cumulative degree days of each collecting sites and finally put evidence ecological zones effects on aphid densities.
- As MFC is invasive for the region and its plant host ranges are not completely known, understanding density-dependent regulating this aphid separately for spring and summer, can help to clarify this ambiguity status. This will be the subject of our future efforts.

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