

Biorational alternatives for leaf vegetables in Spain

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Heliothis (Helicoverpa armigera) on lettuce.

Certis Spain has been working on the development of a new Integrated Pest Management (IPM) programme to control a variety of pests and diseases in leaf vegetables. The objective is to develop a programme that achieves zero crop residues within two to three years.

Trials were carried out on lettuce to compare a Certis IPM programme of biorationals and limited conventional chemicals to the Standard chemical programme used by growers with a view to achieving results that could be extrapolated to other leaf vegetables classified as minor crops. These minor crops could include escarole, lamb's lettuce, sprouts and shoots, cresses, land cresses, roman rocket, red mustard, baby leaf, spinach, chards, endives and aromatic herbs.

The project was developed for PROEXPORT, an association of more than

55 large producers and exporters of fruits and vegetables.

TRIALS MATERIALS AND METHODS

Open field lettuce, type Iceberg variety Kafir, grown in the Mazarrón region (Murcia) The lettuce were transplanted at BBCH 12 (33 days after sowing).

Large plots with four areas for sample collections in order to obtain four replications per treatment. Each replicate for sample collection was 15m² and 75 plants.

Fifty percent of the total plot surface was covered during the crop cycle to facilitate the development of diseases such as *Botrytis* and *Sclerotinia* which were inoculated. Powdery mildew and downy mildew occurred as natural infections.

During the crop cycle nine foliar spray applications were applied using a knapsack sprayer (Maruyama) at a pressure and water volume adequate to cover the crop, from 400 to 600 litres per hectare.

The nine applications (A to I) were applied between 1st October 2018 and 14th December 2018.

The control for snails and slugs was applied at the time of the first application; spread by hand on the soil at the label rate, (7 kg/ha). Tusal was applied by drip irrigation within the last 2000 litres/ha of irrigation water.

PROGRAMME EVALUATION

Pest control monitored:

Lepidoptera (*Spodoptera exigua*, *Spodoptera littoralis*, *Helicoverpa armigera*, *Chrysodeixis chalcites*, *Autographa gamma*), aphids (*Nasonovia ribisnigri*, *Myzus persicae*, *Aphis gossypii*, *Aphis fabae*), white fly, thrips (*Frankliniella occidentalis*), snails (*Helix sp.*) and slugs (*Limax sp.*, *Agriolimax sp.*).

Disease control monitored:

Sclerotinia (Sclerotinia sclerotiorum, Sclerotinia minor), *Botrytis (Botryotinia fuckeliana)*, Downy mildew (*Bremia lactucae*) and Powdery mildew (*Golovinomyces cichoracearum*).

Harvest outcomes measured:

Yield at harvest.
Percentage weight loss after storage.
Residues on leaf vegetables at harvest.

Quality parameters for marketable fruits measured:

The diameter of lettuce after harvest, firmness, root weight, plant weight, levels of nitrates (ppm), sodium (ppm), calcium (ppm), potassium (ppm), total solutes, pH, conductivity, salt content per leaf.

These measures give an idea of the biotic (pest and disease) and abiotic (transpiration, drought etc.) stress on the plant and overall plant health.

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Far left: Lettuce roots from Certis programme
Left: Lettuce roots from untreated plots

CONTROL PROGRAMMES – PESTS

PEST	CERTIS IPM PROGRAMME	STANDARD (CHEMICAL) PROGRAMME
Lepidoptera	Early application of Mimic (tebufenozide) and Spintor (Spinosad). Followed by the rotation of Turex and Delfin: 7 to 10 day intervals in the early phase (up to 39-DAT*), 10 to 20 day intervals on the final phase (up to 72-DAT*) at harvest. *DAT: days after transplanting.	Spintor (Spinosad), Minecto Alpha (cyantranilprole + acibenzolar S-metil), Altacor (chlorantranilprole) and Steward (indoxacarb), Karate Zeon (lambda cyhalothrin) and cypermethrin, The control of lepidoptera was completed with several treatments using <i>Bacillus thuringiensis</i> , Bactur and XenTari.
Thrips	Spintor followed by Breaker Max and Botanigard.	Spintor, Minecto Alpha (cyantranilprole + acibenzolar S-metil),
White fly	Controlled in the early phase with the use of Mospilan Max (acetamidiprid) followed by Breaker Max and Botanigard.	Minecto Alpha (cyantranilprole + acibenzolar S-metil),
Aphids	Controlled in the early phase with the use of Mospilan Max (acetamidiprid) followed by Breaker Max and Botanigard. The same application intervals described for Bacillus were also applied to the other Biorational products to control thrips, aphids and white fly.	Movento (spirotetramat), Aphox (pirimicarb), Karate Zeon (lambda cyhalothrin) and cypermethrin,
Slugs and Snails	Iroxx (ferric phosphate) to control slugs and snails.	Metaldehyde was used to control slugs and snails.

The standard programme uses eight chemical products. The Certis IPM programme uses mainly biorational products, with just a couple of chemical treatments with Mospilan Max and Mimic.

Spintor, which is certified for organic farming, is considered as a biorational for this study.

CONTROL PROGRAMMES - DISEASES

DISEASE	CERTIS IPM PROGRAMME	STANDARD (CHEMICAL) PROGRAMME
Sclerotinia and Botrytis	Tusal by drip irrigation*, Amylo-X*, One application of Switch (cyprodinil and fludioxonil).	Two applications of Switch (cyprodinil and fludioxonil) and one application of Signum (boscalid and pyraclostrobin).
Botrytis	Amylo-X.	Two applications of Switch and one application of Signum.
Powdery mildew (<i>Golovinomyces cichoracearum</i>)	Armicarb (Iceberg lettuce is highly susceptibility to powdery mildew).	Signum (applied for control of Sclerotinia and botrytis) also provided control of powdery mildew.
Downy Mildew (<i>Bremia lactucae</i>)	A single treatment of Revus (mandipropamid) and mancozeb.	Two consecutive treatments of Revus (mandipropamid) plus mancozeb.

*The application of Amylo-X with low crop intercept, at early phase, was fully compatible with the Tusal application when both are applied following their label recommendations; drip and foliar respectively.

Within the Certis IPM programme, Armicarb was applied for the control of powdery mildew and the positive results from this experiment indicates that we should include Armicarb against powdery mildew on lettuce in a project to achieve formal label extension.

Lepidoptera control

The Lepidoptera control was evaluated for damage caused by *Spodoptera exigua* and *Helicoverpa armigera* and significant differences were seen between treated and untreated plots. 60% of plants were damaged on the untreated plots and the average percentage of damaged plant area was up to 12% on the untreated plots.

Both the IPM and Standard programmes obtained very good control of lepidoptera with a range of between 90% and 99% efficacy. No significant differences were observed between the two programmes.

The Certis IPM programme based on alternating Delfin and Turex provided very efficient control of lepidoptera (see figure 1).

Thrips, white fly and aphid control

During the course of the trial the pest incidence and severity of thrips, white fly and aphids was very low and control was maintained using preventive treatments by both the IPM and Standard programmes.

Disease control

Significant differences were observed in the control of downy mildew (*Bremia lactucae*) on the treated and untreated plots. 57% of plants were affected on the untreated plot and the average affected plant area increased to 18.6% over the course of the trial.

Within the treated plots the percentage efficacy ranged from 97% to 100% with the Standard programme and 88% to 100% with the IPM programme (see figure 2).

There were also significant differences between treated and untreated plots regarding the control of powdery mildew (*Golovinomyces cichoracearum*) on lettuce. The percentage of damaged plants on the untreated plots was 46.0%, and the average percentage of affected plant area increased during the trial to 16.6%. Both treatment programmes showed very good efficacies that ranged from 94% to 100% under the Standard programme and 89% to 97% using the IPM programme.

The percentage of plants in the untreated plots affected by *Sclerotinia sclerotiorum* was very low (3.33%) while the percentage

of plants affected by *Botryotinia fuckeliana* was very high (71.67%) (see figure 3).

The IPM programme showed better control of botrytis, with efficacies ranging from 89% to 100%, while the Standard programme showed control that ranged from 70% to 100%. These results were very positive for the IPM programme since most of the control was based on Amylo-X with just one application of Switch, while the Standard programme required three chemical treatments based on Switch and Signum.

Results on yield and quality parameters:

Both programmes resulted in an average of 125% yield increase compared to the un-treated crop.

The plant diameter in the IPM programme was 11% higher when compared to the untreated, while the Standard programme plant was just 4% higher. Despite application of the same N-P-K nutritional programme to all plots (untreated, IPM and Standard), the IPM programme produced marketable lettuce that showed plant firmness 35% higher than the Standard plots and 42% higher than the untreated plots (see figure 4).

The Certis IPM programme showed lettuce with higher root weight (see figure 5). In general, the greater root development is consistent in most of the trials where Tusal is included as it helps to biostimulate the plant root system and facilitates uptake by the plant of micronutrients and macronutrients from the soil. In summary, the use of biorationals in the Certis IPM programme, in particular Tusal and Amylo-X, showed higher intake of nitrogen, sodium, calcium and potassium.

The loss of weight after storage for 17 days was also evaluated and the IPM programme resulted in lower weight loss (8.6% from dehydration) compared to the Standard programme (11.5%) and the non-treated (13%) weight lost.

The IPM programme also resulted in fresh and firm lettuce (see figure 6). After storage in a chamber for 17 days at 4-6°C, the IPM lettuce had 25% lower weight lost compared to the Standard programme and 33% lower weight lost compared to untreated (see figure 7).

Residues at harvest:

The programme has not yet achieved zero residues at harvest in its first year of development however the results were close. With the use of the Certis IPM programme, based on early applications of conventional chemistry, and the use of biorationals during the whole crop cycle, just three active substances were recovered as residues at harvest versus the Standard programme that showed five active substances as residues. All three residues in the IPM programme were below 0.1 ppm (see figure 8).

The Certis IPM programme achieved healthy plants, with excellent size and weight, good firmness and low residues of active substances at harvest. The sustainable IPM programme enhances the uptake of natural nutrients from the soil and reduces the resistance pressure on pests and diseases by the use of biorational products with multi-site mode of action. ■

All photos: Certis Spain

FURTHER READING

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