Population dynamics and natural enemies of the tobacco aphid (*Myzus nicotianae* Blackman) in central Chile

FUENTES-CONTRERAS EDUARDO, BASOALTO ESTEBAN, MUÑOZ CRISTIÁN, GAETE-EASTMAN CARLOS, PERALTA GERALDINE, CARRASCO CLAUDIO

Abstract

Since 1998 the tobacco aphid (*Myzus nicotianae* Blackman) has been reported producing severe damage to the tobacco (*Nicotiana tabacum* L.) industry in central Chile. Chemical control is used continuously against this aphid during the growing season, with little information about flight periods of the alates and subsequent colony development in the field. We studied the population dynamics of this aphid in one locality of central Chile, using Möericke yellow traps and sampling tobacco leaves in fields with and without pesticide applications. Our results indicated that during the 2000-2001 season, the alates were present late in the summer season (end of January), coincident with colony development on tobacco under field conditions, for both insecticide treated and untreated plants. Natural enemies were observed to be active during the whole season in the insecticide-free tobacco plants. The most important species were the coccinellids *Eriopis connexa* (Germar) and *Hippodamia variegata* (Goeze), while parasitoids were represented mainly by the generalist *Praon volucre* (Haliday). The results of the 2000-2001 evaluations indicated that the standard pretransplant application of insecticide against *M. nicotianae* was not necessary, as well as the summer treatments since natural enemies were able to maintain the aphid population below the economic threshold. The aphids were subjected to esterase analysis that revealed its susceptibility to conventional organophosphate and carbamate insecticides.

Introduction

The tobacco aphid *Myzus nicotianae* was described by Blackman (1987), as a new species distinct from *Myzus persicae* (Sulzer) by morphometric characters and its close association with tobacco (*Nicotiana tabacum* L.) as main host-plant. These populations were initially thought as permanently anholocyclic on tobacco and hence reproductively isolated from *M. persicae*. However, more recent studies have shown that some level of hybridisation may exist, which does not support the species status of *M. nicotianae* (Margaritopoulos *et al.*, 1998; 2000; Clements *et al.*, 2000). From 1998 to 1999 important outbreaks of a red morph of *Myzus* were observed for the first time in tobacco fields in Chile. Morphometrically they were identified as *M. nicotianae* (Fuentes-Contreras *et al.*, in press). Significant yield losses, as well as the apparent resistance toward traditional organophosphate insecticides associated with this aphid species, lead the tobacco growers to increase the application of insecticides. This chemical control strategy has been widely implemented, with little information about flight periods of the aphids and subsequent colony development in the field, as well as about the natural enemy species that may be acting as biocontrol agents. Therefore, we studied the population dynamics of this aphid and its natural enemies in one locality of central Chile, using Möericke traps and sampling tobacco leaves in experimental plots with and without pesticide applications. In addition, in order to estimate the impact of the insecticide applications on the yield of tobacco, we evaluated the weight at harvest of tobacco from these experimental plots.

Materials and methods

The field of tobacco used in the evaluations was located at Estación Experimental Panguilemo, Universidad de Talca, Chile (35° 26' S, 71° 40' W). An experimental area of nearly 0.15ha was cultivated with Burley tobacco CV BY64 (Profigen do Brazil Ltd.), according with the specifications followed by Compañía Chilena de Tabacos. Six blocks of $137m^2$, with nearly 312 tobacco plants each, were divided in two halves (plots) which were randomly assigned to the treatments with or without insecticide applications. Aphid population dynamics and natural enemy species composition and diversity were evaluated using Möericke traps (circular yellow trays, 40cm in diameter, filled with 10% formaldehyde) located in each plot. The development of aphid colonies on tobacco plants was evaluated by recording the number of aphids in 10 plants randomly selected in each plot. Tobacco plants, once selected, were marked and used in all subsequent sampling dates. On each plant the numbers of aphids on four leaves (larger than 10cm) were counted, including the individuals that were at the right side of the mid-vein, between the fourth and sixth lateral veins of the lower (abaxial) side of the leaves, such as described by Reed and Semtner (1992). From this section of the tobacco leaves, a sample of 100 apterous aphids were removed and transported to the laboratory, to evaluate the level of parasitism in the field. All evaluations were performed weekly from tobacco transplant (November 5^{th}, 2000) to harvest (March 22^{nd}, 2001). All *Myzus* spp. aphids collected from Möericke traps were slide-mounted and identified using Blackman (1987) morphometric key as *M. persicae* or *M. nicotianae*.

Tobacco plants subjected to the insecticide treatment received an Orthene 75 SP (a.i. acephate) application on seedbeds in October 20^{th} 2000, at a dose of 2.5g/l. Later a drench application of Confidor Supra 51% WP (a.i. imidacloprid + cyfluthrin), two days before transplant at a dose of 1.8g/l was also performed. Finally, 52 days after transplant (December 26^{th}, 2000) an application of Dipel 2X (a.i. *Bacillus thuringiensis* var. *kurstaki*) at a dose of 2.1g/l was applied to reduce damage by lepidopterous larvae. On the contrary, tobacco plants subjected to the insecticide free treatment only received a similar volume of tap water at the same dates.

At the end of the season, tobacco yield was compared from plots with and without insecticide applications. In each plot the fresh weight of 32 randomly selected tobacco plants was individually recorded and averaged to avoid pseudoreplication. A single value per plot was used in an ANOVA with treatment (with or without insecticides) and block as main effects. Finally, in order to evaluate the potential resistance of tobacco aphids toward organophosphate and carbamate insecticides, a sample of ten adult apterous aphids was subjected to evaluations of the total esterase activity, following the methodology of microplate assay described by Devonshire *et al.* (1992).

Results and discussion

Population dynamics of *Myzus* spp. alate aphids from plots with and without insecticides are shown in Fig. 1. Subsequent mounting and morphometric identification of *Myzus* spp alates revealed that all aphids trapped in the November flight were *M. persicae*, whilst over 90% of the aphids collected on January-February were *M. nicotianae*. Consistently, apterous *M. nicotianae* on tobacco plants (Fig. 1) appeared from late January until harvest in March. Although alate *M. nicotianae* from Möericke traps were present in plots with and without insecticides (Fig. 1), apterous of this species were able to produce dense colonies only on insecticide free plots (Fig. 1).

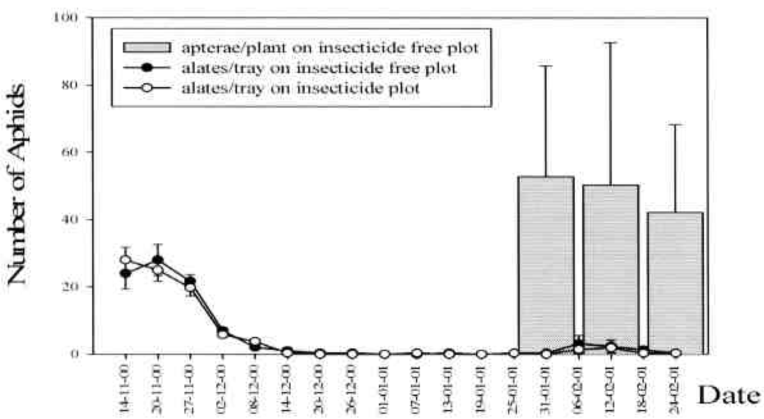

Figure 1: Abundance of *Myzus* spp. aphids in Moericke traps and tobacco plants from plots with and without insecticides. Error bars represent one standard error.

Although no aphicides were applied after transplant, even in the insecticide treated plots, the absence of colonies of *M. nicotianae* might be related with the pretransplant application of imidacloprid. This insecticide has a long residual effect on *M. nicotianae*, estimated around 80 days under field conditions in Chile (Burgos, 2000). This resulted in tobacco plants that allowed aphid settlement only during February and March, a situation that did not occur probably because at this time natural enemies were very active.

Natural enemy species richness and diversity obtained from Moericke traps in untreated plots was higher than in insecticide treated plots (Table 1), with the coccinellids *Eriopis connexa* (Germar) and *Hippodamia variegata* (Goeze), and the generalist parasitoid *Praon volucre* (Haliday) as the most abundant species. Parasitism in the aphid colonies on tobacco was produced only by *P. volucre* reaching up to 5%, a low level that could be associated with the dense colonies developed by this aphid on leaves heavily covered by adhesive trichomes, which may enhance aphid defence against natural enemies of small body size like parasitoids. Wells and McPherson (1999) in Georgia (USA), also detected an apparently predominant influence of coccinellids over parasitoids, but Lykouressis and Mentzos (1995) in Greece reported a higher importance of parasitoids and entomopathogenic fungi as biocontrol agents of *M. nicotianae* on tobacco.

Table 1: Cumulative abundance of aphidophagous Coccinellidae and Braconidae collected with Moericke traps from plots with and without insecticides.

Species	Insecticide Treated	Insecticide Free
Coleoptera, Coccinellidae		
Eriopis connexa	18	95
Hippodamia variegata	25	55
Adalia bipunctata	0	28
Hyperaspis sp	0	2
Hymenoptera, Braconidae		
Praon volucre	7	48
Aphidius ervi	0	11
Diaretiella rapae	1	5
Shannon Diversity Index	1.08	1.55

Tobacco yield in insecticide treated plots was 2.78 ± 0.22kg/plant (around 63.3ton/ha), while on insecticide free plots it was equal to 2.69 ± 0.42kg/plant (around 61.5ton/ha), with no statistical differences between them (MS = 0.0056, $F_{(1,5)}$ = 0.1342 , P = 0.73, N.S.) or between blocks (MS = 0.1823, $F_{(5,5)}$ = 4.3616, P = 0.06, N.S.). Therefore, the application of insecticides did not significantly increased yield, which may be explained by the low aphid density observed even in the insecticide free plots. Esterase activities of field collected aphids from the experimental field at Panguilemo showed a level of 13.51 ± 1.13 (μM 1-naphtol mg^{-1} $aphid^{-1}min^{-1}$), which was rather close to the mean level of 19.76 (μM^{-1}-naphtol mg^{-1} $aphid^{-1}min^{-1}$) shown by the insecticide susceptible clones of *M. nicotianae* studied in North Carolina (USA) by Harlow and Lampert (1990). This low level of esterase activity indicates that the aphids collected on tobacco at Panguilemo were susceptible to the traditional organophosphate and carbamate insecticides.

The late detection of alates and colonies of *M. nicotianae* on tobacco plants during the 2000-2001 season in the area of Talca, Chile, as well as the organophosphate and carbamate susceptibility of the aphids found, suggest that insecticide applications against this aphid could be reduced with no major impact on tobacco yield. This might result in an increase of natural enemy activity and reduction of the risk of build-up of insecticide resistance of this aphid.

Acknowledgements

This work was supported by FONDECYT 1000079. This research is part of the activities of the Centre for Advanced Studies in Ecology and Research in Biodiversity funded by the Millennium Scientific Initiative (P099-103-F ICM).

References

BLACKMAN R.L., 1987. Morphological discrimination of a tobacco-feeding form from *Myzus persicae* (Sulzer) (Hemiptera: Aphididae), and a key to New World *Myzus* (*Nectarosiphon*) species. *Bull. Entomol. Res.* 77, 713-730.

BURGOS R., 2000. *Evaluación del efecto de aplicaciones de Imidacloprid para el control de* Myzus nicotianae *Blackman, como vector de virosis en tabaco*. Agr. Eng. Thesis, Universidad de Talca. 80 pp.

CLEMENTS K.M., SORENSON C.E., WIEGMANN B.M., NEESE P.A. & ROE R.M., 2000. Genetic, biochemical, and behavioural uniformity among populations of *Myzus nicotianae* and *Myzus persicae*. *Entomol. Exp. Appl.* 95, 269-281.

DEVONSHIRE A.L., DEVINE G.J. & MOORES G.D., 1992. Comparison of microplate esterase assays and immunoassay for identifying insecticide resistant variants of *Myzus persicae* (Homoptera: Aphididae). *Bull. Entomol. Res.* 82, 459-463.

FUENTES-CONTRERAS E., BURGOS R., LAVANDERO B. & MUÑOZ C., Presencia en Chile del áfido *Myzus nicotianae* Blackman y su importancia para la producción de tabaco. *Rev. Chil. Entomol.* 28, in press.

HARLOW C.D. & LAMPERT E.P., 1990. Resistance mechanisms in two colour forms of the tobacco aphid (Homoptera: Aphididae). *J. Econ. Entomol.* 83, 2130-2135.

LYKOURESSIS D.P. & MENTZOS G.V., 1995. Effects of biological control agents and insecticides on the population development of *Myzus nicotianae* Blackman (Homoptera: Aphididae) on tobacco. *Agri. Ecosyst. Environ.* 52, 57-64.

MARGARITOPOULOS J.T., ZISSIS M. & TSITSIPIS J.A., 1998. Attempted discrimination of *Myzus persicae* and *Myzus nicotianae* (Homoptera: Aphididae) by random amplified polymorphic DNA chain reaction technique. *Ann. Entomol. Soc. Am.* 91, 602-607.

MARGARITOPOULOS J.T., TSITSIPIS J.A., ZINTZARAS E. & BLACKMAN R.L., 2000. Host-correlated morphological variation of *Myzus persicae* (Hemiptera: Aphididae) populations in Greece. *Bull. Entomol. Res.* 90, 233-244.

REED T.D. & SEMTNER P.J., 1992. Effects of tobacco aphids (Homoptera: Aphididae) populations on flue-cured tobacco production. *J. Econ. Entomol.* 85, 1963-1971.

WELLS M.L. & MCPHERSON R.M., 1999. Population dynamics of three coccinellids in flue-cured tobacco and functional response of *Hippodamia convergens* (Coleoptera: Coccinellidae) feeding on tobacco aphids (Homoptera: Aphididae). *Environ. Entomol.* 28, 768-773.