Influence of Rose Flower Cell Sap pH on Infestation by the Rose Aphid (*Macrosiphum rosae* L.) under Plastic Greenhouse Conditions

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Abstract

The rose aphid, *Macrosiphum rosae* L. (Hemiptera: Aphididae), is one of the most destructive insect pests affecting rose production by reducing both flower quality and market value. This study investigated the relationship between rose flower cell sap pH and infestation by M. rosae under plastic greenhouse conditions. Three rose cultivars (Dream, Freedom, and Montana) differing in flower cell sap pH were evaluated at two greenhouse locations in Cairo (El-Zohrya Garden) and Alexandria (International Garden), Egypt, during the 2025/2026 growing season. Aphid populations were monitored throughout the flowering period, and flower sap pH was determined using a digital pH meter. In addition, selected biochemical constituents of aphids feeding on each cultivar, including total carbohydrates, total lipids, total proteins, and several enzyme activities (lipase, kinase, chitinase, phosphatase, α-esterase, and β-esterase), were determined under laboratory conditions.

The results showed significant differences in aphid infestation among the three rose cultivars. Dream, which exhibited the lowest flower sap pH (4.5), had the lowest aphid population density, whereas Montana, with the highest pH (6.5), showed the greatest infestation. Freedom (pH 5.3) displayed intermediate values. Similar trends were observed at both experimental locations. Aphids feeding on Dream also exhibited lower concentrations of total carbohydrates, proteins, lipids, and enzyme activities compared with those feeding on Freedom and Montana.

These findings indicate a significant association between flower sap pH, rose cultivar, and aphid infestation under greenhouse conditions. The results suggest that flower sap acidity may contribute to differences in cultivar susceptibility to M. rosae. However, because other varietal biochemical characteristics were not investigated, the observed relationship should be interpreted with caution.

Key words: *Macrosiphum rosae*; *Rosa gallica*; flower cell sap pH; aphid infestation; greenhouse conditions; host plant resistance.

1-Introduction:

Rose (*Rosa gallica* L.) is one of the world's most important ornamental crops and is widely cultivated for the cut flower industry because of its high aesthetic and commercial value. Roses are grown extensively under both open-field and greenhouse conditions, where they contribute significantly to the

floriculture industry. Their economic importance has led to continuous efforts to improve flower quality and reduce losses caused by insect pests and diseases.

Among the insect pests attacking roses, the rose aphid, Macrosiphum rosae L. (Hemiptera: Aphididae), is considered one of the most destructive species. Both nymphs and adults feed on young shoots, flower buds, leaves, and developing flowers by extracting phloem sap, resulting in leaf curling, bud deformation, reduced flower quality, and considerable economic losses. Severe infestations may also reduce the ornamental value and marketability of cut roses (Jaskiewicz, 1997; Golizadeh et al., 2017).

The susceptibility of plants to aphid infestation is influenced by numerous morphological and biochemical characteristics, including nutrient composition, soluble sugars, amino acids, phenolic compounds, and other secondary metabolites. These factors may affect host selection, feeding behaviour, survival, and reproduction of aphids. Differences among rose cultivars in their biochemical composition may therefore contribute to variations in aphid infestation levels.

Cell sap pH is one of the physiological characteristics that may influence plant metabolic processes and the chemical composition of plant tissues. Although previous studies have investigated differences in aphid infestation among rose cultivars, limited information is available regarding the possible relationship between flower cell sap pH and infestation by M. rosae under greenhouse conditions.

Therefore, the present study aimed to investigate the association between flower cell sap pH of three rose cultivars and infestation by the rose aphid, Macrosiphum rosae, under plastic greenhouse conditions. In addition, selected biochemical characteristics of aphids feeding on the different cultivars were evaluated to determine whether variations in flower sap pH were associated with differences in aphid physiological responses.

2. Materials and Methods

2.1. Experimental Sites

The study was conducted during the 2025/2026 growing season under plastic greenhouse conditions at two locations representing different climatic regions in Egypt: El-Zohrya Garden, Cairo Governorate, and the International Garden, Alexandria Governorate.

2.2. Plant Material

Three commercial rose (*Rosa gallica* L.) cultivars were used in this study: **Dream**, **Freedom**, and **Montana**. The cultivars were selected because they exhibited similar horticultural characteristics, including plant growth habit, flower colour, plant height, and flower morphology, while differing in flower cell sap pH.

2.3. Experimental Design

At each location, one plastic greenhouse (27 × 45 m) was divided into three equal sections using fine polyethylene mesh to prevent aphid movement among cultivars. Each section was further divided into nine plots (3 × 5 m), and each plot contained 25 rose plants.

Rose seedlings were planted simultaneously in November 2025. All cultural practices, including irrigation, fertilization, pruning, and greenhouse management, were carried out uniformly throughout the experiment. No insecticides were applied during the study period.

2.4. Artificial Infestation and Population Assessment

Artificial infestation was conducted simultaneously at both locations using naturally infested rose leaves carrying colonies of *Macrosiphum rosae*. The infested leaves were carefully transferred onto experimental plants using a fine camel-hair brush to ensure minimal disturbance.

Beginning in February and continuing until June 2026, aphid populations were assessed at weekly intervals. Five plants were randomly selected from each plot. From each selected plant, ten leaves and five flowers were examined, and the numbers of aphid nymphs and adults were recorded.

2.5. Determination of Flower Cell Sap pH

Flower cell sap pH was determined in the Plant Physiology Laboratory, Faculty of Science, Ain Shams University.

Fresh flower samples were collected randomly from each cultivar at both experimental locations. Cell sap was extracted immediately after sampling, and pH was measured using a calibrated digital pH meter according to standard laboratory procedures.

2.6. Biochemical Analysis of Aphids

Physiological analyses were carried out in the Entomology Laboratory, Faculty of Science, Ain Shams University.

Aphids collected from each rose cultivar were analysed for selected biochemical constituents, including total soluble proteins, total carbohydrates, total lipids, and enzyme activities (lipase, kinase, phosphatase, chitinase, α-esterase, and β-esterase).

Protein extraction and determination followed Daughaday et al. (1952). Total carbohydrates were determined according to Fairbairn (1953) and Homme et al. (1992). Enzyme extraction and determination followed AOAC (1975).

2.7. Statistical Analysis

The obtained data were analysed using analysis of variance (ANOVA), and treatment means were compared using the Least Significant Difference (LSD) test at the 5% probability level. Statistical analyses were performed using SAS software (SAS Institute, 1988).

3. Results and Discussion

3.1. Population Dynamics of *Macrosiphum rosae* on the Three Rose Cultivars

The population density of *Macrosiphum rosae* differed significantly among the three rose cultivars at both experimental locations throughout the 2025/2026 growing season (Table 1, Fig. 1).

At the Cairo site, the mean aphid population reached 20.9, 16.7, and 13.1 individuals per flower on Montana, Freedom, and Dream cultivars, respectively. Similarly, at the Alexandria site, mean aphid populations were 24.9, 19.5, and 15.8 individuals per flower on Montana, Freedom, and Dream, respectively. Regardless of location, Montana consistently supported the highest aphid population, whereas Dream showed the lowest infestation level.

In both locations, aphid populations increased gradually from December, reached their maximum density during early to mid-March, and then declined progressively until June. Seasonal fluctuations followed a similar pattern in both governorates, although overall infestation levels were consistently higher in Alexandria than in Cairo.

The observed differences among cultivars may reflect variation in host suitability. Although flower cell sap pH differed among the cultivars, additional biochemical and physiological characteristics not evaluated in the present study may also contribute to differences in aphid colonization and population development.

The seasonal population trend observed in this study agrees with previous reports describing spring as the period of maximum population development of *M. rosae* (Jaskiewicz, 2005; Mohsen et al., 2016; Ahmed et al., 2022). Higher aphid abundance during spring is generally associated with favorable environmental conditions and the availability of actively growing plant tissues, which provide suitable feeding sites for aphid development.

Table (1): Population fluctuation of *M. rosae* infested rose flowers at Cairo and Alexandria Governorate during season 2025/2026

Date	Cairo Governorate			Alexandria Governorate		
	Montana	Freedom	Dream	Montana	Freedom	Dream
1/12/2025	14.3	10.5	6.5	18.4	13.5	9.5
15/12/2025	17.5	13.7	9.8	20.9	16.5	12.6
1/1/2026	19.8	15.3	11.5	23.5	19.6	14.8
15/1/2026	22.3	18.7	14.7	26.5	22.4	17.5
1/2/2026	25.5	21.5	17.5	29.3	24.3	19.8
15/2/2026	27.7	23.8	20.6	33.7	26.5	22.5
1/3/2026	30.9	25.6	22.3	36.5	28.3	25.2
15/3/2026	27.5	22.5	18.5	32.7	25.3	21.7
1/4/2026	25.5	20.7	15.9	30.4	22.8	18.5
15/4/2026	22.7	17.8	13.5	25.7	19.2	16.7
1/5/2026	20.4	15.3	11.7	23.5	17.8	13.9
15/5/2026	16.3	12.6	9.8	20.4	15.6	11.6
1/6/2026	12.5	9.5	6.7	15.8	12.2	9.5
15/6/2026	9.4	6.7	3.9	12.5	9.5	6.8
Total	**292.3**	**234.2**	**182.9**	**349.8**	**273.5**	**220.6**
Mean	**20.9**	**16.7**	**13.1**	**24.9**	**19.5**	**15.8**
F(0.05)	**344.75**			**298.81**		
L.S.D	**1.038**			**1.076**		

Means within columns bearing different subscripts are significantly different (P< 0.05)

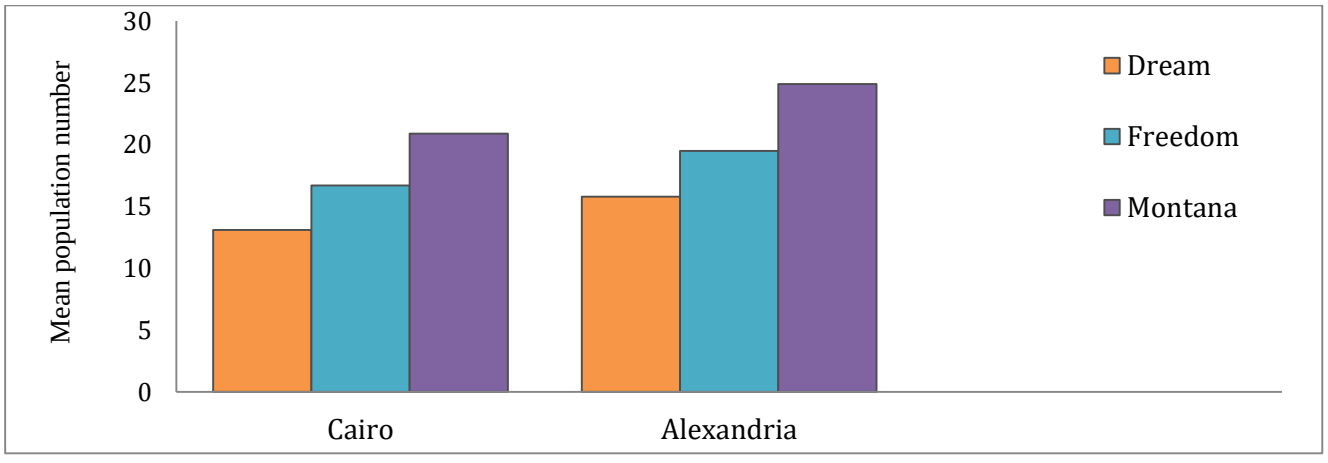

Fig. (1): Mean population fluctuation of *M. rosae* infested rose flowers at Cairo and Alexandria Governorate during season 2025/2026

3.2. Biochemical Characteristics of Aphids Feeding on Different Rose Cultivars

Significant differences were observed in the biochemical composition of aphids collected from the three rose cultivars (Table 2, Figs. 2–3).

Table (2): Concentrations of the important substances secreted by *M. rosae* fed on Dream, Freedom and Montana rose varieties

Parameters (mg/100g)	Montana	Freedom	Dream	$F_{(0.05)}$	L.S.D
Carbohydrates	13.5 ^{a}	11.2 ^{b}	8.7 ^{c}	325.16	1.022
Total Lipids	15.7 ^{a}	13.4 ^{b}	11.3 ^{c}	421.73	1,039
Total proteins	28.9 ^{a}	25.3 ^{b}	22.7 ^{c}	297.55	1,024
Vital Enzymes					
Lipase	31.5 ^{a}	28.7 ^{b}	25.3 ^{c}	311.27	1.037
Kinase	19.7 ^{a}	16.5 ^{b}	13.7 ^{c}	356.81	1.041
Chitinase	15.3 ^{a}	13.7 ^{b}	11.5 ^{c}	472.11	1.024
Phosphatase	23.5 ^{a}	21.4 ^{b}	19.7 ^{c}	279.85	1.021
Alpha Esterase	11.8 ^{a}	9.6 ^{b}	7.4 ^{c}	387.12	1.036
Beta Esterase	9.5 ^{a}	7.3 ^{b}	5.8 ^{c}	311.74	1.027

Means within columns bearing different subscripts are significantly different (P< 0.05)

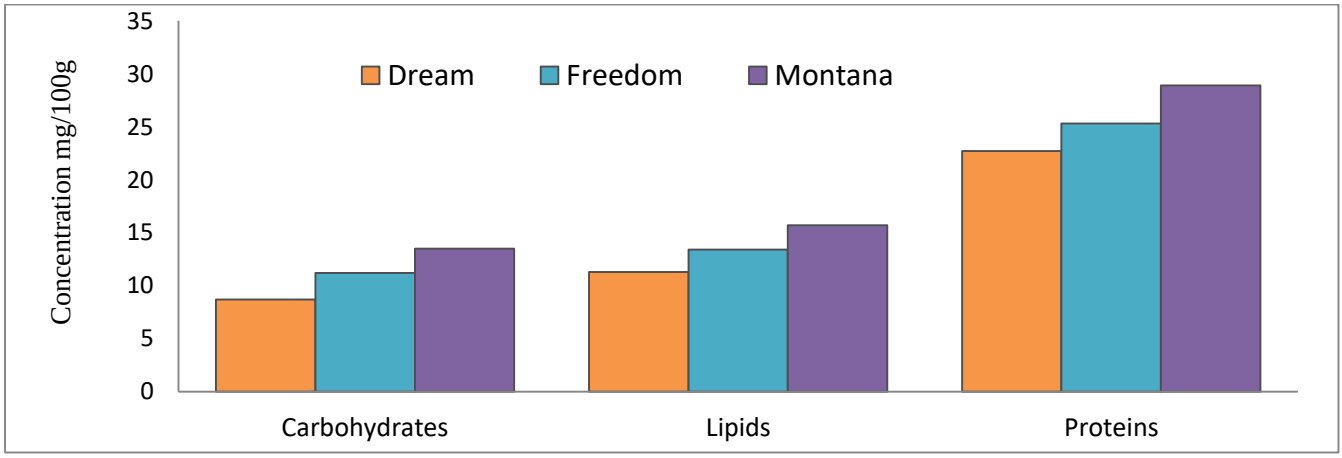

Fig. (2): Concentrations of the important substances secreted by *M. rosae* fed on Dream, Freedom and Montana rose varieties

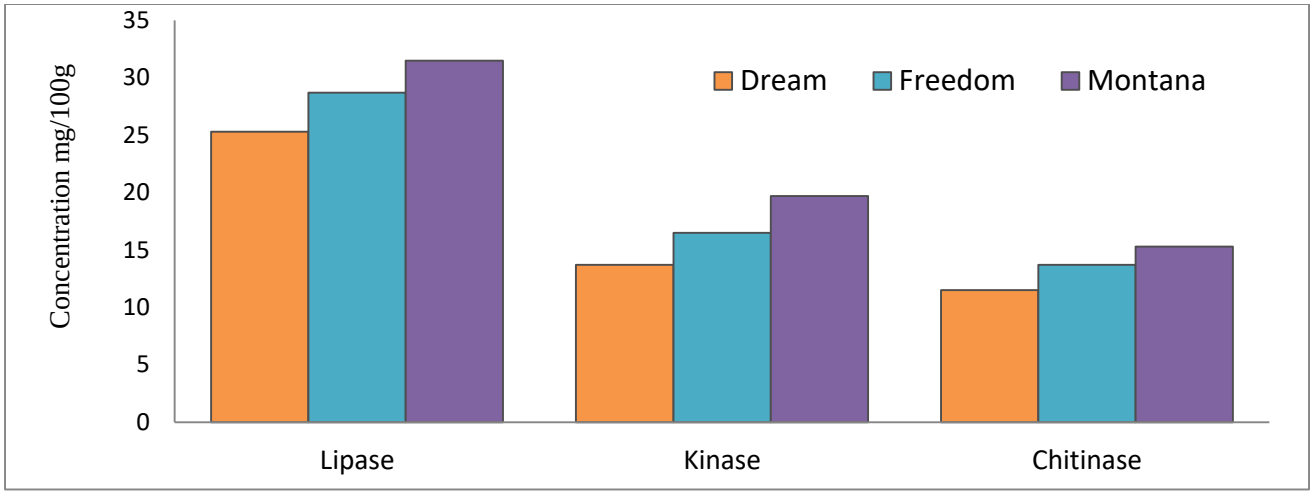

Fig. (3): Concentrations of the important enzymes secreted by *M. rosae* fed on Dream, Freedom and Montana rose varieties

Aphids feeding on Montana exhibited the highest concentrations of total carbohydrates, total lipids, total proteins, and all measured enzyme activities, whereas aphids feeding on Dream consistently showed the lowest values. Aphids collected from Freedom displayed intermediate values for all measured biochemical parameters.

The lower biochemical constituent levels recorded in aphids feeding on Dream coincided with the lower aphid population observed on this cultivar. Conversely, Montana supported both higher biochemical constituent levels and greater aphid abundance. These findings suggest that differences among rose cultivars may influence aphid physiological status and population development.

However, because only flower cell sap pH was measured, it cannot be concluded that pH alone was responsible for the observed differences. Other plant characteristics, including nutrient composition, amino acid profile, soluble sugars, phenolic compounds, and additional secondary metabolites, may also influence host suitability for aphids.

Previous studies have demonstrated that host plant biochemical composition can affect aphid feeding behaviour, survival, and reproduction (Ali et al., 2012; Mohammad et al., 2015; Imke et al., 2022). The present findings are generally consistent with those studies, although further investigations are required to clarify the relative contribution of flower sap pH compared with other plant biochemical traits.

Overall, the present results indicate that flower sap pH is associated with differences in aphid infestation among the studied rose cultivars under greenhouse conditions. Nevertheless, additional physiological and biochemical investigations are required before establishing a direct causal relationship between flower sap pH and aphid population development.

5. Conclusion

This study demonstrated significant differences in the infestation of the rose aphid, *Macrosiphum rosae*, among the three evaluated rose cultivars under plastic greenhouse conditions. Dream, which exhibited the lowest flower cell sap pH, consistently showed the lowest aphid population, whereas

Montana, with the highest pH, supported the greatest aphid infestation. Freedom displayed intermediate values for both flower sap pH and aphid abundance.

Differences in aphid biochemical constituents were also observed among the cultivars, with aphids feeding on Dream exhibiting lower concentrations of total carbohydrates, total proteins, total lipids, and enzyme activities than those feeding on Freedom and Montana. These findings suggest that variation among rose cultivars may influence aphid physiological performance and population development.

The results indicate that flower cell sap pH is associated with differences in aphid infestation under greenhouse conditions. However, because only flower sap pH was evaluated, the observed differences cannot be attributed solely to pH. Other biochemical and physiological characteristics of the host plant, including nutrient composition, phenolic compounds, soluble sugars, amino acids, and secondary metabolites, may also contribute to cultivar susceptibility.

Further studies involving a larger number of rose cultivars, together with comprehensive biochemical analyses and correlation or regression approaches, are recommended to better understand the relative contribution of flower sap pH to host plant resistance against *Macrosiphum rosae*. Such investigations may support the development of integrated pest management strategies and facilitate the selection of rose cultivars with improved tolerance to aphid infestation.

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