SUSTAINABLE POME FRUIT PRODUCTION IN PATAGONIA, ARGENTINA

PROFESSIONAL PAPER

V. Sfara[1*], T. Fonovich[2], C. Pérez-Coll[1,2]

[1]Environmental Engineering and Research Institute; [2]School of Science and Technology.
National University of San Martín.
Av. 25 de Mayo y Francia (1650), San Martín, Prov. de Buenos Aires
*Corresponding author: vsfara@unsam.edu.ar

ABSTRACT

Apple and pear production in Argentina mostly takes place in the provinces of Río Negro and Neuquén, along a valley located in an area irrigated by the rivers Neuquén, Limay and Negro. Most commonly agrochemicals applied for these cultures protection are pesticides against mite and codling moth (*Cydiapomonella*, L). Carbaryl,azinphos-methyl and dimethoate have been recently detected and quantified in water samples from these rivers. Heptachlor, was also found sporadically, despite its use is forbidden in our country. Although these organophosphorus pesticides use is allowed, dimethoate and azinphos-methyl, as well as carbaryl are harmful substances that exert adverse effects through inhibition of cholinesterases and carboxylesterases. Also they are responsible of eliciting antioxidant responses in different organisms. Fruit production in this region became more sustainable in the last years as the consequence of government prohibition on the use of old generation pesticides and the introduction of new generation ones. A National Program designed to avoid codling moth damage, through a sexual confusion method, was implemented in 2006. The codling moth induced damage reached 6,1% of total production in 2003 in farms that were afterwards included in the Program, and 0,73% of it, after 3 years of program development; and at the same time there was a 385 ton/year decrease in azinphos-methyl use. Improvement in management techniques for pests as San José louse and European red mite, as well as government programs for their control promoting the use of non-toxic natural compounds, will certainly contribute to achieve sustainable fruit production in Patagonia.

Key words: fruit production, apple, pear, pesticides, sexual confusion control.

INTRODUCTION

The requirements of food in the last decades produced an expansion of the agricultural areas and an increase in the use of agrochemicals, such as pesticides and fertilizers, to reach greater crop yields. Pest control is a fundamental tool to increase crop productivity, since the economic loss due to pest damage is very high. It has been calculated that there would be a loss of the third part of the total global food production if agrochemicals were not used to control pests and crop diseases. However, the excessive use of pesticides can cause air, soil and water pollution. After application, pesticide formulations are distributed in all environmental compartments in relation to their physicochemical properties. In this way, the active principle as well as the excipients and the degradation products, interact with the soil matrix, eliciting changes in their structure and chemical composition. Weather conditions also influence the fate of pesticides, because they can be transported by the wind several kilometers away from the application site. Finally, pesticides and their degradation products can reach surface and underground waters, by means of transport phenomena such as leaching or run-off. Pesticide residues have also an impact on non-target species, including humans, causing acute and chronic intoxications that lead to different type of diseases.

On the other hand, taking into account the economic aspect of food production, the presence of residues of certain pesticides restrict or avoid the possibility to export the production of crops, such as fruits, from Latin American countries to United States and Europe. Thus, it became evident the need for development of novel strategies replace

or decrease the use of synthetic pesticides. The purpose of the present paper is to describe one Argentinian program already implemented and compare it with other experiences.

Fruit production: Damages on pome fruits by insect pests and climate conditions in the Alto Valle

Agriculture in Argentina is centered on the production of wheat, corn, sunflower, soya, tobacco, cotton, potato, grape, stone fruits, pome fruits and others [1].1.8 million tons of pome fruits are produced annually in Argentina, distributed equally between apples and pears. 85% of the apples and 75% of the pears are produced in the Alto Valle of Río Negro and Neuquén provinces, in the north of the Patagonia region, among the basins of the rivers Neuquén, Limay and Negro.

There are several species of arthropods that cause damage to pome fruit plantations in the Alto Valle region. The most conspicuous are four species of mites, some homopterans such as mealybugs, aphids and leafhoppers, the lepidopterans*Cydiapomonella*, *Cydiamolesta* and *Oiketicusplatensis*, and, in a lower extent, thrips and pear psylla. Due to its distribution and to the magnitude of the damage it causes, *Cydiapomonella* is the most important pest of fruit cultures in the Alto Valle. This pest can elicit a loss of the 80 to 100% of the total pome fruit production, if it is not controlled. The Alto Valle is characterized by a continental climate, which is temperate and arid.This region soil is mostly composed by sand and silt, with a relatively high rate of infiltration. It has a high salt content but a low content of organic matter. Rain is scarce in the whole area, reaching 200 mm/year. Annual media temperature is 14°C, reaching 40°C in summer and -13°C in winter [2,3]. All of these conditions are favorable for fruit production.

This zone is often affected by strong westerly winds, with gusts reaching velocities as high as 80 to 100 km/h, southern-west winds and by occasional hail in summer. Frost taking place during springtime, generally causes serious damage to the fruit cultures.These climate conditions demand extra economical and working efforts to farmers, in order to implement active protection measures. Poplar plantations are used to protect the fruit cultures against the winds. To avoid the damage caused by the frost, sprinkler irrigation systems are used, as well as heaters. In many cases farmers burn different materials to produce heat [4], but the smoke originated in this combustion is a source of pollutants that can affect people living in the neighboring towns. The only protection against hail available for farmers to count on is to pay insurance policies. Table 1 summarizes old and new generation control methods usually implemented by farmers in the recent past years to ameliorate damage caused by pests and climatic factors.

Table 1. Methods used to ensure acceptable levels of fruit production and quality in Patagonia, Argentina

Month/season of application	Pest/Frosts	Control method
September-October	Frost	Smoke (tire burning), heaters (fuel combustion), irrigation
October (1st generation) December (2nd generation)	*Cydiapomonella*(Codling moth)	SCT (Sexual confusión technique); Granulosis virus
November to May	*Quadraspidiotusperniciosus* (San Joselouse)	Insecticides (buprofezin, metomil, spirotetramat, clorantraniliprole + lambdacialotrina + suprathion, acetaminoprid) ; Calcium polysulfide (organic production);Oils
October to March	*Cydiamolesta* (Grapholite)	SCT;OrfamoneBaits
Spring and end of summer	*Panonychusulmi* (European red mite)*Psyllapyricola* (psyllids)	Oils; Abamectine
End of February	*Phitoptuspyri*	Sulfur-based products; Acaricides (endosulfan)

Data from INTA (2014) [8]

Pesticides in use for pest control and contamination of environmental compartments

Pome fruit production in Argentina occupies the fourth place of the agricultural activities requiring the use of great amounts of pesticides. Insecticides are widely used for pome fruit production and belong to group Ib (very toxic) according to toxicological risk classification by WHO. Loewy et al (2000) have made a complete report on some pesticides found in groundwater of the Alto Valle and their concentration, during 1996, 1997 and 1998 [5]. The list included dimetoate, metidathion, methylazimphos, fosmet, cypermethrin, carbaryl, propoxur, carbofuran, benomil and carbendazim. More recently, other authors have monitored pesticide concentrations at different locations and months of the year 2005, in water and sediments of the rivers Negro, Limay and Neuquén [6]. They found levels of the organophosphorus insecticide dimetoate (moderately toxic) between 0,085 and 0,0934 mg/l in superficial water of the Neuquén river, and traces of carbaryl (carbamate), methylazinphos (organophosphate) and heptachlor (organochlorinated compound). Though these concentrations were well below established limits by World Health Organization [7] for potable water, it is of concern that they were found in river waters after reaching groundwater.

Semiochemicals. Use of the sexual confusion technique (SCT) to control the codling moth in pome fruit production of the Alto Valle

Fruit producing countries are continuously looking for alternatives to old generation insecticides use. New integrated pest management programs are being implemented and include the use of more selective and non-pollutant products, such as botanical insecticides or repellents, insect growth regulators, or behavior modifiers, combined with cultural practices.

The use of semiochemicals (allelochemicals and pheromones) as behavior modifiers is one of the most widespread strategies to control agricultural pests.

Pheromones have many advantages to be used for pest control. They are very selective, because of their specificity; the manipulation of pheromones is safe because they are non-toxic, and as they are not persistent, they have a low potential as environmental pollutants.

Sex pheromones are the main tool of the sexual confusion technique (SCT). This method has been successfully implemented to control fruit pests, especially lepidopterans. The sexual confusion technique consists on the application in the field of formulations of a synthetic analog of the sex pheromone produced by females of the species to control, in order to avoid males to locate the females. Pheromones are formulated to permit a constant and prolonged release of the active substance. The concentration reached in the atmosphere is higher than the physiological concentration released by the female in natural conditions, eliciting confusion of males. In 2006 a National Program to eliminate the codling moth in the production of apple and pear in the Alto Valle region was implemented, based on the sexual confusion technique. The program consisted in the use of plastic pheromone emitters, containing the active principle codlemone, in apple and pear trees [9].

The principal goal achieved by the implementation of this program was the decrease in the percentage of fruit (apple and pear) damaged by codling moth from 6,1% to 0,73%in production areas under National Program [9]. Figure 1 shows reduction only in apple production damage both in farms under the program and those outside it (insecticide fumigation and SCT outside the program), along three years of application of this control strategy. The cited reduction percentage represents that 71713 tons of apples are recovered as commercial products, for being free of the damage caused by this pest. At the same time there was a 385 ton/year decrease in azimphos-methyl use [9].

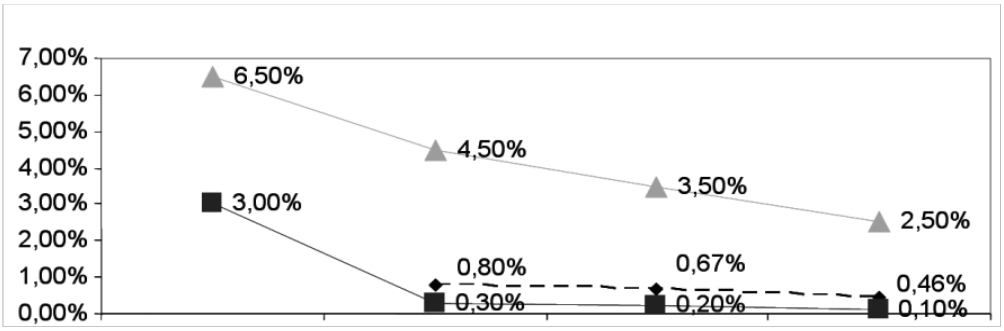

Figure 1. Decrease in the percentage of damage caused by Cydia pomonella in apples after the application of the Program; ▲ = conventional pesticides; ◆ National program SCT and ■ = SCT outside National Program. From http:// www.funbapa.org.ar

The use of this technique has also permitted that Argentinean fruit could overcome a number of restrictions of the international markets regarding the presence of quarantine pests and pesticides residues. The decrease in the use of conventional pesticides causes an increase in the abundance of beneficial species that can eventually act as biological controllers of the pest. Moreover, the development of insecticide resistance is delayed because the exposure of the pests to conventional active principles is lower. In the same way, health conditions of workers and people of the neighboring towns were improved, as the consequence of a decrease in their exposure to old-generation pesticides. Different pome fruit producer countries have implemented similar programs and have also had beneficial effects during pilot experiences. A small pilot test in Asturias has rendered beneficial effects, but only when pheromones were applied after three pretreatments with granulovirus, perhaps due to proximity of farms not participating in the test [10]. Similar results than the ones from the National Program presented here, were obtained in Spain and Italy and have been recently described by Damos et al. [11].

CONCLUSION

While the fight against spring frost and summer hail continue to demand high economical efforts, local farmers have found an important tool in the above mentioned National Program using SCT technique. The proof of Program success is evident as farmers have now to fulfill local government forms on SCT as a mandatory requirement to export their fruit production. The implementation of similar programs against other pests, like San José louse and European red mite, shall constitute other important tools to increase benefits of pome fruit production, together with environment and human health protection, in the Alto Valle of Río Negro and Neuquén.

REFERENCES

1. E.C. Villaamil Lepori, G. Bovi Mitre, M. Nassetta M Rev. Int. Contam. Ambie. 29 (Special Issue on Pesticides) (2013) 25-43.

2. L. Conticello, B. Cerazo, A. Bustamante. Gayana Bot. 59 (2002) 13-20. http://dx.doi.org/10.4067/S0717-6432002000100003

3. Autoridad interjurisdiccional de cuencas. Pronósticos meteorológicos (*Interjurisdictional Watershed Authority. Weather forecasts*) (2015). http://www.aic.gov.ar/aic/prono01.aspx

4. L. Digiacomo. Revista Agrovalle (*Agrovalle Journal*) (2015) http://www.revista-agrovalle.com.ar/info/

proyectos05.htm
5. R.M. Loewy, M. Novelli, L.G. Carvajal, H. Labollita, G. Neme, J. Ramos, C.Saenz , A.M. Pechen de D'Angelo (2000). 1st Joint World Congress on Groundwater.
http://aguassubterraneas.abas.org/asubterraneas/article/viewFile/24298/16307
6. H.P. Boland, M.I. Gil, H.A. Labollita, B.Laurenzano, M.Novelli, J. Ramos, P. Reyes (2007). Congreso Nacional del agua (*National congress on water*). Tucumán, Argentina.
http://www.ecopuerto.com/bicentenario/informes/MONITOREOAGROQUIMICOS.pdf
7. World Health Organization. Guías para la calidad del agua (*Guide for water quality*), Third Edition, Vol. 1, 2004. http://www.who.int/water_sanitation_health/dwq/gdwq3sp.pdf
8. INTA. Rev F y D (2014).
http://inta.gob.ar/sites/default/files/script-tmp-inta_-_fyd_73.pdf
9. P. Villarreal, S. Mattei, M. Villegas Nigra and G. Forchetti. FunBaPa Ediciones, Buenos Aires, Argentina 2010, 81 pp. http://www.funbapa.org.ar/wp-content/uploads/2013/06/impacto-carpocapsa.pdf
10. M. Miñarro y E. Dapena. Bol. San. Veg Plagas, 26 (2000) 305-316. http://www.mapama.gob.es/ministerio/pags/biblioteca/plagas/BSVP-26-03-305-316.pdf
11. P. Damos, L. A. Escudero Colomar, C. Ioriatti. Insects 6(3) (2015) 626–657.
Doi: 10.3390/insects6030626.