



## Evolution of the phytosanitary control system in the intensive horticulture model of high yield in Almería (2005-2008)

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### Abstract

The purpose of this work was to analyse the crisis effect, caused by the presence of unauthorized pesticide, isophenphos-methyl, in fresh peppers of Spanish origin in December 2006, on the model of horticultural production of high yield in Almería. The surveillance plan of residues of phytosanitary products in origin of the Regional Ministry of Agriculture and Fish of the Andalusian Regional Government has been analysed between the years 2005 and 2008, in the province of Almería. The year 2007 represented a clear turning point with the drastic decrease in the presence of residues from active substances above the MRLs and unauthorized ones in the crops where the samples had been taken. Due to the economic importance and the specific weight of pepper crops in the intensive horticulture system of high yield in Almería, this has been the most damaged crop due to a bad use of phytosanitaries. The last results of the plans analysed confirm that all vegetables produced now in Almería meet the requirements of safety, hygiene, quality of products and respect the environment that the market demands. The development and implementation of new phytosanitary control programmes, as the biological control and the integrated production, are now perfectly implemented in the field of Almería, therefore, high quality fruit and vegetable production, food safety and competitiveness were obtained in the markets.

**Key words:** Greenhouse, isophenphos-methyl, pesticide, biological control, integrated production, food safety.

### Introduction

The use of chemical products to control the harmful agents that affect horticultural crops is a habitual practice legally permitted, although not everybody accepts it, mainly due to the harmful effects on environment, generated by this kind of products. In general, such effects are caused by the abuse as well as by a bad use and handling of the products.

Nowadays, one of the most worrying harmful effects is the presence of residues of phytosanitary products in vegetable products used directly for human consumption or those used for livestock food, whose products and subproducts are included in the human diet.

Currently there is a great awareness and demand for quality in products and food, nationally and worldwide, supported by the pertaining legislation, and especially about the possible presence of toxic substances.

More often, the problems caused by the residues are due to the need for using high amounts of phytosanitary products to fight against crop pests, more and more numerous; or even, as the case of Almería, due to the use of unauthorised active substances, e. g. isophenphos-methyl, in protected horticultural crops.

On 27<sup>th</sup> December 2006 the RASFF (Rapid Alert System for Food and Feed) sent to AESA (Spanish Agency of Food Safety) information coming from Germany, and according to this information, some analyses had been carried out in November and December in that year and they had detected residues of unauthorized phytosanitaries in fresh peppers of Spanish origin.

Concretely, residues of the unauthorized pesticide, isophenphos-methyl, were found in 9 of the 15 samples of fresh peppers analysed. The presence of unauthorized pesticides in peppers coming from Almería was important news in the mass media, generating notable concern in the productive sector (greenhouses closed down, negative image of the same, etc.) as well as in the Spanish and European consumers. Their confidence on the consumption of safe food, particularly of fruit and vegetable products, was again affected.

In addition to a series of “shock” actions, before this new crisis situation, the response of the Provincial Government Office of Agriculture and Fish of Almería was to intensify the action plan that was being implemented from 2002. This plan consisted of the implementation of a phytosanitary control system that included preventive, cultural, and reasonable phytosanitary control measures, and above all, the biological fight, which has been known as “Green Commitment”.

The practical implementation of the action plan and its effectiveness requires the strict compliance with a series of measures established in the Act 43/2002, of 20<sup>th</sup> of November, of vegetable health <sup>1</sup> and specified in the order of the Regional Ministry of Agriculture and Fish of 12<sup>th</sup> December 2001 <sup>2</sup>. This order established the compulsory control measures as well as those recommended in the fight against viral diseases in horticultural crops.

The result of the implementation of this plan during several years is translated into minimizing risks for people and animal health, as well as the negative effects on the environment, keeping profitability in the farms and obtaining healthy and high quality horticultural products.

The purpose of this work has been to analyse the crisis effect caused by the presence of isophenphos-methyl in fresh products of Spanish origin, provoking the evolution of a conventional production system towards a production system that establishes regulations to ensure respect to the environment, the safety and hygiene of workers and the quality of products.

### Materials and Methods

The control of residues of phytosanitary products in food of plant origin is established in the directives 86/362/EC and 90/642/EC<sup>3,4</sup>, as well as in the regulations (EC) no 396/2005 and no 178/2006 of the European Parliament and the Council, and the regulation (EC) no 645/2000 of the Commission<sup>5,7</sup>. This control is carried out checking if the levels in the harvested products do not exceed the maximum residue levels (MRLs) established in the regulations in force; watching over the consumers' health and the environment. Nationally, the competent authority for the present control system is the General Direction of Agricultural and Farming Resources of the Ministry of the Environment and Rural and Marine Affairs (MARM). The autonomous regional competence falls on the Regional Ministry of Agriculture and Fish and the Regional Ministry of Health. The General Direction of the agricultural and farming production, belonging to the Regional Ministry of Agriculture and Fish, is the responsible body for the implementation, management, coordination and supervision of the national surveillance plan of residues of phytosanitary products in origin and within this general direction, the plant health service is in charge of carrying out the duties derived from the previous competences. The staff belonging to the plant health departments, corresponding to the eight Andalusian provinces is in charge of the material execution of the control plan of residues of phytosanitary products in origin, as well as of applying the disciplinary procedure.

**Control activities:** The control activities include the origin identification of plant products after the harvesting and immediately before allowing them into circulation, in order to know their traceability in the food chain, the taking of samples by the technical staff of the provincial government offices, and also the sending of samples to be analysed to the network of production and plant health laboratories. The purpose is controlling the presence of residues in food from plant origin and knowing their levels (if they are within the specifications of the legislation in force or if they exceed the MRLs established), contributing to the prevention and reduction of risks that may affect human or animal health. The control activities are carried out within the framework of:

- National surveillance plan of residues of phytosanitary products in origin, regulated by royal decree 280/1994 and its subsequent amendments<sup>8</sup>.
- Coordinated plan of the EU, published through the regulation (EC) 1213/2008, of the 5<sup>th</sup> December<sup>9</sup>, which establishes the coordinated multiannual community control programme for the years 2009, 2010 and 2011.

-Control plan of residues of phytosanitary products in the horticultural production of Almería, Cádiz, Granada, Huelva and Málaga, established in Andalucía to reinforce and complement the national programme, increasing the number of samples taken in the main horticultural productions of the provinces involved.

The control is carried out immediately, before allowing into circulation of plant products in the following points:

- Handling centres (cooperatives, public premises to buy and sell commodities, warehouses, mills for making olive oil).
- Agricultural plots and greenhouses (where plant products are prepared and sent to the consumption points).

### Control Staff

**Phytosanitary inspectors:** They carry out the inspection tasks established in section 50 of the Act 43/2002, of plant health, and they have authority nature. They are qualified technicians and can carry out informative actions (only one sample is taken) and also statutory actions (a sample by triplicate with the obliged participation of a phytosanitary inspector).

**Technicians to support the phytosanitary inspection:** They are qualified technicians of public companies, who can only carry out informative actions.

**Risk categorization process:** The selection of the sample can be randomized, or directed based on non compliance with rules in the previous season, claims or a reasonable suspect. To carry out the sampling at random, different aspects are taken into account in the risk prioritization:

- Products of higher consumption.
  - Products that have caused food alerts or have had a high level of infractions in the previous seasons.
  - Volume of production of each producer or handling centre.
- The selection process of the sample varies depending on each of the control plans.

**National Surveillance Plan of Residues of phytosanitary products in vegetable products in origin (NSPR):** The number of samples is obtained taking into account common criteria agreed by all the autonomous regions, considering that it is necessary to obtain a sample for each 10000 t of vegetables. Each year, the Andalusian Plan of Vegetal Health (APVH) states the selection of fruit and vegetable processing companies to be inspected in each province. Likewise, the number of samples by product to be taken is also pointed out.

**Control Plan of Residues of Phytosanitary products in fruit and vegetable production of Almería (CPRP), Granada, Huelva and Málaga:** The selection of fruit and vegetable companies to be inspected is carried out by the department of plant health, in accordance with the number of samples assigned to each province and the risk analysis in accordance with the provincial circumstances. Annually, the result of the selection is published in the APVH. The sample is obtained from a randomized selection of companies registered in the RIA (Agri-Food Industries Registry), along with samplings directed to farmers who did not fulfill some of the regulations in the previous seasons.

**Coordinated Surveillance Plan of the EU (CSPEU):** According to the regulation (EC) 1213/2008, 45 samples for each of the years 2009, 2010 and 2011 correspond to Spain; the same regulation lists the pesticides to be analyzed in each plant, and the Ministry of Agriculture and of Rural and Marine Affairs shall distribute the samples among the autonomous regions. Every year, those corresponding to Andalusia shall be enumerated in the APVH (Andalusian Plan of Vegetal Health).

**Methods and control techniques:** The taking of samples is carried out following the guidelines of the directive 2002/63/EC of the commission incorporated to the Spanish legal system through the royal decree 290/2003, of 7<sup>th</sup> March<sup>10,11</sup>, by which the methods of sampling to control the pesticide residues in the products of plant and animal origin are established; and the royal decree 1945/1983 of 22<sup>nd</sup> June<sup>12</sup>, by which the infractions and sanctions referred to the consumer defense are regulated. The taking of samples is carried out in presence of the commercial operator or his agent, the process takes into account the later contrast that allows determining the compliance or non compliance with the maximum residue levels laid down. The information obtained in the visit is registered in a legalized inspection record and at least by triplicate, the inspection records are signed by the inspector(s), the supporting technicians and the commercial operator or his agent, to whom a copy is delivered. A statutory sample is taken. There are two types of statutory samples:

-With immobilization of the commodities until the results of the analysis are obtained.

-Without immobilization of the commodities.

The immobilization of the commodities is only adopted when there is a risk assessment that allows taking this precautionary measure and provided that the laboratory that is going to carry out the analysis, can provide the results of such analysis within a maximum 48 hours period (for perishable plant material). This kind of sample is not carried out in the ordinary controls, except for special cases, when the phytosanitary inspectors, having sending previously a communication to the vegetal health service, contact with the laboratory with the purpose of giving priority to the analysis required and the results may be communicated within the maximum period fixed. Each statutory sample has three homogeneous test samples, that are prepared, sealed and labeled and in accordance with these formalities and also with the signature of the participating parties on each test sample, the identity of the samples along with their content is guaranteed, during the preservation period of the same. One of the test sample remains in the hands of the entity subject to inspection, on deposit along with a copy of the record, with the obligation of keeping it in perfect conditions to use it later in a contradictory analysis, if it is necessary. For this reason, the disappearance, destruction or deterioration of such test sample is considered as malicious, except for conflicting evidence. The other two test samples remain in the hands of the inspection service, sending one of these to the laboratory which is going to carry out the initial analysis and also the controversial test sample can be sent for its custody and preservation to the laboratory selected for the initial analysis. Generally, the entity to be controlled is not informed about the date and moment of inspection, except for exceptions, when they can be informed within a maximum 48 hours period in advance.

**Sample analysis:** The four main methods (general multiresidues, dithiocarbamates, benzimidazoles and methyl carbamates) are used in the sample analysis. The general multiresidues method is applied to all the samples, meanwhile the other methods are only applied to a percentage of the same, established in the APVH. While other methods of analysis are not established officially, internationally recognized methods are used or those validated in each laboratory according to the standard quality ISO 17025<sup>13</sup>. The correction of the global uncertainty is a factor to be taken into account in the analytic results and its purpose is the correction of the mistake in the careful choosing of the sample in relation to the lot. It is calculated applying an interval of 50% above and below the concentration determined in the laboratory. For example, if we determine 0.50 mg/kg of any active substance, the interval shall be:  $[0.50-0.25, 0.50+0.25] = [0.25-0.75]$ . To consider as punishable a positive analytic result in intervention samples, following the FVO (Food and Veterinary Office) recommendations and the corresponding document SANCO/2007/3131<sup>14</sup>, in this kind of samples, the concentration value in mg/kg obtained from an active matter in a plant product, shall be reduced by 50% and this new value has to be equal or higher than the MRL established.

**Contingency plan:** The contingency plan is activated providing that the information coming from the controls in force determines that the commercialization of a batch from which a sample has been analyzed, means a risk for health, as a consequence of the presence of residues of phytosanitary products above the MRLs legally established. In this case, the appropriate measures are adopted with respect to the immobilized batches (withdrawal of market or destruction) and the farming is also immobilized, subjecting it to periodical controls until checking the lack of residues above the MRL. The regional ministry of health is also informed, by fax, in order to proceed to the control of batches in origin and the recording of the appropriate alert in the SCIRI (Coordinated System of Rapid Information Exchange), if the level of residues represents a risk for health.

## Results and Discussion

**Coordinated surveillance plan of the EU:** This plan is implemented by a communitarian decision to assess the relevance of some parameters related with the analytic uncertainty. To implement this plan only informative samples are taken without intervention. Table 1 shows the results obtained for this plan between the years 2005 and 2008. Samples are considered as positive when they have at least an active substance whose concentration (mg/kg) exceeds its maximum residue level or its use is not authorized in the horticultural product from which samples have been taken. The total number of positives is composed of all the active matters that do not fulfill the regulations in force about the use and/or MRLs, because in the same positive sample we can find several positives.

Between the years 2006 and 2007 there was a notable decrease in the number of positive samples (that pass from 26% to 5%) as well as this trend was kept in 2008. Other fact to highlight is that the positive samples detected between the years 2005 and 2006 were found in horticultural indoor crops (green bean, cucumber, pepper and eggplant), while the two positive samples detected between 2007 and 2008 were found in lettuce, then, the horticultural indoor crop is exempted from any incidence.

**Table 1.** Results of the CSPEU between the years 2005 and 2008.

Coordinated Surveillance Plan of the EU (CSPEU)							
2005		2006		2007		2008	
No. of samples	Positive	No. of samples	Positive	No. of samples	Positive	No. of samples	Positive
27	7 (26%)	42	11 (26%)	20	1 (5%)	20	1 (5%)
Chemical group	No. positive	Chemical group	No. positive	Chemical group	No. positive	Chemical group	No. positive
Acylalanines	1	Neonicotinoids	4	Organophosphates	1	Organophosphates	1
Chloronitrites	1	Carbamates	6				
Dicarboximides	1	Choronitrites	1				
Imidazoles	1						
Neonicotinoids	1						
Organophosphates	2						
Pyrethroides	4						
Total	11	Total	11	Total	1	Total	1
Crop	No. positive	Crop	No. positive	Crop	No. positive	Crop	No. positive
Green bean	4	Pepper	4	Lettuce	1	Lettuce	1
Cucumber	7	Eggplant	7				
Total	11	Total	11	Total	1	Total	1

**National surveillance plan of residues of phytosanitary products in plant products in origin:** This annual sampling plan provides the knowledge about the extent to which the plant products that go on market from the autonomous region of Andalusia and particularly, from Almería, meet the legal specifications, understanding as such the Maximum Residue Levels (MRLs).

As it is shown in the Table 2, between the years of study a decreasing trend was appreciated in the number of positive samples that pass from a 21% in 2005 to 6% in 2008, as well as in the number of positive samples appeared. In relation with this circumstance, it is important to highlight that in 2005 some active substances belonging to 9 different chemical groups (acylalanines,

**Table 2.** Results of the NSPR between the years 2005 to 2008.

National Surveillance Plan of Residues of Phytosanitary Products in Vegetable Products in Origin (NSPR)							
2005		2006		2007		2008	
No. of samples	Positive	No. of samples	Positive	No. of samples	Positive	No. of samples	Positive
197	42 (21%)	150	15 (10%)	129	10 (7.7%)	100	6 (6%)
Chemical group	No. positive	Chemical group	No. positive	Chemical group	No. positive	Chemical group	No. positive
Acylalanines	1	Neonicotinoids	7	Carbamates	2	Dicarboximides	1
Benzylates	1	Organochlorides	2	Cinnamic acids	1	Neonicotinoids	2
Carbamates	6	Organophosphates	9	Neonicotinoids	6	Organophosphates	3
Imidazoles	1	Oxadiazines	1	Organochlorides	2	Pyrethroides	1
Neonicotinoids	22	Pyrazoles	3	Organophosphates	1		
Organochlorides	4						
Organophosphates	8						
Pyrazoles	5						
Pyrrols	4						
Total	52	Total	22	Total	12	Total	7
Crop	No. positive	Crop	No. positive	Crop	No. positive	Crop	No. positive
Pepper	31 (60%)	Pepper	7 (32%)	Pepper	2 (17%)	Pepper	1 (14%)
Eggplant	10	Eggplant	3	Eggplant	5	Eggplant	1
Pumpkin	4	Pumpkin	6	Pumpkin	4	Tomato	2
Green bean	1	Green bean	1	Watermelon	1	Lemon	1
Cucumber	6	Cucumber	3	Tomato		Grapes	2
		Melon	1				
		Tangerine	1				
Total	52	Total	22	Total	12	Total	7

benzylates, carbamates, imidazoles, neonicotinoids, organochlorides, organophosphates, pyrrols and pyrazoles) were detected as positive from a total of 52 positive samples, all of them in horticultural crops. In 2006, they were 5 (neonicotinoids, organochlorides, organophosphates, oxadiazines and pyrazoles) from a total of 22 positive samples, from which, all of them except for one were detected in horticultural crops. In 2007, 12 positive samples were detected distributed between 5 different chemical groups (cinnamic acids, carbamates, neonicotinoids, organochlorides and organophosphates), all of them in horticultural crops; and in 2008, 7 positive samples, 4 of them in horticultural crops, were found, that represent 4 chemical groups (dicarboximides, neonicotinoids, organophosphates and pyrethroides) (Fig. 1). The analysis of this plan proves not only a decrease in the number of positive samples detected, but also it shows a reduction in the chemical diversity of the same, highlighting above the rest neonicotinoids (imidacloprid, tiametoxan, thiacloprid, etc.) and organophosphates (pirmifos-methyl, malathion, chlorpyrifos, etc.).

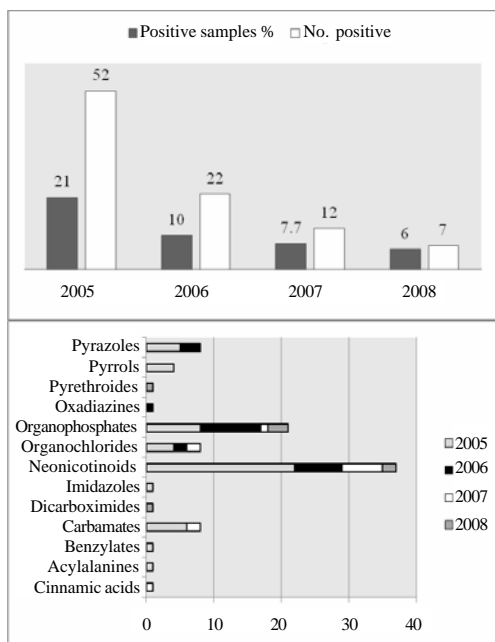


Figure 1. Evolution of the NSPR between the years 2005 and 2008.

If we analyse the evolution of the NSPR considering the type of crop, we find that between the years 2005 and 2006, pepper was the crop that registered a higher number of positive samples, representing a 60% of the total in 2005 and a 32% in 2006. However, during the years 2007 and 2008, pepper obtained results similar to those obtained by other specialty crops of the horticulture from Almería, with a 17% of the total positive samples registered in 2007 and 14% in 2008. In relation with these results, it has to be highlighted that in accordance with the sampling criteria explained previously, this is the most inspected crop.

**Control plan of residues of phytosanitary products in the fruit and vegetable production in Almería:** Due to the importance that the horticultural production has in Almería, the implementation of a control plan of residues of phytosanitary products in vegetables has been considered fit, complementing the national plan of residues.

This plan of action consists of the taking of samples according to a selection at random of the horticultural companies registered in the registry of operators of the general direction of industries and agri-food quality, in addition to the taking of samples in those companies that did not fulfill some of the regulations in the previous season, and such samples are sent to be analysed to the production and vegetal health laboratory of Almería.

Like in the NSPR, there is a downward trend of the number of positive samples between the years analyzed, as it is shown in the Table 3, passing from a 17% in 2005 to 3% in 2008. However, this similarity between plans is not confirmed with respect to the number of positive samples, generating a fluctuating result (215 in 2005, 137 in 2006, 148 in 2007 and 24 in 2008) (Fig. 2a). Table 3 also shows the chemical groups that include all the active substances that through the period analyzed were considered as positive within this plan. In the year 2005, neonicotinoids highlighted as the most representative group within the total of positive samples, with 45%; this percentage was similar in the year 2006 with 46%, the organophosphates being also this year very represented with 31% of the positive samples. In 2007, neonicotinoids and organophosphates followed being the predominant groups with respect to positive samples with 35% and 42%, respectively; this situation was also kept in 2008. It must be also highlighted the percentage decrease and the absolute value so noticeable that both groups suffered between 2007 and 2008 (Fig. 2b).

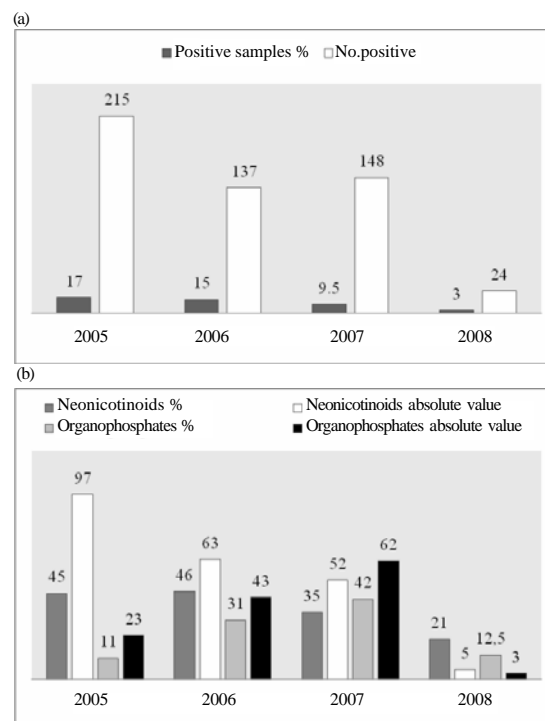


Figure 2. Evolution of the CPRP between the years 2005 and 2008.

**Table 3.** Results of CPRP between the years 2005 and 2008.

Control Plan of Residues of Phytosanitary Products in the Horticultural Production of Almería (CPRP)							
2005		2006		2007		2008	
No. of samples	Positive	No. of samples	Positive	No. of samples	Positive	No. of samples	Positive
1116	184 (17%)	830	126 (15%)	901	86 (9.5%)	757	22 (3%)
Chemical group	No. positive	Chemical group	No. positive	Chemical group	No. positive	Chemical group	No. positive
Benzimidazoles	9	Carbamates	16	Acylalanines	1	Benzimidazoles	1
Carbamates	26	Neonicotinoids	63 (46%)	Carbamates	9	Carbamates	3
Neonicotinoids	97 (45%)	Organochlorides	6	Chloronitrites	3	Chloronitrites	2
Organochlorides	8	Organophosphates	43 (31%)	Cinnamic acids	1	Cinnamic acids	4
Organophosphates	23	Pyrazoles	3	Neonicotinoids	52 (35%)	Dicarboximides	2
Pyrazoles	23	Pyrrols	6	Organochlorides	3	Imidazoles	1
Pyrethroides	2			Organophosphates	62 (42%)	Neonicotinoids	5 (21%)
Pyrrols	27			Oxadiazines	1	Organophosphates	3 (12.5%)
				Pyrazoles	2	Pyrethroides	2
				Pyrethroides	3	Thiadiazinones	1
				Pyrrols	7		
				Spinosines	1		
				Thiadiazinones	2		
				Thiophanates	1		
<b>Total</b>	<b>215</b>	<b>Total</b>	<b>137</b>	<b>Total</b>	<b>148</b>	<b>Total</b>	<b>24</b>
Crop	No. positive	Crop	No. positive	Crop	No. positive	Crop	No. positive
Pepper	143 (66.5%)	Pepper	70 (51%)	Pepper	108 (73%)	Pepper	3 (12.5%)
Eggplant	36	Eggplant	26	Eggplant	18	Eggplant	8
Pumpkin	21	Pumpkin	24	Pumpkin	9	Pumpkin	7
Green bean	1	Green bean	2	Green bean	1	Green bean	1
Cucumber	9	Cucumber	11	Cucumber	8	Lettuce	1
Melon	2	Tomato	4	Melon	2	Cucumber	2
Watermelon	1			Watermelon	1	Tomato	2
Tomato	1			Tomato	1		
Grapes	1						
<b>Total</b>	<b>215</b>	<b>Total</b>	<b>137</b>	<b>Total</b>	<b>148</b>	<b>Total</b>	<b>24</b>

If we analyze the evolution of CPRP considering the type of crop, we find that pepper crop highlights only too well above the rest of crops, accumulating 66.5% from the number of positive samples in 2005, 51% in 2006, 73% in 2007 and 12.5% in 2008, this last percentage being very inferior to the rest of years of study.

Obviously, the results obtained show the producer's change of attitude in Almería, who from the season 2006/2007 included new criteria in the development of his activity (fully controlled use of phytosanitaries, biological control, adaptation of the structures to the virosis order, etc.). The trigger of this change was the known isophenphos-methyl crisis.

**Isophenphos-methyl crisis:** On 27<sup>th</sup> December 2006, the information received from Germany, through the Rapid Alert System for Food and Feed (RASFF) was communicated to the Provincial Government Office of Agriculture and Fish of Almería, that the unauthorized pesticide isophenphos-methyl had been detected in samples taken from Spanish peppers. The Spanish Agency of Food Safety of the Ministry of Health and Consumption (AESAs), requested to the competent authorities of Andalusia to make the pertaining inquiries in such companies

and they informed about the results of the investigations carried out and the measures taken. Immediately, the Provincial Government Office of Agriculture and Fish established the action protocol detailed below:

- Inspection of all the companies implied in the sale of peppers with residues of isophenphos-methyl, to establish the traceability and to obtain in this way, data of the farmers, greenhouse, area and plot where such peppers were grown.
- Inspection of the greenhouses and analysis of the pesticide residues of peppers existing in the farming.
- In case of finding residues of any unauthorized active substance, it proceeded the immediate immobilization of the production of that greenhouse and the starting of the disciplinary procedure.
- If one month later, the residue had not disappeared in a new analysis, the impossibility of dissipation of the product was arisen and the farmer had to pull up the plants.

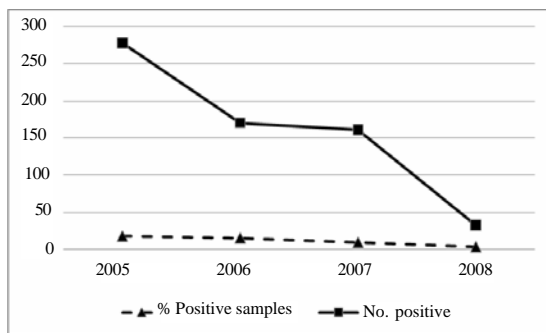
Such actions were repeated during the first six months in 2007, until the season 2006/2007 ended and all the plants were pulled up.

From the resulting traceability in the companies involved in the alerts, 112 greenhouses were closed down as a preventive

measure, 10 from them by isophenphos-methyl (9%). Also, 293 ex officio inspections were carried out in greenhouses, 56 samples were positive (19.11%), 17 of them by isophenphos-methyl (5.8%). With respect to the actions carried out in commercialising companies, the results showed that from the 806 samples taken, 133 (16.50%) were positive, 42 of them by isophenphos methyl (5.2%).

In total, from December 2006 to August 2007, 1099 actions were carried out, with 189 positive results (17.20%), from which 59 were positive by isophenphos-methyl (5.5%). In all the positive results the pertaining disciplinary procedure was started. The total sum of sanctions could amount to 9.5 million Euros.

The consequence of all these actions was a clear turning point between the season 2006/2007 and the 2007/2008, with the drastic decrease of the presence of residues from active substances above the MRLs and unauthorized ones in the crops where the samples had been taken. This situation shows the efficacy of the surveillance measures and the corrective actions carried out by the provincial government office with the main purpose of producing fruits and vegetables of high quality and food safety (Fig. 3).



**Figure 3.** Evolution of the CSPEU, NSPR and CPRP between the years 2005 and 2008.

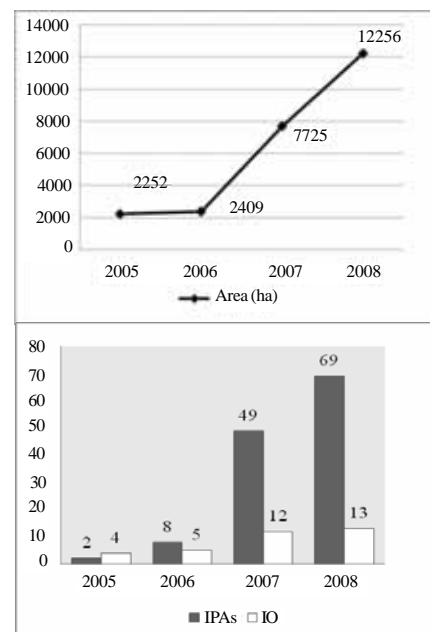
The development and implementation of new phytosanitary control programmes, as the biological control and the integrated production are now perfectly implemented in the field of Almería, high quality fruit and vegetable production, food safety and keep competitiveness in the markets are obtained.

**The integrated production in Almería:** Integrated production is defined as agricultural system for the obtaining of plant products that use to maximum the resources and mechanisms of natural production and assure at medium and long term a sustainable agriculture, introducing biological and chemical control methods and other techniques that reconcile the society needs, the protection of the environment and the agricultural production, as well as the operations carried out for the handling, packing, transformation and labeling of plant products included in the system.

The support of the Regional Ministry of Agriculture and Fish to the integrated production has been important since the beginning of this production system. In 2006, the Regional Ministry of Agriculture and Fish began a programme of aids to the Integrated Production Associations (IPAs), used for paying a part of the

expenses, such expenses can be derived from the hiring of the required technical service staff, from water, soil or self-control tests, as well as the certification expenses. The legal basis of these aids, whose purpose is the promotion of the integrated production through the encouragement of the IPAs, are established in the order of the 12<sup>th</sup> of January 2006 (call 2006/2007)<sup>15</sup>, and amended by resolution of the 3<sup>rd</sup> of December 2008 (call 2009/2010)<sup>16</sup>. The legal basis of the aids, whose purpose is the promotion of the integrated production through the encouragement of the Associations for Integrated Treatments in Agriculture (AITRAs), are established in the order of 12<sup>th</sup> January 2006 (call 2006/2007)<sup>17</sup>, and amended by the resolution of 2<sup>nd</sup> December 2008 (call 2009/2010)<sup>18</sup>.

In the last years, with the implementation of the control programme of vector virus insects in horticultural crops, there has been a noticeable increase in the area where the technical protocols laid down in the specific regulation of integrated production are applied. Fig. 4 shows the area cultivated under the integrated production system in Almería in the last years, as well as the evolution of IPAs and individual operators. The significant increase is foreseeable for the next seasons of IPAs as well as producers within the IPAs that have been already constituted. Some of the circumstances that favor this increase and strengthening of the application of the integrated production are: making aware the different sectors implied in the production and commercialization of the need of implementing an alternative to the phytosanitary control system based on the phytosanitary products as essential element; aids received through the administration; elimination of risk that supposes the abusive use of phytosanitary products; decrease of “bad uses” by the farmers (improper applications, not appropriate pulling up of the crops,

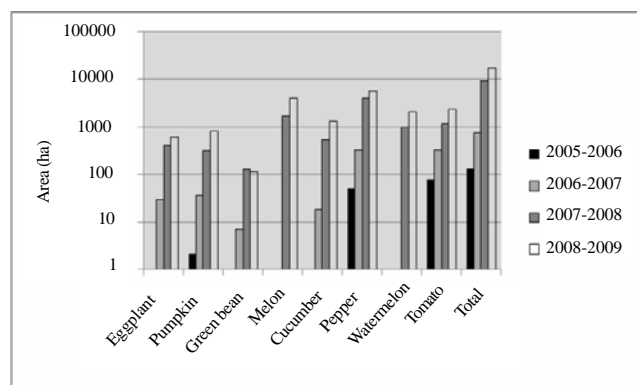


**Figure 4.** Evolution of the area under integrated production in Almería, IPAs and individual operators (IO). Source: Registry of integrated production of Andalusia. Regional Ministry of Agriculture and Fish of the Andalusian Regional Government, May 2009.

poor closing, etc.); checking the possibility of use and effectiveness of the application of the specific regulation; convergence agreements of integrated production with other rules or certifications: AENOR (Spanish Association for Standardisation and Certification) and NATURANE (Good Agricultural Practices Protocol).

**The biological control in Almería:** In the specific case of Integrated Production of protected horticultural crops, it must be highlighted the important advance that the techniques of pest biological control has had in the recent years, through the release of auxiliary insects or beneficial ones (biological control organisms, BCOs) in greenhouses where they control the pests of different crops (Fig. 5). In this way, an environmentally-friendly and guarantee agriculture has been achieved for consumers, obtaining maximum quality and safety productions where the use of phytosanitary products has been enormously reduced, using only those who have a profile compatible with pollenizers and BCOs. In these moments, there are in Almería 17,039 hectares where the biological fight systems are being implemented (Table 4).

The Regional Ministry of Agriculture and Fish published the order of 13<sup>th</sup> March 2006 (call 2006/2007)<sup>19</sup>, amended by the order of 9<sup>th</sup> May 2008 (call 2008/2009)<sup>20</sup>, by which the compulsory



**Figure 5.** Evolution of the area of the national programme of biological control (vector insects) in the province of Almería in the last seasons. Source: Regional Ministry of Agriculture and Fish of the Andalusian Regional Government, May 2009.

**Table 4.** Evolution of biological control in Almería in the last seasons.

Crops (ha)	2005-2006	2006-2007	2007-2008	2008-2009	Total cultivated area 2008-2009
Eggplant	-	30.15	402.53	606.14	1622
Pumpkin	2.1	35.92	311.98	821.81	4492
Green bean	-	6.98	130.62	115.81	1259
Melon	-	-	1665.89	4043.37	4981
Cucumber	-	18.39	531.69	1306.26	4551
Pepper	51.1	330.83	4020.49	5756.1	7057
Watermelon	-	-	991.23	2095.92	4775
Tomato	75.5	334.27	1183.87	2294.22	10250
Total	128.7	756.53	9238	17039.64	38987
Number of entities	8	30	56	69	
Aids (thousand €)	198.37	655.74	10719.01	16462.04	

phytosanitary measures of several control plans were established, and among them, we can find the control of vector insects of virosis in horticultural crops. Through this order, an aid is granted to the farmers for the release of auxiliary insects that fight naturally against pests in horticultural crops. The farmers who wish to be adhered to the virus control programme in the horticultural crops must meet a series of requirements, among them, we find the fulfillment of the specific regulation of integrated production for protected horticultural crops, as well as the membership to an Integrated Production Association (IPAs).

## Conclusions

Neonicotinoids and organophosphates have been, in the last years, the most used phytosanitaries in the horticulture from Almería, because many of the active matters that they include are specific for the control of *Bemisia tabaci* (Gennadius) (whitefly) and *Frankliniella occidentalis* (Pergande) (thrips), without doubt, the main vector insects of virosis together with the aphids (Aphididae), for the crops of intensive horticulture model of high yield in Almería.

The detection of the unauthorized pesticide isophenphos-methyl in fresh peppers of Spanish origin and the subsequent phytosanitary alert caused a drastic change in the techniques used for the control of pests and diseases of the crops under plastic in Almería, passing from a mainly chemical control system to a biological and integrated control.

The measures taken by the Provincial Government Office of Agriculture and Fish in Almería, meant, according to the communitarian inspection, one of the highest displays of material and human means, that has been carried out in the EU as a response to a phytosanitary alert.

The season 2007/2008 represents a clear turning point with respect to the results of the programme of control of residues of the Regional Ministry of Agriculture and Fish belonging to the Andalusian Regional Government, with the drastic decrease of residues of active matter above the MRL and other unauthorized ones for using in the protected horticultural crops.

Due to the economic importance and specific weight of pepper crop in the intensive horticulture system of high yield in Almería, this has been the most damaged crop due to a bad use and/or abuse of phytosanitaries. However, the last results of the plans analysed, show that all the vegetables produced now in Almería meet the safety, hygiene and quality of products and environmentally-friendly requirements that the market demands. It has to be highlighted that the greater degree of implementation of biological control organisms has been carried out in pepper crops. We can assure that the integrated production system with the inclusion of biological control has involved a revolution and an alternative to the previous system of phytosanitary control. The high effectiveness achieved along with the guarantee of lack of residues and respect to people and environmental health, guarantees the current acceptance and foresees an important increase of the area adhered to this integrated production regulation.

### Acknowledgements

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### References

- <sup>1</sup>Act 43/2002 of 20 November, of Vegetal Health, [Spanish] Official Gazette no. 279 of 21 November 2002, Spain.
- <sup>2</sup>Order of the Regional Ministry of Agriculture and Fish of 12 December 2001, establishing the compulsory control measures as well as those recommended in the fight against viral diseases in horticultural crops, Official Gazette no. 3 of 8 January 2002 of the Andalusian Regional Government. Spain.
- <sup>3</sup>Council Directive 86/362/EEC of 24 July 1986 on the fixing of maximum levels for pesticide residues in and on cereals.
- <sup>4</sup>Council Directive 90/642/EEC of 27 November 1990 on the fixing of maximum levels for pesticide residues in and on certain products of plant origin, including fruits and vegetables.
- <sup>5</sup>Regulation (EC) no 396/2005 of the European Parliament and of the Council of 23 February 2005, on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending the Council Directive 91/414/EEC.
- <sup>6</sup>Commission Regulation (EC) No 178/2006 of 1 February 2006 amending Regulation (EC) No 396/2005 of the European Parliament and of the Council to establish Annex I listing the food and feed products to which maximum levels for pesticide residues apply.
- <sup>7</sup>Commission Regulation (EC) no 645/2000 of 28 March 2000 setting out detailed implementing rules necessary for the proper functioning of certain provisions of Article 7 of Council Directive 86/362/EEC and of Article 4 of Council Directive 90/642/EEC concerning the arrangements for monitoring the maximum levels of pesticide residues in and on cereals and products of plant origin, including fruit and vegetables, respectively.
- <sup>8</sup>Royal Decree 280/1994, of 18 February, establishing the maximum levels for pesticide residues and their control in certain products of plant origin.
- <sup>9</sup>Commission Regulation (EC) no. 1213/2008 of 5 December 2008 concerning a coordinated multiannual Community control programme for 2009, 2010 and 2011 to ensure compliance with maximum levels of and to assess the consumer exposure to pesticide residues in and on food of plant and animal origin.
- <sup>10</sup>Commission Directive 2002/63/EC of 11 July 2002 establishing Community methods of sampling for the official control of pesticide residues in and on products of plant and animal origin and repealing Directive 79/700/EEC.
- <sup>11</sup>Royal Decree 290/2003, of 7 March, establishing the methods of sampling for the control of pesticide residues in and on products of plant and animal origin.
- <sup>12</sup>Royal Decree 1945/1983 of 22 June, by which the infractions and sanctions referred to consumer defence and agri-food production are regulated. [Spanish] Official Gazette no. 168 of 15 July 1983.
- <sup>13</sup>Quality Systems ISO 17025 for Trial and Calibration Laboratories.
- <sup>14</sup>Method validation and quality control procedures for pesticide residues analysis in food and feed. Document No. SANCO/2007/3131.
- <sup>15</sup>Order of 12 January 2006, establishing the legal basis for the granting of aids used for the promotion of integrated production through the encouragement of the Integrated Production Associations (IPAs), Spain.
- <sup>16</sup>Resolution of 3 December 2008, of the General Direction of Agricultural and Farming Production fixing the public call for the year 2009 for the aids regulated through the Order of 12 January 2006, amended by the Order of 16 of May 2008, establishing the legal basis for the granting of aids used for the promotion of integrated production through the encouragement of the Integrated Production Associations (IPAs), Spain.
- <sup>17</sup>Order of 12 January 2006, establishing the legal basis for the granting of aids used for the improvement of plant health through the encouragement of the Associations for Integrated Treatments in Agriculture (AITRAs), Spain.
- <sup>18</sup>Resolution of 2 December 2008, of the General Direction of the Agricultural and Farming Production fixing the public call for the year 2009 for the aids regulated through the Order of 12 January 2006, amended by the Order of 16 May 2008, Spain.
- <sup>19</sup>Order of 13 March 2006, stating the official existence of the pests listed, and establishing the control measures and the aids to be executed, Spain.
- <sup>20</sup>Order of 9 May 2008, establishing the compulsory phytosanitary measures included in the National Programmes of control and fight against pests and the aids regulated to be executed, Spain.