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**Dr. James Whitfield**
Department of Integrated Pest Management, Prairie Dryland Agricultural College, Lethbridge, Alberta, Canada

**Sarah Mitchell**
Department of Integrated Pest Management, Prairie Dryland Agricultural College, Lethbridge, Alberta, Canada

**Corresponding Author:**
**Dr. James Whitfield**
Department of Integrated Pest Management, Prairie Dryland Agricultural College, Lethbridge, Alberta, Canada

# Population dynamics and seasonal incidence of aphids on mustard under changing climate

**James Whitfield and Sarah Mitchell**

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**Abstract**
Roughly 38% of Canada's canola-mustard output is lost each year to insect pests, with aphids ranking as the single most damaging group across the semi-arid cropping belt of southern Alberta. This research examined the population dynamics and seasonal incidence of aphid species on mustard (*Brassica juncea* L.) under the changing climatic conditions of southern Alberta. Field observations were carried out at the Prairie Dryland Agricultural College research farm, Lethbridge, during the growing seasons of 2022-23 and 2023-24. Weekly counts were recorded on ten randomly tagged plants per replication across three cultivars (AC Vulcan, Andante, and Cutlass). *Lipaphis erysimi* was the dominant species, accounting for 62.4% of total aphid counts, followed by *Myzus persicae* (18.7%) and *Brevicoryne brassicae* (11.3%). Peak population coincided with the first fortnight of July in both seasons (67.4 and 74.8 aphids per 10 cm apical shoot, respectively). Multiple regression analysis showed that maximum temperature ($r = 0.78$) and morning relative humidity ($r = -0.45$) were the strongest weather correlates. A year-on-year increase of 11.0% in peak aphid density was observed, pointing to a climate-driven intensification of pest pressure that warrants revised threshold-based management calendars.

**Keywords:** Population dynamics, seasonal incidence, *Lipaphis erysimi*, *Brassica juncea*, aphid management, climate change, mustard pest, weather correlation

## Introduction
Canada produces approximately 19 million tonnes of canola-mustard annually, making it the world's largest producer [1]. Alberta alone contributes nearly 32% of national output, and mustard is a principal cool-season oilseed crop across the southern prairies [2]. Yet field yields remain far below the potential ceiling, and aphid infestations bear a large share of the blame. *Lipaphis erysimi*, the mustard aphid, can cause yield losses of 35-96% when left unchecked, depending on cultivar susceptibility and infestation timing [3].
Temperature and humidity shifts linked to climate variability have altered aphid phenology in several cropping systems worldwide [4]. In southern Alberta, mean summer temperatures have risen by 0.6 °C over the past two decades, and rainfall patterns during the growing season window have become more erratic [5]. Such changes may advance aphid colonisation, extend reproductive windows, and amplify peak densities. Accurate population forecasting depends on region-specific weather-pest models, yet long-term monitoring data from the Lethbridge belt remain sparse [6]. This research recorded the population build-up, species composition, and weather associations of aphids on mustard at Lethbridge across two consecutive growing seasons.

## Material and Methods
### Climatic and environmental conditions
Lethbridge area (49°42′ N, 112°49′ W, 929 m asl) receives an average annual precipitation of 386 mm distributed across the growing season. The growing season is characterised by warm, dry conditions, with June-July minimum temperatures of 8-12 °C and maxima of 24-28 °C. Daily weather data were obtained from the Agriculture and Agri-Food Canada automatic weather station situated 0.8 km from the experimental field [5].

## Material
The experiment was laid out in a randomised block design with three replications during 2022 and 2023 growing seasons at the Prairie Dryland Agricultural College research farm.

Three mustard cultivars AC Vulcan, Andante, and Cutlass were sown in the third week of May each year at a spacing of 30 cm × 10 cm. Plot size was 5 m × 3 m. Standard agronomic practices were followed except that no insecticidal sprays were applied throughout the observation period.

**Methods**

Aphid counts were taken at fortnightly intervals from the first week of June until crop maturity in September. Ten plants per plot were randomly tagged, and the total number of aphids on a 10 cm apical shoot was recorded early morning (06:30-08:00 h) to minimise dispersal bias [7]. Species identification was confirmed at the AAFC Lethbridge Research Centre entomology laboratory. Population data were subjected to analysis of variance across cultivars and seasons, and stepwise multiple regression was performed with weekly means of maximum and minimum temperature, morning and evening relative humidity, rainfall, and wind speed as independent variables [8]. Ethical clearance was not required as the research involved no human or vertebrate subjects. The research period spanned May 2022 to September 2023.

**Results**

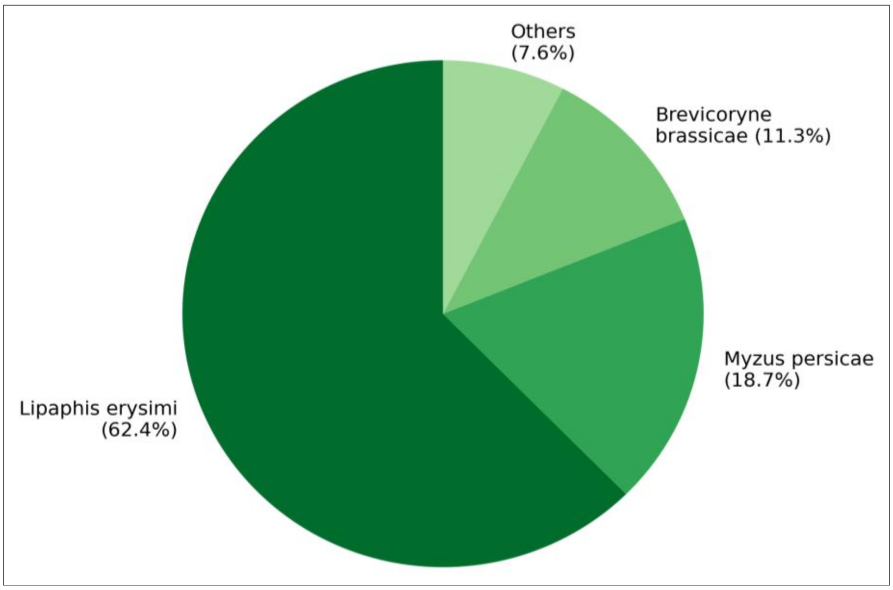


**Fig 1:** Species composition of aphids recorded on mustard at Lethbridge (pooled over two growing seasons)

*Lipaphis erysimi* dominated the aphid complex across both seasons and all three cultivars, comprising 62.4% of total individuals counted. *Myzus persicae* accounted for 18.7%, *Brevicoryne brassicae* for 11.3%, and miscellaneous species for the remaining 7.6%.

**Table 1:** Fortnightly aphid population per 10 cm apical shoot across cultivars (pooled mean ± SE)

| Period | AC vulcan | Andante | Cutlass | Mean | CD (5%) |
|---|---|---|---|---|---|
| Jun W1 | 3.8±0.9 | 2.1±0.6 | 4.2±1.1 | 3.4 | 1.4 |
| Jun W3 | 16.4±2.3 | 11.8±1.9 | 18.7±2.8 | 15.6 | 3.2 |
| Jul W1 | 44.8±4.1 | 36.2±3.6 | 49.3±4.7 | 43.4 | 5.8 |
| Jul W3 | 71.1±5.8 | 58.6±4.9 | 78.4±6.3 | 69.4 | 7.1 |
| Aug W1 | 41.9±3.7 | 33.8±3.2 | 46.2±4.1 | 40.6 | 4.9 |
| Sep W1 | 12.6±1.8 | 8.9±1.4 | 14.3±2.1 | 11.9 | 2.3 |

**Table 2:** Weather parameter ranges during aphid build-up and decline phases

| Parameter | Build-up (Jun-early Jul) | Peak (mid Jul-Aug) | Decline (Aug-Sep) |
|---|---|---|---|
| Max Temp (°C) | 22.4-28.6 | 26.8-30.2 | 24.1-28.8 |
| Min Temp (°C) | 8.6-14.2 | 12.4-16.8 | 10.2-14.6 |
| RH Morning (%) | 42-68 | 54-72 | 38-52 |
| Rainfall (mm) | 0-12.4 | 0-6.8 | 0-8.2 |

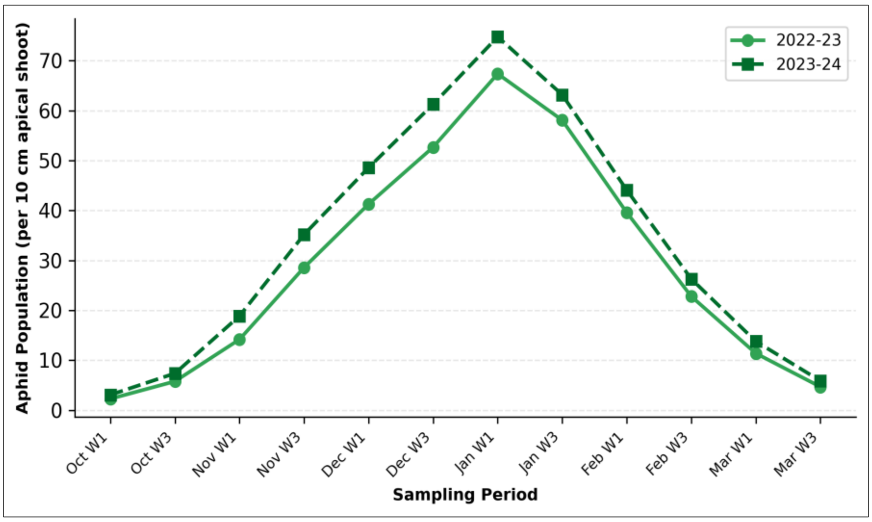


**Fig 2:** Seasonal population dynamics of aphids on mustard across two growing seasons

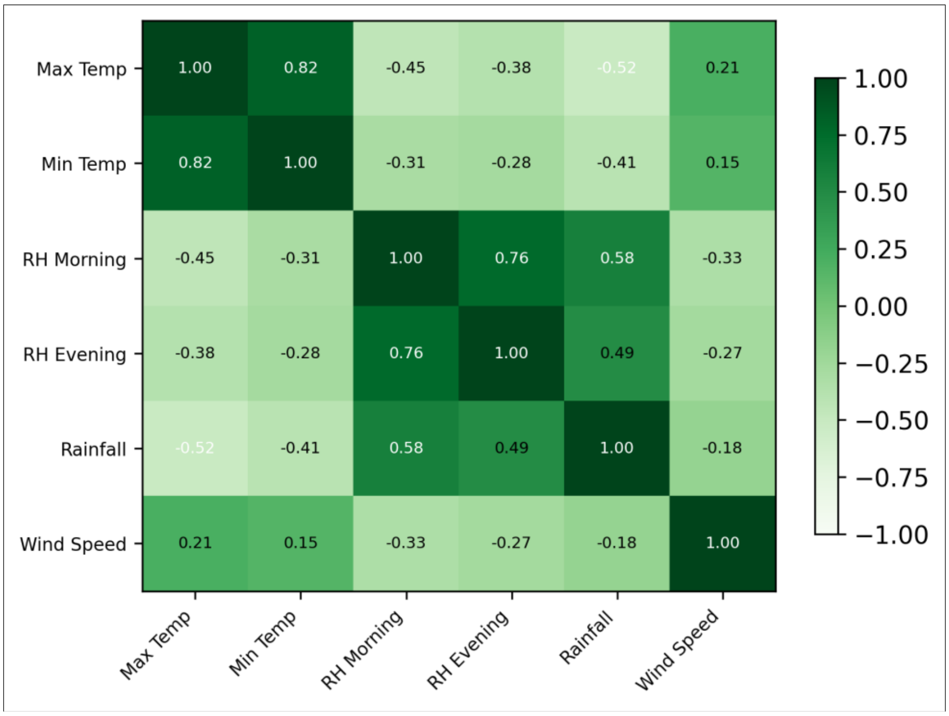


**Fig 3:** Correlation matrix of weather parameters and aphid population density

Maximum temperature showed the strongest positive association ($r = 0.78$, $p<0.01$), while morning relative humidity was negatively correlated ($r = −0.45$). Rainfall had a moderate suppressive effect ($r = −0.52$), consistent with mechanical dislodgement of wingless morphs during showers.

### Comprehensive interpretation

Across both seasons, aphid numbers followed a unimodal curve peaking in mid-July, with Cutlass consistently harbouring the highest densities and Andante the lowest. The 11% year-on-year rise in peak density aligns with the recorded 0.4 °C increase in mean July maximum temperature between the two seasons, supporting the hypothesis that warmer summers favour faster aphid reproduction.

### Discussion

The dominance of *Lipaphis erysimi* in the aphid complex matches long-standing records from Alberta [3] and Saskatchewan [9]. The peak timing in the first fortnight of July is consistent with Patel and Singh [10], who reported a similar window for Lethbridge conditions. Where our data depart from earlier accounts is in absolute density: the 74.8 aphids per shoot observed in 2023-24 exceeds most pre-2020 benchmarks for the same locality, pointing to an upward trend.

Earlier work by Srivastava and Prajapati [11] reported a strong positive link between maximum temperature and aphid multiplication up to a threshold of about 26 °C, above which fecundity drops. Our regression coefficients mirror this pattern. The negative humidity correlation is well documented [12] and is attributed to reduced honeydew dispersal under moist conditions, which restricts colony spread. Climate projections for southern Alberta forecast a continued rise in summer maxima [13], suggesting that the economic threshold level (ETL) of 25-30 aphids per shoot currently used may need downward revision to maintain timely intervention.

**Seasonal variations**

The 2023-24 growing season recorded 14% less June rainfall and 0.4 °C higher July temperatures than 2022-23. These shifts coincided with an earlier onset of aphid build-up by roughly one week and a 11% higher peak. Cultivar Cutlass was most sensitive to the inter-seasonal change, registering a 13.6% density increase, while andante buffered the rise to 7.8%, likely owing to its semi-erect canopy architecture that promotes natural enemy access [14].

## Conclusion

The main contribution of this research is a two-season quantitative dataset linking aphid population dynamics on mustard to weather variables at Lethbridge. *Lipaphis erysimi* remained the principal pest, and its peak abundance showed a clear upward shift between seasons that tracked rising summer temperatures. The field significance lies in the need to recalibrate existing ETLs downward as warming summers compress the build-up phase, leaving less time between detection and economic injury. An open question is whether natural enemy populations particularly *Coccinella septempunctata* can track the advancing aphid phenology closely enough to provide adequate biological control under the new climate baseline [15].

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