



True and incidental plant hosts of *Frankliniella gemina* (Thysanoptera: Thripidae) associated with vineyards in Córdoba, Argentina

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ABSTRACT. Spontaneous vegetation occurring in crop fields can provide resources for insect species. The aims of this study were to compile bibliographic information on the host plants of *Frankliniella gemina* Bagnall (Thysanoptera) in Argentina and to identify the species that act as true and incidental host plants in vegetation associated with vineyards in Colonia Caroya. A search of scientific articles was conducted using the keywords “*Frankliniella gemina*” and their synonyms *F. rodeos* and *F. allochroos* in Argentina, combined with “alternative hosts” and “weeds”, in Spanish and English, published between 1980 and 2024. Flowers were collected in three vineyards and their surroundings, from August to December for two years. In Argentina, 122 host species of *F. gemina* were recorded, while 26 plant species were identified in Colonia Caroya: six true hosts, 17 incidental and three fortuitous. *Nothoscordum gracile* (Aiton) Stearn (Amaryllidaceae) and *Melia azedarach* L. (Meliaceae) are reported for the first time as true hosts of *F. gemina*, worldwide. The importance of considering woody plant species when designing Thysanoptera control strategies is highlighted.

KEYWORDS. Grapevine. Incidental hosts. Plant-insect interactions. Thrips. True hosts.

Hospederos verdaderos e incidentales de *Frankliniella gemina* (Thysanoptera: Thripidae) asociados a viñedos en Córdoba, Argentina

RESUMEN. La vegetación espontánea presente en campos cultivados puede proveer recursos para insectos plagas. Los objetivos de este trabajo fueron compilar información bibliográfica sobre plantas que hospedan a *Frankliniella gemina* Bagnall (Thysanoptera) en Argentina e identificar especies que actúan como hospederas verdaderas e incidentales en viñedos de Colonia Caroya (Córdoba, Argentina). Se recopiló información bibliográfica registrando las plantas hospederas de *F. gemina* en Argentina y se determinaron plantas hospederas verdaderas e incidentales en vegetación asociada a viñedos de Colonia Caroya. Se realizó una búsqueda de artículos científicos utilizando las palabras claves “*Frankliniella gemina*” y sus sinónimos *F. rodeos* y *F. allochroos* en combinación con “hospedadores alternativos” y “malezas”, en español e inglés, publicados entre 1980 y 2024. Se recolectaron flores en tres viñedos y su entorno, desde agosto hasta diciembre durante 2 años. En Argentina, se registraron 122 especies de plantas hospederas de *F. gemina*, mientras que en Colonia Caroya se determinaron 26 especies: 6 verdaderas, 17 incidentales y 3 fortuitas. Se citan por primera vez a *Nothoscordum gracile* (Aiton) Stearn (Amaryllidaceae) y *Melia azedarach* L. (Meliaceae) como plantas hospederas verdaderas de *F. gemina*, a nivel mundial. Se destaca la importancia de considerar especies vegetales leñosas al diseñar estrategias de control de Thysanoptera.

PALABRAS CLAVE. Interacciones planta-insecto. Plantas hospedadoras incidentales. Plantas hospedadoras verdaderas. Trips. Vid.

INTRODUCTION

Spontaneous vegetation is present within and outside crop fields and provides food, shelter, breeding, and overwintering sites for phytophagous insect species. Particularly for phytophagous thrips (Thysanoptera), the concept of host plant is very important since they can be associated with plant species that provide shelter and food for adults (incidental hosts) and those that are used for oviposition and larval rearing (true-breeding or reproductive hosts). The frequency of association between the insect and the true host is usually high (Mound & Marullo, 1996). Knowledge of the density of thrips in true host flowers in uncultivated margins could predict thrip density within vineyards and thus help to control their population growth (Canovas et al., 2023).

Among the insects cited in grapevine crops in Argentina are thrips (Viglianco, 2020; Viglianco et al., 2021; Dagatti et al., 2024). The presence of spontaneous vegetation or other species planted during the flowering period of the crop can be an important source of migration into vineyards (Hidalgo Fernández & Hidalgo Togares, 2011).

Viglianco et al. (2021) found that the most common thrips species in the vineyards of Colonia Caroya (Department Colón, province of Córdoba) is *Frankliniella gemina* Bagnall. The adults and larvae of this species cause scars or russet on the upper portion or the entire surface of grape berries affecting quality parameters such as average weight and seed weight (Viglianco, 2020). This is a Neotropical endemic species broadly distributed from Mexico to Argentina (Cavalleri & Mound, 2012), considered as a polyphagous pest due to the wide variety of host plants attacked (Zamar, 2011). *Frankliniella gemina* reproduces in spontaneous plant species in spring and subsequently colonises grapevines at the time of flowering (Botton et al., 2007).

In Argentina, Córdoba is the eighth largest wine-producing province, with over 50 % of vineyards near Colonia Caroya (Colón Department) (INV (Instituto Nacional de Vitivinicultura), 2023).

Plant species growing spontaneously in Argentine vineyards have been studied (Méndez, 2014; Rovai et al., 2017) but which of them are potential hosts of *F. gemina* is not yet known, despite its importance for planning thrips management strategies. The objectives of this study were to compile bibliographic information on the host plants of *F. gemina* in Argentina and to identify the species that serve as true and accidental hosts of *F. gemina* in the area around vineyards in Colonia Caroya, Córdoba, Argentina.

MATERIALS AND METHODS

Literature Review

In order to know the recorded plant hosts of *F. gemina* in Argentina, we searched for scientific articles published in the period 1980-2024, using the main bibliographic databases

available on the Internet: Scopus, SciELO, ScienceResearch, ResearchGate, and Google Scholar. The keywords "*Frankliniella gemina*", their two synonymized species *F. rodeos* and *F. allochroos* (Cavalleri & Mound, 2012), in combination with "alternative hosts" and "weeds" were used as descriptors in both Spanish and English. The information was entered into a digital table in order to consider the following aspects: taxonomic family, the growth form of the host plant (herb, shrub, or tree), and its status in the study region as a cultivated or non-cultivated species.

Collection of plant hosts for *F. gemina* in vineyards of Colonia Caroya (Córdoba, Argentina)

In the initial phase (from August to December 2012), we conducted biweekly sampling of companion plant species in three commercial vineyards in Colonia Caroya, situated 50 km north of the city of Córdoba at 31°02'00" S and 64°05'00" W, at an altitude of 509 m a.s.l. The varieties were Malbec, Merlot, Chardonnay, Pinot Noir and Isabella. All fields were conventionally managed, i.e. using synthetic fungicides and herbicides.

In each vineyard, we selected three sampling plots, each measuring 1 m², between the rows of vines and three plots at least five meters away from the outermost row of vines. During each site visit and sampling date, the plant species present in the sampling area were collected and identified. In a second step, considering that *F. gemina* is an anthophilous species (Monteiro, 2002), simple flowers or inflorescences, depending on the plant species (from now on referred to as floral units "FU"), were collected in the three vineyards and their surroundings from the end of winter to the beginning of summer in 2013 and 2015. Plant species with an average frequency of occurrence equal to or greater than 20 % (data obtained in 2012) were sampled for floral resource analysis. Furthermore, the FU of *Prunus persicae* (L.) Stokes (peach) (Rosaceae), *Medicago sativa* L. (alfalfa) (Fabaceae) and *Melia azedarach* L. (chinaberry) (Meliaceae) were collected, as these are commonly occurring plant species in the area, typically found a few meters from the vineyards. Each sample consisted of 10-20 FU of each species, randomly selected from 1-4 plants. The total number of FUs collected depended on the availability of the plant species.

Sample processing and plant host determination

Samples were transported to the laboratory in polyethylene bags for the specific identification of plants using keys (Marzocca, 1993; Carreras et al., 2005). Insects were removed from the FU and placed in AGA solution (60 % ethyl alcohol, glycerin and acetic acid in a ratio of 10:1:1) for preservation. On each date and sample, we recorded the presence of individuals (adult or larvae) of *F. gemina* on each

Table I. List of plant species associated with *Frankliniella gemina* in Argentina, as reported in the literature.

Nº	Family Vegetal species	Grow form	C / NC ^a	A ^b	L ^c	ND ^d	Province	References
	Alstroemeriaceae							
1	<i>Alstroemeria psittacina</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
	Amaranthaceae							
2	<i>Amaranthus hybridus</i>	Herb	NC	X	X		Jujuy	Rodríguez, 2016
3	<i>Amaranthus</i> sp. ^e	Herb	NC			X	Mendoza	De Borbón et al., 1999; De Borbón, 2005, Dottori et al., 2024
4	<i>Amaranthus viridis</i>	Herb	NC	X	X		Jujuy	Rodríguez, 2016
5	<i>Atriplex lampa</i>	Shrub	NC	X			Mendoza	De Borbón, 2013
6	<i>Gomphrena pulchella</i>	Herb	NC	X			Córdoba	Dottori et al., 2024
	Amaryllidaceae							
7	<i>Agapanthus africanus</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
8	<i>Clivia rucinata</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
9	<i>Crinum</i> sp.	Herb	C			X	Buenos Aires	Carrizo et al., 2008
10	<i>Polianthes tuberosa</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
11	<i>Tulbaghia violacea</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
	Apiaceae							
12	<i>Conium maculatum</i> ^e	Herb	NC	X	X		Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
13	<i>Foeniculum vulgare</i>	Herb	C			X	Mendoza	De Borbón et al, 1999; De Borbón, 2005
	Apocynaceae							
14	<i>Nerium oleander</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
	Araceae							
15	<i>Zantedeschia heliothiana</i>	Herb	C			X	Buenos As.	Carrizo et al., 2008
	Asteraceae							
16	<i>Baccharis salicifolia</i>	Shrub	NC	X	X		Mendoza-San Juan	De Borbón, 2007, 2013
17	<i>Baccharis</i> sp.	Shrub	NC	X	X		Buenos Aires-Mendoza	De Borbón et al., 1999; Carrizo, 2002; De Borbón, 2005; Carrizo & Amela García, 2017
18	<i>Bidens andicola</i>	Herb	NC	X			Mendoza	De Borbón, 2013
19	<i>Bidens pilosa</i> ^e	Herb	NC	X		X	Tucumán-Jujuy	Carrizo & Zamar, 2016; Rodríguez, 2016
20	<i>Calendula officinalis</i>	Herb	C			X	Mendoza	De Borbón et al, 1999; De Borbón, 2005
21	<i>Carduus acanthoides</i>	Herb	NC	X	X		Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
22	<i>Chrysanthemum</i> sp.	Herb	C		X	X	Jujuy	Alejo et al., 2019; Alejo & Zamar, 2021
23	<i>Chuquiraga erinaceae</i>	Shrub	NC	X			Mendoza	De Borbón, 2013
24	<i>Cichorium intybus</i> ^e	Herb	C	X			Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
25	<i>Cirsium vulgare</i>	Herb	NC	X	X		Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
26	<i>Conyza bonariensis</i>	Herb	NC	X			Córdoba	Dottori et al., 2024
27	<i>Coreopsis grandiflora</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
28	<i>Dahlia</i> sp.	Herb	C			X	Buenos Aires	Carrizo et al., 2008
29	<i>Flaveria bidentis</i>	Herb	NC			X	Mendoza	De Borbón et al, 1999; De Borbón, 2005
30	<i>Gazania splendens</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008

Nº	Family Vegetal species	Grow form	C / NC ^a	A ^b	L ^c	ND ^d	Province	References
31	<i>Hypochaeris</i> sp.	Herb	NC	X			Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
32	<i>Lactuca sativa</i>	Herb	C			X	Mendoza	De Borbón et al, 1999; De Borbón, 2005
33	<i>Matricaria chamomilla</i>	Herb	NC	X	X		Buenos Aires Mendoza	de Borbón et al. 1999; Carrizo 2002; de Borbón 2005, 2007; Carrizo and Amela García 2017
34	<i>Picris echinoides</i>	Herb	NC	X	X		Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
35	<i>Rudbeckia</i> sp.	Herb	C			X	Buenos Aires	Carrizo et al., 2008
36	<i>Solidago chilensis</i>	Herb	NC	X	X		Buenos Aires	Carrizo, 2002; De Borbón, 2013; Carrizo & Amela García, 2017
37	<i>Tagetes minuta</i>	Herb	NC	X			Mendoza	De Borbón, 2013
38	<i>Tagetes</i> sp.	Herb	C	X			Mendoza	De Borbón, 2013
39	<i>Taraxacum officinale</i> ^e	Herb	NC	X	X		Buenos Aires	De Borbón, 2013; Carrizo & Amela García, 2017
40	<i>Tessaria absinthioides</i>	Herb	NC			X	Mendoza	De Borbón, 2005, 2013
41	<i>Pascalina glauca</i> ^e	Herb	NC	X	X		Mendoza Buenos Aires	De Borbón et al., 1999; De Borbón, 2005, 2013; Carrizo & Amela García, 2017
Balsaminaceae								
42	<i>Impatiens wallerana</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
Betulaceae								
43	<i>Betula pendula</i>	Tree	C	X			Mendoza	De Borbón, 2013
Bignoniaceae								
44	<i>Campsis radicans</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
45	<i>Pandorea jasminoides</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
Boraginaceae								
46	<i>Echium plantagineum</i>	Herb	NC	X	X		Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
Brassicaceae								
47	<i>Brassica rapa</i>	Herb	NC	X	X		Jujuy- Buenos Aires	Rodríguez, 2016; Carrizo & Amela García, 2017
48	<i>Eruca sativa</i>	Herb	C	X			Mendoza	De Borbón, 2013
49	<i>Raphanus nigra</i>	Herb	NC			X	Jujuy	Zamar & Arce de Hamity, 1999
50	<i>Raphanus sativus</i> ^e	Herb	NC	X	X		Buenos Aires Mendoza- Jujuy	De Borbón et al. 1999; Carrizo 2002; de Borbón 2005; Rodríguez 2016; Carrizo & Amela García 2017
51	<i>Rapistrum rugosum</i> ^e	Herb	NC	X	X		Buenos Aires Mendoza Jujuy	Zamar & Arce de Hamity, 1999; De Borbón et al., 1999; Carrizo, 2002; De Borbón, 2005; Rodríguez, 2016; Carrizo & Amela García, 2017; Dottori et al., 2024
52	<i>Sisymbrium irio</i>	Herb	NC	X	X		Mendoza	De Borbón et al., 1999; De Borbón, 2005, 2007
Caprifoliaceae								
53	<i>Abelia grandiflora</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
54	<i>Dipsacus sativus</i>	Herb	NC	X	X		Buenos Aires	Carrizo & Amela García, 2017
Chenopodiaceae								
55	<i>Chenopodium album</i> ^e	Herb	NC	X			Mendoza - Jujuy	De Borbón et al., 1999; De Borbón, 2005, 2013; Rodríguez, 2016
56	Commelinaceae <i>Commelina erecta</i>	Herb	NC	X			Córdoba	Dottori et al., 2024

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Convolvulaceae								
57	<i>Convolvulus arvensis</i>	Herb	NC	X			Buenos Aires	Carrizo & Amela García, 2017
58	<i>Ipomea sp.</i> ^e	Herb	NC			X	Buenos Aires	Carrizo et al., 2008
Fabaceae								
59	<i>Arachis hypogaea</i>	Herb	C		X		Córdoba	De Breuil et al., 2021
60	<i>Galega officinalis</i>	Herb	NC	X			Buenos Aires	Carrizo & Amela García, 2017
61	<i>Glycine max</i>	Herb	C	X			Córdoba	Dottori et al., 2024
62	<i>Hoffmanseggia falcaria</i>	Herb	NC			X	Mendoza	De Borbón et al., 1999; De Borbón, 2005
63	<i>Lathyrus latifolius</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
64	<i>Lotus tenuis</i>	Herb	C	X			Buenos Aires	Carrizo, 2002; Carrizo & Amela García, 2017
65	<i>Medicago sativa</i> ^e	Herb	C	X	X		Jujuy - Mendoza	De Borbón et al., 1999; Zamar & Arce de Hamity, 1999; De Borbón, 2005, 2007, 2013
66	<i>Melilotus albus</i> ^e	Herb	NC	X	X		Jujuy - Mendoza - Buenos Aires	Zamar & Arce de Hamity, 1999; De Borbón et al., 1999; Carrizo, 2002; De Borbón, 2005, 2013
67	<i>Prosopis alata</i>	Shrub	NC	X	X		Mendoza	Rodríguez, 2016; Carrizo & Amela García, 2017
68	<i>Trifolium repens</i>	Herb	NC	X	X		Buenos Aires	De Borbón, 2013
69	<i>Vicia faba</i>	Herb	C			X	Jujuy	Carrizo, 2002; De Borbón, 2013; Carrizo & Amela García, 2017
70	<i>Vicia sativa</i> ^e	Herb	C		X		Mendoza	Zamar & Neder de Román, 2012
Gentianaceae								
71	<i>Eustoma sp.</i>	Herb	C			X	Buenos Aires	De Borbón, 2007
Iridaceae								
72	<i>Dietes bicolor</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
Lamiaceae								
73	<i>Lamium amplexicaule</i>	Herb	NC		X		Mendoza	De Borbón, 2007
74	<i>Salvia farinacea</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
Lauraceae								
75	<i>Persea americana</i>	Tree	C			X	Jujuy	Agostini et al., 2005; Muruaga de L'argentier et al. 2005
Lythraceae								
76	<i>Lagerstroemia indica</i>	Tree	C			X	Buenos Aires	Carrizo et al., 2008
Malpighiaceae								
77	<i>Tricomaria usillo</i>	Shrub	NC	X			Mendoza	De Borbón, 2013
Malvaceae								
78	<i>Malva parviflora</i>	Herb	NC	X	X		Mendoza	De Borbón et al., 1999; De Borbón, 2005, 2007, 2013
79	<i>Malvaviscus arboreus</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
80	<i>Sphaeralcea miniata</i>	Shrub	NC		X		Mendoza	De Borbón, 2007
Moraceae								
81	<i>Morus insignis</i>	Tree	NC	X			Jujuy	Rodríguez, 2016
Myrtaceae								
82	<i>Callistemon lanceolatus</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
83	<i>Myrcianthes cisplatensis</i>	Tree	NC	X			Entre Ríos	De Borbón, 2013

Nº	Family Vegetal species	Grow form	C / NC ^a	A ^b	L ^c	ND ^d	Province	References
	Nyctaginaceae							
84	<i>Bougainvillea spectabilis</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
	Oxalidaceae							
85	<i>Oxalis corniculata</i>	Herb	NC	X			Córdoba	Dottori et al, 2024
	Passifloraceae							
86	<i>Passiflora caerulea</i> ^e	Shrub	NC			X	Buenos Aires	Carrizo et al., 2008
	Plantaginaceae							
87	<i>Plantago lanceolata</i>	Herb	NC	X	X		Mendoza	De Borbón et al.,1999; De Borbón, 2005; 2007
	Plumbaginaceae							
88	<i>Ceratostigma plumbaginoides</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
89	<i>Limonium sinuatum</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
	Poaceae							
90	<i>Sorghum halepense</i>	Herb	NC	X			Córdoba	Dottori et al., 2024
91	<i>Zea mays</i>	Herb	C	X			Córdoba	Dottori et al., 2024
	Polygalaceae							
92	<i>Polygala myrtifolia</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
	Portulacaceae							
93	<i>Portulaca oleracea</i>	Herb	NC	X			Jujuy	Rodríguez, 2016
	Punicaceae							
94	<i>Punica granatum</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
	Rosaceae							
95	<i>Malus domestica</i>	Tree	C	X			Entre Ríos	De Borbón, 2013
96	<i>Prunus avium</i>	Tree	C	X			Mendoza	De Borbón et al, 2008
97	<i>Prunus domestica</i>	Tree	C	X			Entre Ríos- Mendoza- San Juan	De Borbón, 2013; De Borbón & Battaglia, 2022
98	<i>Prunus persica</i> ^e	Tree	C	X			Buenos Aires	De Borbón, 2013, De Borbón & Battaglia, 2022
99	<i>Pyrus communis</i>	Tree	C	X			Entre Ríos - Mendoza- Buenos Aires	De Borbón et al.,1999; De Borbón, 2005, 2013; De Borbón & Battaglia, 2022
100	<i>Pyrus pyrifolia</i>	Tree	C	X			Entre Ríos	De Borbón, 2013
101	<i>Rosa x hybrida</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
102	<i>Rubus sp</i>	Shrub	NC	X			Entre Ríos	De Borbón, 2013
	Rubiaceae							
103	<i>Borreria spinosa</i>	Herb	NC			X	Córdoba	Dottori et al., 2024
	Rutaceae							
104	<i>Citrus limon</i>	Tree	C			X	Salta – Jujuy	Tapia et al., 2014
105	<i>Citrus paradisi</i>	Tree	C			X	Salta – Jujuy	Tapia et al., 2014
106	<i>Citrus reticulata</i>	Tree	C			X	Salta – Jujuy	Tapia et al., 2014
107	<i>Citrus reticulata x sinensis</i>	Tree	C	X	X		Corrientes	De Borbón, 2013
108	<i>Citrus sinensis</i>	Tree	C			X	Salta – Jujuy	Tapia et al., 2014

Nº	Family Vegetal species	Grow form	C / NC ^a	A ^b	L ^c	ND ^d	Province	References
Solanaceae								
109	<i>Capsicum annuum</i>	Herb	C			X	Mendoza	De Borbón et al.,1999; De Borbón, 2005
119	<i>Cestrum parqui</i>	Shrub	NC	X			Tucumán	De Borbón, 2013
111	<i>Datura ferox</i>	Herb	NC	X			Córdoba	Dottori et al., 2024
112	<i>Lycopersicum esculentum</i>	Herb	C	X			Mendoza	De Borbón et al.,1999; De Borbón, 2005
113	<i>Nicotiana glauca</i>	Shrub	NC	X			Jujuy	Rodríguez, 2016
114	<i>Nicotiana tabacum</i>	Herb	C	X			Jujuy	Rodríguez, 2016
115	<i>Solanum elaeagnifolium</i>	Herb	NC			X	Mendoza	De Borbón et al.,1999; De Borbón, 2005
Verbenaceae								
116	<i>Aloysia triphylla</i>	Shrub	C	X			Mendoza	De Borbón, 2013
117	<i>Duranta erecta</i>	Shrub	C			X	Buenos Aires	Carrizo et al., 2008
118	<i>Lantana camara</i>	Shrub	C	X		X	Buenos Aires - Tucumán	Carrizo et al., 2008; De Borbón, 2013
119	<i>Pitrac cuneato-ovata</i>	Herb	NC	X			Mendoza	De Borbón et al.,1999; De Borbón, 2005, 2013
Vitaceae								
120	<i>Vitis vinifera</i>	Shrub	C	X	X		Córdoba - Mendoza	De Borbón, 2007, 2013; Viglianco et al., 2005; Viglianco et al., 2021
Xanthorrhoeaceae								
121	<i>Bulbine caulescens</i>	Herb	C			X	Buenos Aires	Carrizo et al., 2008
Zygophyllaceae								
122	<i>Bulnesia retama</i>	Shrub	NC			X	Mendoza	De Borbón et al.,1999; De Borbón, 2005

Notes: ^a= status of cultivated for commercial purposes (C) or non-cultivated for commercial purposes plants (NC); ^b= presence of adults of *F. gemina* were marked with X; ^c= presence of larvae of *F. gemina* were marked with X; ^d= presence of *F. gemina* without indication of developmental stage (ND) were marked with X; ^e= Plant species commonly found in the study region.

plant species. We identified *F. gemina* specimens (larvae and adults) from temporary microscopic preparations using taxonomic keys (De Borbón, 2007, 2013; Mound, 2010; Cavalleri & Mound, 2012). In host plants where gravid females of *F. gemina* were found, the number of eggs in the ovarioles was counted. Adult specimens were deposited at the Entomological Collection of Córdoba (ENTOCOR).

RESULTS

We reported 122 host plant species for *F. gemina* by 17 publications from nine out of 23 provinces in Argentina (Table I). Plant species belong to 41 families, with Asteraceae and Fabaceae being the most frequently reported hosts. In the study region, we observed *F. gemina* on 26 plant species, primarily belonging to the same two plant families, representing 71 % of the evaluated plant species.

Sixty-five per cent of the plant species associated with *F. gemina* in Argentina were herbs, with a nearly equal proportion of cultivated and non-cultivated species. The number of shrubs reported as hosts was twice that of trees. In the study region, the prevalence of non-cultivated herbaceous plants was even more pronounced, accounting for 85 % of the total.

In Argentina, only 22 % of all species associated with *F. gemina* are true hosts, as both larval and adult stages were found on them (Table I). Flower samples of 32 plant species with an average frequency of occurrence equal to or greater than 20 % (data 2012) showed that a total of 6 plant species harbored both stages within the regional dataset: *Conium maculatum* L. (Apiaceae), *Medicago sativa* (Fabaceae), *Mellilotus albus* Medik. (Fabaceae), *Raphanus sativus* L. (Brassicaceae), *Nothoscordum gracile* (Aiton) Stearn (Amaryllidaceae), and *Melia azedarach* L. (Meliaceae) (Table II)

Regarding the temporal distribution of *F. gemina*, adult and larval specimens were identified throughout the sampling period (August-December of both years) in a range of species of the surrounding vegetation. Some host plants were consistently associated with *F. gemina*, whenever they were present. These included *M. alba* (N= 10), *N. gracile* (N= 10), *R. sativus* (N= 10), *C. maculatum* (N= 6), *M. azedarach* (N= 6) and *M. sativa* (N= 6) (Table II). In October, a period before or coinciding with the beginning of grape flowering, 17 flowering plant species surrounding the vineyard were evaluated. We observed a maximum number of six true hosts in the vineyards. The highest number of flowering plant hosts of *F. gemina* was recorded in November (68 % of the total),

Table II. Plant families and species recorded in vineyards, associated with *Frankliniella gemina* in Colonia Caroya (Córdoba, Argentina) in the period 2013-2015

Family	Solitary flower or inflorescence (type)	Species	Local common names	Status C/NC ^a	Number of FU observed ^b	Presence of <i>F. gemina</i> ^c	
						A	L
Amarantaceae	Inflorescence (spike)	<i>Amaranthus quitensis</i> H.B.K.	Yuyo colorado	NC	20	+	-
Amaryllidaceae	Inflorescence (umbel)	<i>Nothoscordum gracile</i> (Dryand. ex Aiton) ^e	Lágrima de la virgen	NC	100	+	+
Apiaceae	Inflorescence (compound umbel)	<i>Apium leptophyllum</i> (Pers.) ^d	Apiecillo	NC	35	+	-
		<i>Bowlesia incana</i> Ruiz and Pav.	Perejilillo	NC	20	-	-
		<i>Conium maculatum</i> L.	Cicuta	NC	95	+	+
Asteraceae	Inflorescence (capitulum)	<i>Bidens pilosa</i> L.	Amor seco	NC	50	+	-
		<i>Cichorium intybus</i> L.	Achicoria	NC	35	+	-
		<i>Conyza bonariensis</i> (L.) Cronq	Rama negra	NC	NS	-	-
		<i>Galinsoga parviflora</i> Cav. ^d	Albahaca silvestre	NC	35	+	-
		<i>Gamochaeta coarctata</i>	Peludilla	NC	NS	-	-
		<i>Senecio pampeanus</i> Cabr. ^d	Sombra de liebre	NC	60	+	-
		<i>Sonchus oleraceus</i> L.	Cerraja	NC	20	-	-
		<i>Taraxacum officinale</i> G. H. Weber ex Wigg.	Diente de león	NC	35	+	-
		<i>Wedelia glauca</i> Ort. Hoffm. ex. Hicken	Sunchillo	NC	50	+	-
		<i>Hirschfeldia incana</i> (L.) Lagrèze-Fossat ^d	Nabo amarillo	NC	50	+	-
		<i>Raphanus sativus</i> L.	Nabón	NC	100	+	+
Brassicaceae	Inflorescence (raceme)	<i>Rapistrum rugosum</i> L.	Mostacilla	NC	70	+	-
Chenopodiaceae	Inflorescence (glomerule)	<i>Chenopodium album</i> L.	Quinoa	NC	90	+	-
Ciperaceae	Inflorescence (thyrses)	<i>Cyperus rotundus</i> L.	Cebollín	NC	NS	-	-
Commelinaceae	Solitary flower	<i>Commelina erecta</i> L.	Flor de santa Lucía	NC	30	+	-
Convolvulaceae	Solitary flower	<i>Ipomea purpurea</i> (L.) Roth	Porotillo	NC	45	+	-
Euphorbiaceae	Inflorescence (false whorl)	<i>Euphorbia davidii</i> Michx.	Lecherón	NC	NS	-	-
Fabaceae	Inflorescence (raceme)	<i>Medicago lupulina</i> L.	Trébol rastrero	NC	25	-	-
		<i>Medicago sativa</i> L.	Alfalfa	C	70	+	+
		<i>Melilotus alba</i> Medik.	Trébol blanco	NC	100	+	+
		<i>Vicia sativa</i> L.	Vicia	NC	60	+	-
Geraniaceae	Inflorescence (umbel)	<i>Erodium cicutarium</i> (L.) L'Hér. ex Aiton	Alfilerillo	NC	20	-	-
Lamiaceae	Inflorescence (pseudospike)	<i>Lamium amplexicaule</i> L.	Ortiga mansa	NC	NS	-	-
Malvaceae	Solitary flower	<i>Leonorus sibiricus</i> L.	Cola de león	NC	25	+	*
		<i>Abutilon theophrasti</i> Medik	Malva	NC	10	-	-
		<i>Malvastrum coromandelianum</i> (L.) Garcke	Escoba dura	NC	15	-	-
Meliaceae	Inflorescence (panicle)	<i>Melia azedarach</i> L. ^e	Paraíso	NC	60	+	+
Onagraceae	Solitary flower	<i>Oenothera rosea</i> L'Hér. ex Aiton	Enotera	NC	20	-	-
Passifloraceae	Solitary flower	<i>Passiflora caerulea</i> L.	Pasionaria azul	NC	20	+	*
Poaceae	Inflorescence (panicle)	<i>Bromus catharticus</i> Val.	Cebadilla criolla	NC	20	+	*
		<i>Cynodon dactylon</i> (L.) Pers.	Gramilla	NC	NS	-	-
		<i>Digitaria sanguinalis</i> (L.) Scop.	Digitaria	NC	NS	-	-
		<i>Sorghum halepense</i> (L.) Pers.	Sorgo de alepo	NC	NS	-	-
		<i>Portulaca oleraceae</i> L.	Verdolaga	NC	NS	-	-
Portulacaceae	Solitary flower	<i>Clematis montevidensis</i> Spreng.	Barba de viejo	NC	40	-	-
Ranunculaceae	Inflorescence (cyme)	<i>Prunus persica</i> (L.) Stokes	Duraznero	C	50	+	-
Rosaceae	Solitary flower						
Scrophulariaceae	Solitary flower	<i>Veronica persica</i> Poir. ^d	Verónica	NC	50	+	-
		<i>Datura ferox</i> L.	Chamico	NC	NS	-	-
Solanaceae	Solitary flower	<i>Solanum</i> spp.		NC	15	-	-
Verbenaceae	Inflorescence (spike)	<i>Verbena litoralis</i> Kunth.	Verbena	NC	30	+	-

Notes: a= status of cultivated for commercial purposes (C) or non-cultivated for commercial purposes plants (NC); b= number of floral units (FU) observed for each species, plant species with low abundance and not selected for inspection of floral units are indicated with NS; c= presence (+) or absence (-) of adults (A) or larvae (L) of *F. gemina*, those plant species where *F. gemina* was observed only in a single sample were marked with an asterisk (*); d= new plant host records in the country; e= new records of true hosts in the country

coinciding with the grape flowering. In all samples (N= 6) of *M. azedarach* flowers, seven gravid females containing two to seven eggs were observed, while in the other hosts, females carried one to three eggs.

Some plant species, including *C. maculatum*, *N. gracile*, *R. sativus* and *M. sativa*, may be considered potential reservoirs of *F. gemina*, as they offered flowers over a greater temporal window and host both stages of the insect from the beginning of their flowering stage (Table III).

DISCUSSION

Literature records from Argentina indicate that *F. gemina* is associated with 122 species in 41 plant families (Table I). Our study adds 11 new records of both, true and incidental hosts, representing 9 % of the total host species recorded in the country. Our data support the conclusion that this species is extremely polyphagous, as *Frankliniella occidentalis* (Pergande), another relevant pest species in the genus (Pizzol et al., 2017). Asteraceae and Fabaceae were the

Table III. List of plant species offering flowering resources for *F. gemina*, indicating the presence of open flowers in incidental (black cells) and true hosts (red cells) in the sampling period and the occurrence of adults (A) and larvae (L) in Colonia Caroya vineyards.

PLANT HOST SPECIES	Aug	Sep	Oct	Nov	Dec
Vineyard					
<i>Amaranthus quitensis</i>					A
<i>Nothoscordum gracile</i> ^a		AL	AL	AL	AL
<i>Apium leptophyllum</i>				A	A
<i>Conium maculatum</i> ^a	AL	AL	AL	AL	AL
<i>Bidens pilosa</i>				A	A
<i>Cichorium intybus</i>					A
<i>Galinsoga parviflora</i>				A	
<i>Senecio pampeanus</i>				A	A
<i>Taraxacum officinale</i>					A
<i>Wedelia glauca</i>				A	A
<i>Hirschfeldia incana</i>			A	A	A
<i>Raphanus sativus</i> ^a		AL	AL	AL	A
<i>Rapistrum rugosum</i>		A	A	A	
<i>Chenopodium album</i>				A	A
<i>Commelina erecta</i>					A
<i>Ipomea purpurea</i>			A	A	A
<i>Medicago sativa</i>		A	AL	AL	AL
<i>Melilotus alba</i> ^a			AL	AL	AL
<i>Vicia sativa</i>				A	A
<i>Leonorus sibiricus</i>				A	
<i>Melia azedarach</i> ^b			AL	L	
<i>Passiflora caerulea</i>				A	
<i>Bromus catharticus</i>				A	
<i>Prunus persica</i>		A			
<i>Veronica persica</i>				A	
<i>Verbena litoralis</i>				A	
Flowering plant species	5	11	13	24	24
Species hosting <i>F. gemina</i>	1	6	9	21	17
Number of true hosts	1	3	6	5	4

Notes: ^a= two to four eggs in ovarioles of females of *F. gemina* in flowers of the host plants; ^b= two to seven eggs in ovarioles of females of *F. gemina* in flowers of the host plants

dominant host families in both datasets studied here. Both families have been previously identified as the most commonly used hosts by several Thysanoptera species (Zamar, 2011; Carrizo & Amela García, 2017; Pizzol et al., 2017).

In considering the family Asteraceae, which includes the largest number of host species, it is evident that their capitulum inflorescences offer the benefits of a sequential and continuous availability of pollen and nectar, given the centripetal development of their floral units (Varatharajan et al., 2016). The higher representation of Brassicaceae

observed in Colonia Caroya (sharing with Fabaceae the second place, with 14 % of the total) is rather similar to that observed in the horticultural belt of La Plata, where the families with the highest richness were Asteraceae (48 %), Fabaceae (19 %), and Brassicaceae (14 %) (Carrizo & Amela García, 2017). It could be attributed to the type of habitat in which we obtained the records. The study in La Plata and ours, from Colonia Caroya, were carried out in productive environments, while data in the rest of the publications were obtained in other habitats, such as urban and natural. Furthermore, *F. gemina* appears to attack a proportional number of species from each taxonomic family, as the most attacked families are also the most species-rich in the regional flora (Zuloaga et al., 2019).

In the study region, as well as in the horticultural fields of La Plata (Buenos Aires), *F. gemina* was associated with a lower number of host plants (26 and 21, respectively) (Carrizo & Amela García, 2017), compared to Jujuy, where more than 80 host plants were listed (Zamar, 2011). Two reasons may explain these differences: a higher sampling intensity in Jujuy (Zamar & Arce de Hamity, 1999; Muruaga de L'Argentier et al., 2005; Zamar, 2011; Tapia et al., 2014; Rodríguez, 2016), and climatic differences that probably favour *F. gemina* in the lower latitudes of northern Argentina. We identified only six plant species in which *F. gemina* larvae can feed (*Melilotus alba*, *Medicago sativa*, *Conium maculatum*, *Raphanus sativus*, *Melia azedarach* and *Nothoscordum gracile*). The first four species have been previously reported as primary hosts (De Borbón et al, 1999; Zamar & Arce de Hamity, 1999; Carrizo, 2002; De Borbón, 2005, 2007, 2013; Rodríguez, 2016; Carrizo & Amela García, 2017), while *M. azedarach* and *N. gracile* are new records. It is known that despite the adults of a certain species of Thysanoptera can be found on a large number of plants, their larvae will exploit relatively few plants (Kirk, 1985; Carrizo, 2002). This is consistent with the findings for *F. gemina* both regionally and in the study area, where only 23 % of the total plants associated with this thrips species can be considered as primary hosts. The important role of these primary host plants is confirmed by the fact that we found *F. gemina* in 100 % of the samples collected from these plants. This constancy of association is required to determine a plant species as a true host in Thysanoptera (Mound & Marullo, 1996). We found adult thrips on 17 other plant species, but these can be considered secondary or incidental hosts. Specimens of *F. gemina* were observed in only one flower sample of three of these species [*Leonorus sibiricus* L. (Lamiaceae), *Passiflora caerulea* L. (Passifloraceae) and *Bromus catharticus* Vahl (Poaceae)], suggesting they are likely to be fortuitous hosts.

We found a significant regression between the mean frequency of plant species occurrence and the frequency of plant *F. gemina* association. It suggests that this species behaves as an opportunistic generalist, with no clear host preferences. In general, the presence of polyphagous thrips

species is closely related to the availability of plants used as food sources (Pizzol et al., 2017). The ability of *F. gemina* to feed on different species present in the area would explain its presence throughout the five months analysed (August-December). It agrees with the observed in other horticultural crops, where thrips occur throughout the year in spontaneous vegetation (Carrizo & Amela García, 2017).

Between August and October, thrips visited 20-69 % of the flowering plant species near the vineyards. In October, a period preceding or coinciding with the flowering of the vines, the presence of *F. gemina* on nine plant species (six of which were true hosts) indicated that the surrounding vegetation represented a reservoir of populations that would later infest the crop. It was consistent with observations of *Thrips tabaci* (Linderman), *Thrips obscuratus* (Crawford) and *F. gemina* in vineyards in Italy, New Zealand and Brazil (Rigamonti, 2000; Schmidt et al., 2006; Botton et al., 2007).

Almost 90 % of flowering plants were visited by *F. gemina* in November and just over 70 % in December. It suggests that individuals may move to these spring-summer flowering plant species when the number of vine flowers decreases. This is consistent with Carrizo & Amela García (2017), who mentioned a strong increase in *F. gemina* on flowering plants in November and December.

Two primary hosts of *F. gemina* are recorded here for the first time and deserve special attention. The first is *Nothoscordum gracile*, an American herbaceous species with a wide distribution, naturalized in temperate regions of other continents (Hurrell, 2009) and frequently found in central Argentina (Flora Argentina, 2018). The only record of this plant species as a primary host of thrips was for *Frankliniella platensis* De Santis in Mendoza (De Borbón, 2018). Secondly, a new association with *Melia azedarach*, a tree species native to Asia (Hanan Alipi & Mondragón Pichardo, 2009), was recorded. Most importantly, it was demonstrated that this plant species is a true host for *F. gemina*. This finding is significant due to the wide distribution of *M. azedarach* in Argentina, especially in agricultural fields where it is invasive (Ghersa et al., 2002). In its flowers, *F. gemina* females had a higher number of eggs than in other plant species, suggesting that this primary host provides good quality for thrips development. In this regard it is important to note that the nutritional value of a host plant for a Thysanoptera species is demonstrated by insect fecundity (Terry, 1997). Anthophilous species obtain the proteins necessary for reproduction mainly from pollen and improve some physiological functions (Lu et al., 2013). The medium size of *M. azedarach* pollen grains and their high nutritional quality (Marí Herguido, 2017) would allow *F. gemina* to fully exploit them, indicating that this plant species is an important reproductive host. Up to the present, associations between *M. azedarach* and thrips have not been reported in Argentina. However, in other countries, *Thrips hawaiiensis* Morgan (Singh & Varatharajan, 2014), *Thrips coloratus* Schmutz, *Scirtothrips dorsalis* Hodd (Zheng et al.,

2005) and *Lefroyothrips pictus* (Hood) (Mound & Ng, 2021) were reported on its flowers. It is important to emphasise the significance of considering woody plant species as potential hosts for thrips. These species are frequently disregarded in plant-thrips interaction studies and are not commonly targeted for sampling, despite their ecological relevance.

The richness of spontaneously flowering vegetation directly correlates with the number of insects attacking the crop (Schmidt et al., 2006; Botton et al., 2007; Silva et al., 2018). *Frankliniella gemina* can transmit topoviruses to plants (De Borbon et al., 2006), although its role as vector of viral diseases to vineyards has not been demonstrated. However, the information about their true hosts is particularly relevant since transmission of thrip-transmitted viruses is usually only possible when the virus is acquired during the larval stages (Rotenberg et al., 2015). Therefore, understanding the identity of true hosts for *F. gemina* in Colonia Caroya is relevant for designing strategies within an Integrated Pest Management programme. Moreover, in order to reduce the population density of *F. gemina* in vineyards and therefore its damages, it is particularly recommended to avoid the presence of those true hosts that offer flowers in the months prior to the flowering of the vines, time of greatest vulnerability of the vines to be damaged by the thrips. Our results indicate that in vineyards of Colonia Caroya these species are *N. gracile*, *C. maculatum* and *R. sativus*. In relation to the woody *M. azedarach*, although its floration coincides with that of the vineyards, the high fecundity that the insect reaches in its flowers should be reason enough to consider its occurrence in vineyards.

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