Establishing a weed host ranking for thrips vectors of tospovirus in La Plata horticultural belt of Buenos Aires, Argentina

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Abstract: Tospoviruses are carried and delivered by thrips. They find physical refuge and breeding sites on weed plants growing around crops. Those volunteer plants have been previously recognised as key factors in virus spread. However, there have been not attempts to identify those weed species that really act like 'breeding hosts' and 'reservoir hosts'. In addition, even if only larvae can acquire virus, a plant that supports adults in high numbers may indeed acts like a dangerous virus source. In order to establish a preference degree for weeds, they were taken flower samples from two different locations within La Plata horticultural belt. They were selected several weed species previously recorded as supporting high, medium and low abundance of *Frankliniella occidentalis*, *Frankliniella schultzei* and *Thrips tabaci* - those TSWV vectors reported in Argentine -. Twenty-five flowers by every weed species were considered enough to obtain a minimal error in sampling. The project involves almost three years of field sampling; even preliminary, results from first six months showed a kind of change from those first results after WFT arrival in early '90s. Onion thrips and some local *Frankliniella* species seem to be dominant species at present. This would indicate that weed species might not be as dangerous as thought or WFT dispersion and survival in a weedy environment is not as successful as previously considered.

Key words: weed hosts, breeding hosts, reservoir hosts, virus source

Introduction

An understanding of TSWV vector relationships with specific plant species is important in determining important reservoir hosts (Cho et.al.1986). Agricultural weed species are known to be major sources of TSWV infection within various crops. However, the incidence of TSWV can be quite low in weeds on the sample farms, despite its presence in many distinct host species (Wilson 1998).

It might be possible that weeds are not as dangerous virus and thrips source as commonly considered. There have been extensive and valuable studies on weed hosts for thrips and tospoviruses. More than a hundred weed hosts have been identified around world. However, the only advice offered is to eradicate with no discrimination, every plant surrounding crops.

In La Plata horticultural belt, greenhouses are like small islands within a huge weedland. It would not be possible to eliminate all vegetation without economic or environmental consequences; chemicals, time and combustible spent in weed control, mud, soil erosion, and lack of suitable sites for local fauna and predators.

A more comprehensive view to identify truly risk hosts might be recognise those weed species that really act like 'breeding hosts', 'reservoir hosts', or 'incidental host', in a way similar to that of Teulon et al. (1994). In addition, if only larvae can acquire virus (German et al. 1992), a plant that supports adults in high numbers may indeed act like a dangerous virus source. By establishing a preference degree for weeds, it might be possible to design a management plan for vegetation, in a similar way to that proposed by Chellemi et al. (1994). A three-year project was begun in late spring 2000, in order to establish that preference degree for La Plata horticultural area.

Materials and methods

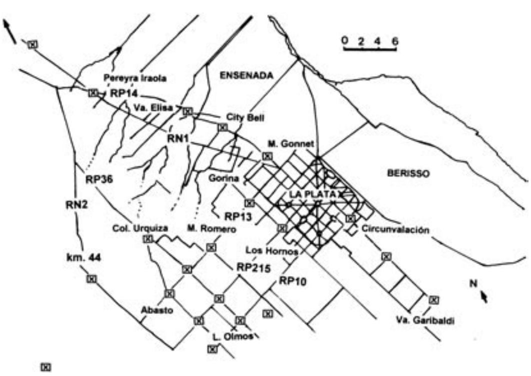
La Plata City is in Buenos Aires Province, 70 km. from Buenos Aires D.C. Sampling sites within La Plata horticultural belt were Gorina Experimental Station, and Pereyra Station - an organic commercial farm - (Figure 1).

Six months - November to April - comprise our main crop season, from late spring to mid autumn. Random plant samples were selected from known host weed species (Carrizo

	Spring			Summer						Autumn		
	1°f	2°f	1°f	2°f	1°f	2°f	1°f	2°f	1°f	2°f	1°f	2°f
	nov-00		dic-00		jan-01		feb-01		mar-01		apr-01	
Baccharis												
Carduus acanthoides												
Cichorium intybus												
Cirsium vulgare												
Conium maculatum												
Convolvulus arvensis												
Cynara cardunculus *												
Dipsacum sativus												
Echium plantagineum												
Hypochoeris												
Lotus tenuis												
Matricaria chaemomilla												
Melilotus alba												
Picris echiodes												
Raphanus sativus												
Raphistrum rugosum												
Solidago chilensis												
Trifolium repens												

* only 16 samples; 1°f = first fortnight; 2°f = second fortnight

Table 1. Survey season for weed species. Gorina and Pereyra sites, La Plata, 2000-2001.



Horticultural belt around La Plata

1996) during their flowering period (Table 1). Flower samples from weed species, were taken fortnightly for exploratory purposes, and to verify previous status. One sampling unit is that smallest blossom unit and it varies between weed species. Fifty sampling units by week and weed species were taken from November 2000 to mid January 2001, and twenty-five sampling units from mid January 2001 to April 2001.

Flowers were placed in plastic bags and kept in a refrigerator until insects were counted. They were dissected and total adults and juvenile forms were extracted and counting from every single bag, using a dissecting microscope (40X). They were separated for major morphological characteristics and three representative specimens from every suspected different thrips species were mounted on glass slides in Faure media. Adults were identified using a compound microscope, descriptions and keys from De Santis (1980), La Rossa (1999), and Mound and Marullo (1996).

Results and Discussion

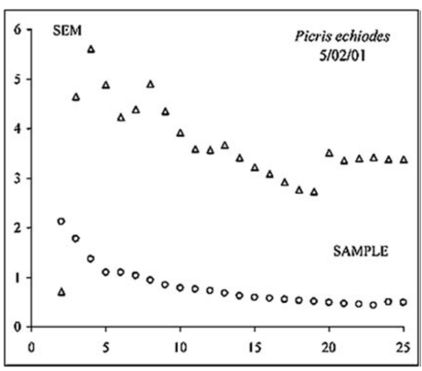
Vasiliu-Oromulu (1993) made a calculation on sample size for thrips community for sweepnet methods and she detected fifty samples was enough for a precision of 80%. During first three months, they were taken fifty samples for weed species. Sample size had to be reduced in the second part of this survey because of time required for flower dissection and thrips counting.

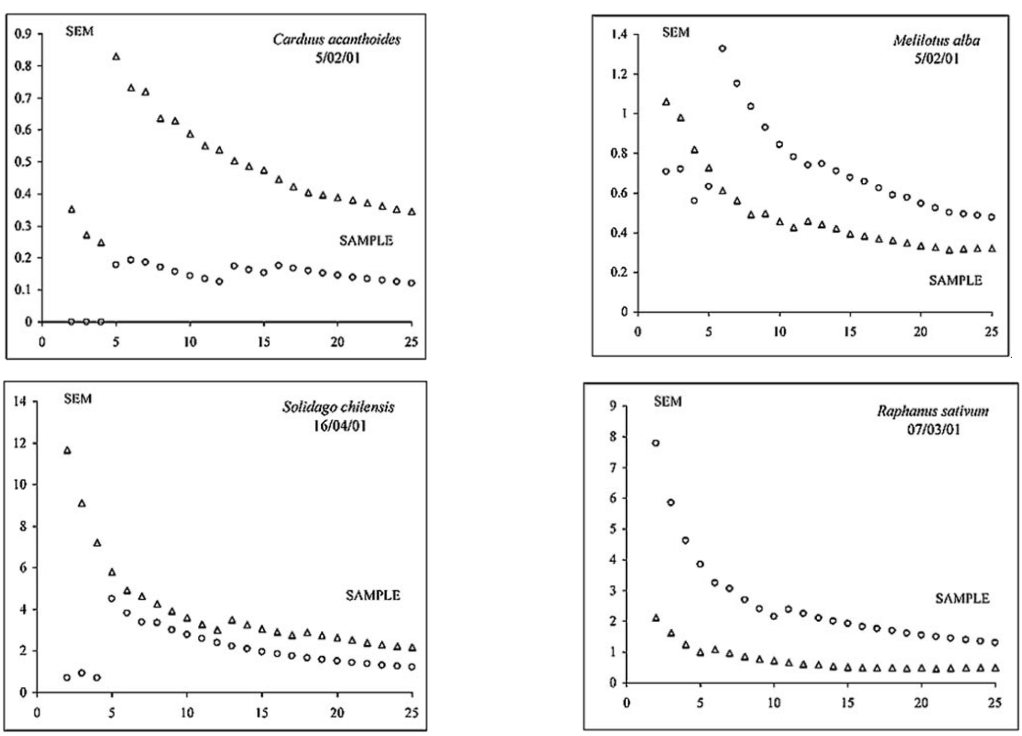
Yudin et al. (1986) selected five units because there was not difference in mean numbers from 5 to 20 samples, where only WFT was present - tested for one weed host -. In surveys it was possible to detect WFT for Chellemi et al. (1994) and Carrizo (1996) by taken only five or six samples by weed species where WFT relative presence was high. However, such sample size was not enough to detect that thrips species in 1998-99 (Carrizo 2001) because of its very low presence - less than 10% -. For a given species in a community, the lower its presence, the higher sample has to be taken in order to detect it.

Figure 2 displays for five different weed species and three different sampling dates, a simple analysis of standard error of mean, diminishing by increasing sample size. This test was chosen to overcome such a diversity of architecture and size of weed host sampled. This error attained its lowest value by using twenty-five sampling units. Consequently, this sample size was succeed to stabilise standard error in mean abundance, despite of differences between weed flowers, development stage of thrips and season.

Thrips species in weed hosts

In Figure 3, they were drawn thrips species found in all weed species sampled, first grouped by their family, and secondly by flowering season. It is necessary to explain nomenclature used for thrips species: *F. rodeos* is actually a complex of two or presumably three species: *Frankliniella*





References: SEM = standard error of mean; triangle = adult forms; circle = immature forms

Figure 2. Analysis for standard error of mean for five weed species and three sampling dates. La Plata, 2000-2001.

rodeos, *F. gemina* and *F. allochroos* (females). They are all yellowish and very similar, not discernible because of the way they were separated under the dissecting microscope. They are known only from South America (De Santis 1980) and we know almost nothing about their biological features. *F. rodeos*? is a non identified yellowish male, always related to the presence of those *Frankliniella* females.

As drawn in Figure 3, every weed species has it own thrips community, not because of thrips species but because of their relative presence, with a few exceptions. *Echium plantagineum* was the only showed a relatively high presence of *Aeolothrips* already reported from earliest local studies (Carrizo 1996). There was not other weed host with such a community structure; it may have some additional interest, since it is a predator species. Vasiliu and Banită (1977) reported for *Aeolothripidae* a secondary importance in their study. Later, Vasiliu-Oromulu (1993) mentioned two *Aeolothrips* species as relevant species, mostly in vernal situations and always referred to grass and cereal cultures. Although it is not possible to affirm what produces that preference for this particular weed host, it should notice about its hairy structure.

Also different from general trend, were *Picris echiodes* and *Hypochoeris* with a dominance of *Tenothrips frici* (higher than 70% of individuals). On the other hand *Conium maculatum* and *Convolvulus arvensis*, *Trifolium repens*, *Raphanus sativus* and *Melilotus alba* showed a dominance for *Thrips tabaci* (about 60% of individuals). The remainder hosts offered an arrangement where WFT is not the predominant one, despite of previous reports for the same area (Carrizo 1996).

All weeds supported a complex of onion thrips and native *Frankliniella* species, reported for studies in 1998-99 (Carrizo 2001). For those surveys, it was thought a consequence of location since it was carried out in experimental plots inside La Plata City, and disconnected from the main producing area (Figure 1). Greenhouse abundance is quite lower at Gorina and Pereyra sites, but they are within horticultural belt.

Yudin et al. (1986) sampled forty-five crops and weeds, and reported only WFT occurs as a flower-inhabiting thrips species. It might be attributed to the small sample size, but Carrizo (1996 and 2001), Chellemi et al. (1994), and Doederlein and Sites (1993) found more than four thrips species, by taking such a low sample size for each weed plant. Only in *Festuca rubra*, or *Phleun pratense*, Vasilieu-Oromulu (1993) found six different thrips species, from five different genera, and in field crops Eckel et al. (1996) found a community with more than 20 thrips species.

Stobbs et al. (1992) sampling of weeds and native plant species across southern Ontario in 1990 failed to reveal any evidence of TSWV or WFT in field vegetables, though they both were introduced in 1989. They explained several factors were likely responsible for this, including a cool wet spring in previous year, and the apparent failure of the WFT to overwinter. In our horticultural belt, because of greenhouses in the same area, this species does not need wild plants outdoors to overcome a hard winter; flowers and temperatures indoors should be enough to survive. In past two years we had cooler and wetter springs, but we have mid temperate climate and have long warm summers. It should ensure WFT produces offspring and disperses itself, unless something else is disturbing it.

The thrips species responsible for primary spread of TSWV into field crops is likely to vary spatially in a large area; however, it is not known what a large enough area means for WFT. Latham and Jones (1997) in field crops reported an infection lower than 5% within a single row, if it was more than 12 meters apart from the main virus source, an adjacent crop with TSWV and WFT. As drawn in Figure 1, main greenhouses area - Col. Urquiza, L.Olmos - are about 10 or 20 kilometres far from Gorina, and about 20 or 30 kilometres far from Pereyra. Then, WFT mobility and survival in a weedy sustenance seems to be quite less than expected since volunteer plants show less dangerous than expected as a WFT source for crops.

Thrips abundance and immature stages in weed hosts

A total of 24,741 adults and 7,401 immature forms were collected. Table 1 (season sampling) early introduced was filled out with thrips abundance (adult and immature stages), to make Table 2. Then, it was represented mean data for all species collected, and zero therefore means weed flowers were collected but no individuals were encountered.

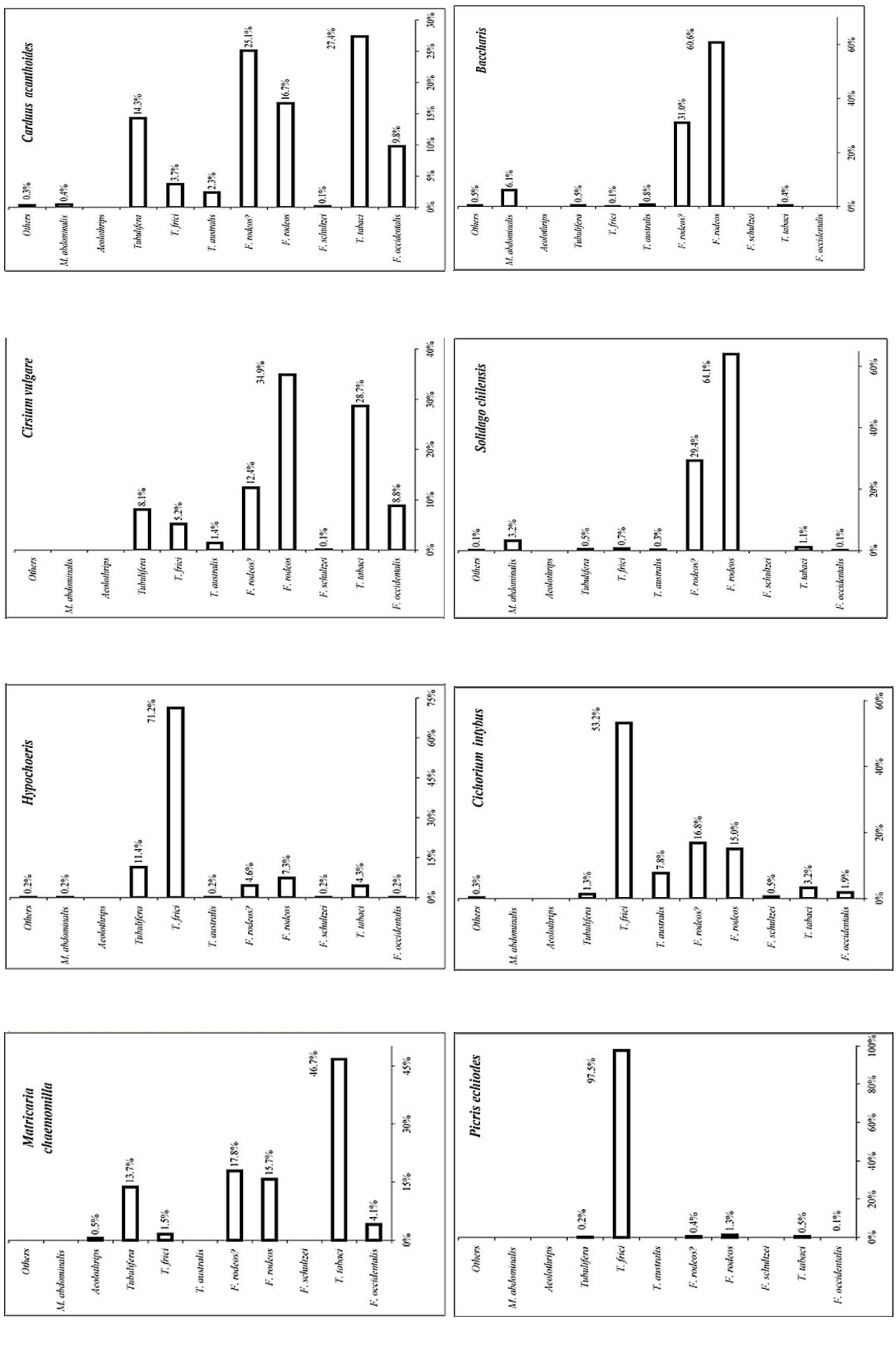


Figure 3. Weed species and thrips species. La Plata, 2000-2001.

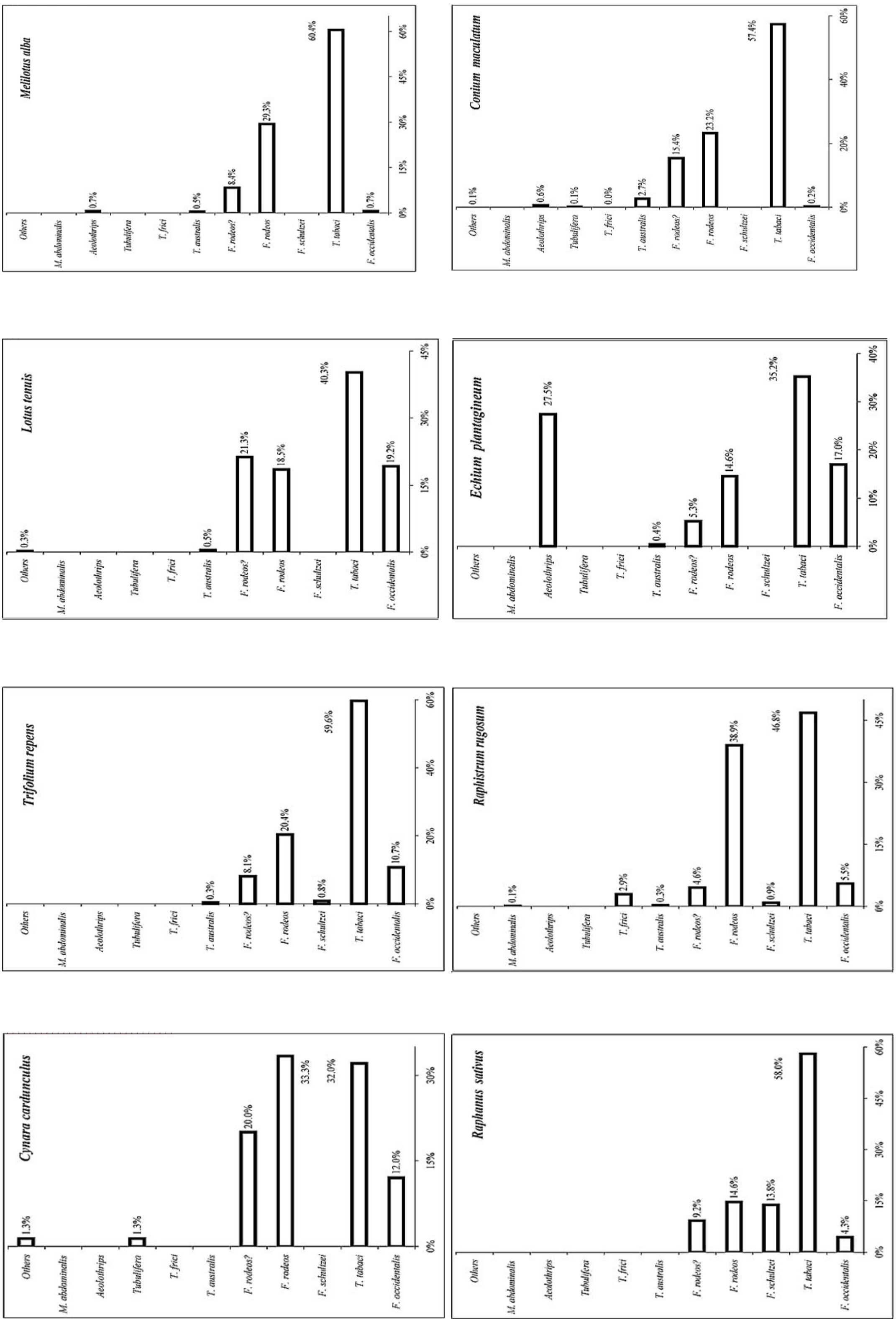


Figure 3. Weed species and thrips species. La Plata, 2000-2001.

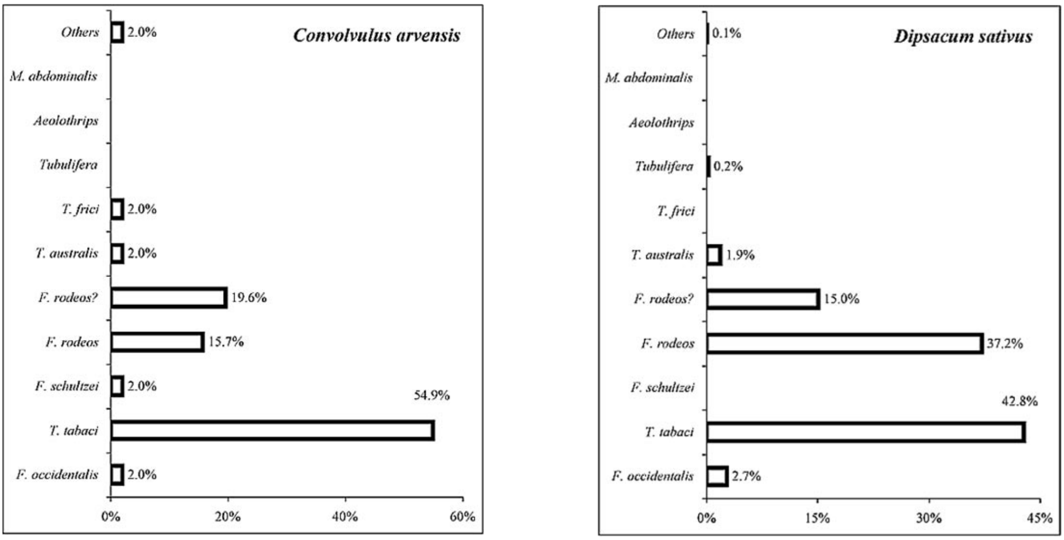


Figure 3. Weed species and thrips species. La Plata, 2000-2001.

Adult abundance varied along season for every weed species, and almost every one has a peak; for example, in *C. acanthoides*, *E. plantagineum*, *Lotus tenuis*, *Matricaria chaemomilla* and *T. repens* it happened at the end of December. For *C. maculatum* and *Dipsacum sativus*, the highest abundance was between that time and the beginning of January; in *Baccharis* flowers the same happened early in April. Nevertheless, this is always about a complex of thrips species not TSWV vectors alone.

As already mentioned, some effort has been spent in identifying those weed species which support the highest thrips abundance. However, thrips abundance alone is not meaningful if does not have information about species supported. Abundance parameter as a tool by itself might be a dangerous one to decide what weed species should be eradicated as proposed by Chellemi et al. (1994). In Table 2, thrips abundance in *C. maculatum* probably mirrored *T. tabaci* abundance; similarly, insect abundance in *P. echiodes* probably copied *T. frici* changes. Moreover, thrips abundance in *E. plantagineum* probably reflected those from of *T. tabaci* and *Aeolothrips*, being WFT less than 20% (Figure 3). If relative abundance of main vector is not high, a correlation between thrips abundance and vector abundance could be obtained only because of abundance trends.

Trends in Figure 3 shows abundance for immature stages had peaks in almost every weed species. Even their identity has been not yet verified, probably most of them will be not WFT, since most of adults were not. Several of those peaks for juvenile stages are next to adult peaks, and some of them are at the end of blossom period. It supposes these last developed into adults, and migrated to any other available flower as usual in decaying crops.

When a single female is maintained in a controlled and favourable environment, Stobbs et al. (1992) considered a weed host as a potential oviposition host if one immature survives seven days later. Teulon et al. (1994) proposed two categories of breeding hosts, depending on documentation clearly identified about the presence of adults, eggs and larvae. Information collected here is not so detailed. However, in a population census data, its button should be wider than the top. Therefore, immature counts should be at least as high as adult counts to ensure its survival on a host, if that is a breeding host. It is already known it is not that easy since the half of life cycle in thrips is spent as a pupa, not inside flowers, then population records usually misses that developmental stage. With this additional care in analysis for immature data, the remainder hosts should be qualified as incidental hosts as named by Teulon et al. (1994).

	Spring			Summer						Autumn			
	1°f	2°f	1°f	2°f	1°f	2°f	1°f	2°f	1°f	2°f	1°f	2°f	
	nov-00		dic-00		jan-00		feb-00		mar-00		apr-01		
Baccharis									0.00	2.60	10.24	6.80	ad.
									0.00	*0.00*	*0.14*	*1.12*	*immat.*
C. acanthoides			0.00	14.00	2.50	6.12	1.40	1.16	0.48	0.68	0.44	0.63	ad.
			0.00	*7.16*	*1.26*	*0.50*	*0.18*	*0.04*	*0.00*	*0.00*	*0.08*	*0.05*	*immat.*
C. intybus	1.38	0.08	0.60	0.12	0.15	1.31	0.74	1.24	1.64	0.20	0.04	0.72	ad.
	0.00	*0.04*	*0.00*	*0.02*	*0.07*	*0.20*	*0.68*	*0.92*	*0.00*	*0.02*	*0.04*	*0.00*	*immat.*
C. vulgare			0.00	2.08	9.54	6.22	4.18	3.20	0.52	0.60	0.80	0.00	ad.
			0.00	*0.36*	*0.68*	*0.10*	*0.06*	*0.12*	*0.00*	*0.00*	*0.04*	*0.00*	*immat.*
C. maculatum	4.84	1.34	3.88	31.96	22.88	7.02	1.58	0.00	0.00				ad.
	0.96	*6.32*	*4.24*	*15.40*	*4.56*	*4.74*	*11.52*	*0.04*	*0.00*				*immat.*
C. arvensis	0.01	0.10	0.26	0.14	0.21	0.08	0.48	0.05	0.00				ad.
	0.01	*0.04*	*0.00*	*0.04*	*0.00*	*0.00*	*0.00*	*0.16*	*0.00*				*immat.*
C. cardunculus		0.00	9.83	4.40	0.00								ad.
*		*0.00*	*0.80*	*0.33*	*1.50*								*immat.*
D. sativus			0.00	1.56	10.26	6.06	0.00						ad.
			0.00	*1.08*	*1.28*	*0.48*	*0.00*						*immat.*
E. plantagineum	0.16	0.60	0.78	3.66	0.88	0.30	0.00						ad.
	0.13	*4.42*	*6.40*	*1.83*	*2.52*	*0.14*	*0.00*						*immat.*
Hypochoeris	0.24	0.08	0.76	0.56	0.63	1.01	3.36	1.04	0.00				ad.
	0.00	*0.02*	*0.00*	*0.00*	*0.00*	*0.15*	*0.34*	*0.08*	*0.00*				*immat.*
L. tenuis		0.12	0.58	3.24	0.30	1.00	1.08	0.92	0.04	0.00			ad.
		0.04	*0.04*	*0.80*	*0.09*	*0.13*	*0.30*	*0.32*	*0.04*	*0.00*			*immat.*
M. chaemomilla	0.21	0.34	0.94	1.38	0.72	0.08	0.00						ad.
	0.31	*2.42*	*0.16*	*2.26*	*5.44*	*0.00*	*0.00*						*immat.*
M. alba				0.00	1.37	3.17	1.92	1.04	0.16	0.00			ad.
				0.00	*3.24*	*1.29*	*2.00*	*0.64*	*1.00*	*0.00*			*immat.*
P. echiodes	0.12	0.26	0.30	0.40	1.16	11.45	36.42	6.84	5.60	5.30	3.80	0.00	ad.
	0.00	*0.08*	*0.00*	*0.16*	*0.11*	*1.58*	*1.32*	*1.32*	*0.00*	*0.00*	*0.08*	*0.00*	*immat.*
R. sativus	0.18	2.20	2.06				0.00	2.32	3.32	0.00			ad.
	0.10	*0.48*	*0.50*				*0.00*	*7.08*	*4.08*	*0.00*			*immat.*
R. rugosum	0.25	3.88	1.60	0.86	1.02	4.06	1.76	0.76	0.76	0.14	0.64	0.92	ad.
	0.15	*9.12*	*3.16*	*0.12*	*7.28*	*5.54*	*4.88*	*3.76*	*1.44*	*0.06*	*1.44*	*0.68*	*immat.*
S. chilensis								0.00	13.64	16.06	17.02	14.88	ad.
								0.00	*0.92*	*0.00*	*0.46*	*1.64*	*immat.*
T. repens	0.14	0.16	1.42	3.56	1.50	1.26	0.94	0.87	0.00				ad.
	0.02	*0.06*	*0.06*	*0.84*	*0.25*	*0.08*	*0.10*	*0.00*	*0.00*				*immat.*

* only 16 samples; 1°f = first fortnight; 2°f = second fortnight; ad.= adult stage; immat. = immature stage

Table 2. Mean abundance of thrips in weed species. Adult and immature stages. Gorina and Pereyra sites, La Plata, 2000-2001.

Concluding remarks

Chellemi et al. (1994) proposed that wild plant host with high thrips populations may be targeted for removal, pesticide application or surveyed for the detection of TSWV vectors. They validated a correlation between abundance of thrips fauna and TSWV vectors in flowers, then suggested reasonable take thrips abundance as an indicator of TSWV vectors at any time. In previous surveys Carrizo (1998) proposed some similar, being WFT the dominant thrips species in most weeds collected. In agreement with Chellemi et al. (1994) proposal, it should be remember they found a mix of *Frankliniella* species, being not WFT the dominant one. Moreover, they called attention about a change in thrips species dominance along months; then, abundance trends are not a robust index of risk for weed hosts.

Results presented here showed an important presence for native fauna and predator thrips that may be also targeted if not care is applied to select what weed species is removed. The associated fauna could be playing a role in thrips community, to keep vectors abundance lower - by competition or predation - than expected if they were no present. Diversity of thrips fauna worth to be sheltered in weeds not favourable for main TSWV vector. Then, the best program for weed management may be matter of weed species to be targeted in a particular time for a given surface around greenhouses.

This study focused on WFT as the primary interest because of the role stressed on weed host, as a risk of inoculum source for this species. Indeed, this risk has been related to thrips abundance, being WFT the main species since *T. tabaci* is not a vector in several regions (also Argentina) and *Frankliniella schultzei* does not perform as capable to spread itself in our environmental conditions. Future interest should be stressed on the whole thrips community inhabiting flowers of weed host, and not to exclude native and well adapted thrips fauna inhabiting and sharing the same habitat. No matter how cosmopolitan WFT seems to be or how prevails in greenhouses, it should expect a different community composition outdoors. After its arrival to a new environment, a community arrangement will be an outcome of interactions no feasible to repeat everywhere. Nevertheless, its behaviour outdoors may help to learn through that outcome, by means of a higher effort in studies about local faunas, and more attention invested on dispersion characteristics of thrips vectors, especially WFT.

Additionally, it may raise some hypothesis for discussion because of differences between earliest results (Carrizo 1996 and 1998), those from 1998-1999 (Carrizo 2001) and last presented here. It may be related with the not yet known mobility and reproductive features of vectors on weeds - specifically WFT -, our ignorance about biological characteristics for native species plus the possible interactions emerged. Indeed, there would be some evidence supporting a weak capability of WFT to spread itself beyond greenhouses perimeter. Surveys carried out in San Pedro (La Rossa, unpublished data) showed that WFT could not be find in discernible numbers only fifty meters away, from a pepper greenhouse crop. Most of data previously reported (Carrizo 1996 and 1998) came from samples collected just around greenhouses' boundaries.

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