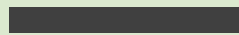




TECNOLOGÍAS AVANZADAS
AGRÍCOLAS S. L

January 2024

Report Solyfert



Tavan

INTRODUCTION

The company TAVAN (Tecnologías Avanzadas Agrícolas, S.L.) has biotechnology applied to agriculture as a main feature in its DNA. During these 30 years of work we have specialised both in the development of products for plant nutrition and in the treatment of diseases caused by fungi and bacteria using biotechnology in a wide range of crops and ornamental plants.

TAVAN has two production plants, one in South America and the other in Spain, from where it supplies the national market, European markets (Portugal, France, Italy and Turkey) and international markets (Chile, Brazil, Morocco and Dominican Republic among others).

Thanks to this diversification of markets, our technical team gathers all the experiences of our customers based on a multitude of crops from different countries, climates, orographies and other particular characteristics of each region. All this knowledge is of great importance to improve treatments and adapt them to the changing nature of crops, especially in the uncertain situation we are in at the moment. The earth's temperature is rising, the different meteorological phenomena are occurring more intensely, more frequently and in unusual places, so we have to be adapting our way of working the land to cushion the damage they can cause us.

This is why TAVAN works hand in hand with farmers to offer solutions adapted to new agri-environmental and agri-food situations on a daily basis. All our products have no safety deadline and are zero waste, thus guaranteeing sustainable agriculture that respects the planet's ecosystems and natural resources.

OUR DEVELOPMENT

One of our strongest pillars for developing such successful crop products has been observation. Observation based on the behaviour of the plant life in the face of all the adversities it suffers on a daily basis, and, its response to them.

The reaction mechanisms of plants to external aggressions of different kinds are repeated throughout the length and breadth of the Earth. Each species has developed different types of adaptation that have been modified generation after generation to ensure their survival and, above all, their reproduction.

Apart from all the internal adaptations that these organisms make through mutations or transformations, there are other adaptation mechanisms where other actors intervene. We are talking about the micro-organisms that reside in the soil.

Soil microbial ecology is a precious asset for agriculture. Decreasing biodiversity in this area is detrimental to good crop development.

It is no news to say that the chemical applications that have been carried out during the last decades have reduced these soil colonies and, consequently, also the quality of the substrate. For this reason, continuous treatments of fertilisers and mineral correctors that should be in the soil in a natural and permanent way by the mere action of nature are established.

TAVAN has extensive experience in studies and trials related to microorganisms interacting with plants. How they help to combat stressful situations by reinforcing cell walls to prevent pathogen attacks. Or how they are able to circulate through the raw and processed sap stream to reach any corner of the plant where it is suffering attacks or stress.

In addition, some micro-organisms are able to improve the soil structure so that the plant is able to develop optimally without the need for additional fertilisation. Just look at demanding environments such as forests or jungles, where ecosystems function perfectly without the need for human intervention.

In this line, TAVAN has been able to develop a product with the help of biotechnology, which makes use of non-mycorrhizal microorganisms, SOLYFERT (product with MAPA Registration F0005387/2032), to promote the good development of crops without the need for additional fertilisers.

Our company also has a wide range of products developed in our laboratories to improve the organoleptic characteristics of the fruit or to resist situations of hydric stress, among others.

BACKGROUND

The nutritional aspect of plants is a factor that has great relevance in crops and is of great concern to farmers in any country in the world. This importance is reflected in the following graph, where fertiliser consumption worldwide has skyrocketed in the last two decades.



The rapid rise in fertiliser prices in 2021 has been very noticeable, especially for nitrogenous fertilisers. And in view of recent events, between pandemics and wars, we do not know what the future will be and how it will affect world agronomy, the source of food for all the world's people.

On the other hand, the excessive use of synthetic fertilisers has a serious negative impact on both groundwater and surface water, as well as on soils, deteriorating their structure and the existing microfauna. Soils must be understood as a complex system with physical, chemical and biological properties that are of paramount importance for the optimal development of crops.

Due to these problems and increasingly restrictive legislation against these harmful effects on nature, it is necessary to use a new technology that is capable of reducing the fertiliser units necessary for proper plant nutrition, using more sustainable products and reducing production costs on farms.

Fertilisation of a crop is very important because unbalanced fertilisation can have very negative consequences for the plants, changing their biochemistry and affecting their consumers.

Faced with the need to find a solution to the diversity of problems surrounding the fertilisation of crops, TAVAN has been researching for many years to develop the product that we now have in our hands. A product that not only does not damage ecosystems, does not deplete natural resources, is sustainable for agriculture and all that surrounds it, but also helps to promote biodiversity. Moreover, it is respectful of soil biology, it does not interfere with the relationships that exist at the microbiological level, allowing them to develop for the benefit of the balance of nature.

The 3 elements most commonly used in agriculture in general are: NITROGEN, PHOSPHORUS and POTASSIUM. Most of the formulations to improve the fertilisation of crops contain these macro-elements and are usually called 'NPK fertilisers'.

But why this need to massively use these elements for agriculture?

Phosphorus is the most abundant chemical fertiliser element in the earth's crust, although it is found in forms that cannot be assimilated by plants. Even when this element is added to the soil, practically only 5% is used, the rest is degraded in the soil and becomes insoluble in water, and therefore not assimilable by the plant.

With regard to potassium, its retrogradation or insolubility is similar to that of phosphorus, but it is less frequent in soils, and its utilisation after applications does not exceed 40%.

Finally, 90-95% of the total nitrogen in the soil is in organic form, so it is not directly assimilated by plants, but must undergo a transformation process called mineralisation. Some micro-organisms are capable of transforming this organic N into ammonium and nitrates, forms that are more usable by plants. Another important source of N is atmospheric nitrogen, which makes up about 78% of the total composition of the atmosphere, but not all plants are able to mineralise this element in order to assimilate it.

This very limited availability of the most important macro-elements to plants makes it imperative to develop products that help agriculture and reduce the costs of farming.

For all these reasons, the objectives of the search for a solution focused on taking advantage of the resources in the plant's own environment, making both P and K assimilable by the plant and taking advantage of all possible N sources.

The research began in 2016 with soil samples from a field of organically grown olive trees located in Jaén, Andalucía (Spain). In this field, the technicians of Tecnologías Avanzadas Agrícolas S.L. observed that the characteristics of the olive trees were very good in general with hardly any fertilisation, good production and with a vegetative development far superior to the rest of the crops in the area, especially if we are talking about organic crops.

After several isolation techniques, which involved more than five years of cultivation of the microorganisms that appeared in these samples, discarding up to 15 of them as fungi, bacteria or nematodes, it was concluded that a new microorganism or strain had been isolated that had the characteristics that were being sought. This micro-organism had the capacity for aerial nitrogen assimilation and fixation in the soil-plant and, in addition, it also had the capacity to solubilise phosphorus and potassium from the soil.

SOLYFERT MECHANISM OF ACTION

Our product SLOYFERT, although it is registered as a fertilizer, is within the group of products that contain non-mycorrhizal microorganisms. These microorganisms we are talking about are *Bacillus megaterium* C-2, a strain developed by Tecnologías Avanzadas Agrícolas S.L. after many years of research. Descripción del microorganismo:

- Genus: *Bacillus*
- Species: *Megaterium*
- Strain: C-2 (Registered by Tecnologías Agrícolas Avanzadas S.L. in the Spanish type culture collection as type of crops. "C.E.C.T.")

***Bacillus megaterium* C-2 characteristics:**

- *Bacillus* large endospore-forming, aerobic metabolism, flagellar movement.
- Strain that has demonstrated its ability to fix atmospheric nitrogen.
- Strain capable of solubilising phosphorus and potassium.
- It is an endophytic micro-organism, so that by enveloping the inner cells of the root cortex it prevents colonisation by phytopathogenic micro-organism and fungi and some species of nematodes.
- It produces excretion of lipopeptide substances (metabolites) such as iturin, phenazines and surfactins which act as antibiotics against other pathogenic micro-organism.
- It secretes lytic enzymes such as chitinases and beta-glucanases and can therefore prevent parasitisation by phytopathogenic fungi.
- It has shown the ability to synthesise siderophores, regulating the concentration of iron in the medium through its chelation (Fe + siderophore), making this metal unavailable to pathogenic micro-organisms, whose growth is highly dependent on this element.
- It produces a great diversity of elicitor molecules (metabolites) that induce systemic resistance in plants, including lipopeptides, phytohormones and volatile compounds.

- Contributes to the phenological development of the plant by activating the metabolic pathways of sugars.
- *Bacillus Megaterium C-2* stimulates the density and length of root hairs, as well as the growth of secondary roots and root surface.
- The mechanisms by which Bacillus C-2 exerts these effects are varied.

This micro-organism, in particular its species, was not classified either as a nitrogen fixer or as a solubiliser of phosphorus and potassium in the soil, until TAVAN demonstrated these characteristics of strain C-2 in its laboratories.

Thus, they can fix atmospheric nitrogen and supply it to the plant; they can synthesise different phytohormones that act to enhance different stages of plant growth; solubilise phosphorus and potassium minerals and make them available to the plant; and synthesise various low molecular weight compounds or enzymes involved in plant growth and development. This particular Bacillus bacterium can affect plant development by one or more of these mechanisms.

After many successful trials in different field experiences on different continents, a product has been designed to supplement plant nutrition and enhance beneficial soil microfauna.

SOLYFERT has the ability to fix atmospheric nitrogen and solubilise blocked phosphorus and potassium present in the soil, converting these macronutrients into available forms to be used by the plant.

The microorganisms present in SOLYFERT establish symbiotic relationships with the crop, improving its defence systems and generating stimuli that favour the processes of cell division and elongation, resulting in greater vegetative growth.

The use of nitrogen-fixing bacteria such as *Bacillus megaterium C-2* represents a great opportunity for agriculture as the nitrogen fixed in the soil by the bacteria is available directly at the place (rhizosphere) where it is required, whereas inorganic fertilisers applied to the soil suffer a loss of 50% to 70% due to natural leaching and denitrification processes. Furthermore, excessive leaching of inorganic fertilisers can lead to contamination of groundwater, rivers and lakes causing ecological damage, and can constitute a risk to animal and human health (in drinking water).

It has been proven that, with the correct dosage and frequency of application of SOLYFERT, a reduction of between 30% and 80% in synthetic fertilisers can be obtained, increasing not only production but also the final quality of the product. It should also be noted that a new, more sustainable and less polluting form of agriculture would be developed on the farm or land treated, which will undoubtedly contribute to the balance of the biosphere by contributing to biodiversity.

TESTS CARRIED OUT

A multitude of tests are those that endorse the benefits of our product SOLYFERT. Over the last 3 years, its effectiveness has been tested on different crops, demonstrating that by reducing the application of NPK fertilisers to 50%, 70% or even 100%, and supplementing this percentage with SOLYFERT (at a specific dose and frequency), the quality of the soil has been the same in all three situations.

Firstly, these tests were carried out in the laboratory where TAVAN worked with its own strain of bacillus discovered to test the properties of this microorganism. This strain is registered by the company in the Spanish Type Culture Collection (C.E.C.T.) of the University of Valencia.

During laboratory tests, it was found that the isolated micro-organism C-2 was able to grow and form colonies in three different media tested in the laboratory, thus demonstrating that it fixes atmospheric nitrogen as well as solubilising insoluble forms of phosphorus and potassium.

It should be noted that, apart from the studies carried out for N, P and K, other tests were also carried out which proved to be successful for the rapid uptake of iron from the soil.

In order to demonstrate in the laboratory that *Bacillus C-2* fixes nitrogen and solubilises phosphorus and potassium in the soil, culture media were prepared without nitrogen, with insoluble phosphorus and with insoluble potassium, bearing in mind that they needed nitrogen, assimilable phosphorus, assimilable potassium and other elements for their development. If the *Bacillus* survived and developed, it is because they extracted these elements from the atmosphere in the case of nitrogen, in the case of phosphorus they changed it from insoluble to soluble form, and in the same way for potassium. And this is what happened in the trial, as can be seen in the following image, where you can see the development of the colonies in the Petri dishes in the second row.

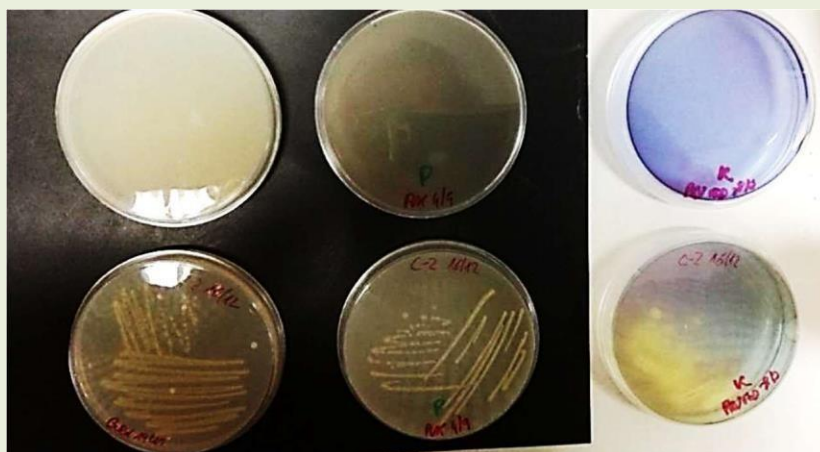


Imagen 1. Results of the *Bacillus megaterium* C-2 test at TAVAN¹.

¹ for further information, please refer to the data sheet provided at the end of this document.

Following the results obtained in the laboratory with the TAVAN strain, field trials were carried out.

Several tests carried out on the company's crops in different countries have demonstrated the enormous efficacy of SOLYFERT, a product developed with the company's own strain *Bacillus megaterium* C-2.

These tests showed that the fertility of the soil was maintained at the same values using SOLYFERT or using the usual fertiliser.

In addition, a series of trials were carried out on different crops which demonstrated the increased yields of crops treated with SOLYFERT.

EFFICACY TESTS WITH SOLYFERT

EFFICACY TRIALS CARRIED OUT BY TAVAN (TOMATO HORTICULTURE)

According to the test carried out by the TAVAN team in a tomato plantation in Extremadura, the Solyfert product acts as an activator of different enzymes related to the development of the plant and, after its application, a more balanced vegetative and root growth is achieved, favouring the absorption of nutrients, an increase in the size and quality of the fruit.

In this trial, an increase in the size of the fruits treated with SOLYFERT was observed, being significantly larger than the control fruits..

It was concluded that the SOLYFERT-treated plantation saw a significant increase in crop yield, which was 60% higher than the control. It was also observed that less damage and greater plant vitality was achieved, strengthening the crop and, indirectly, avoiding damage caused to the weaker plants by "cracking" and other physiopathies such as "peseta disease".

EFFICACY TRIALS SUBMITTED TO THE SPANISH MINISTRY OF AGRICULTURE FOR REGISTRATION (ONION HORTICULTURE)

According to the test carried out by the company NEVAL GRUPO FARMALENT S.L. (outside the TAVAN company), the product SOLYFERT at a dose of 4L/ha and applied at two times throughout the cycle, shows statistically significant differences in the harvest (Kg/ha) with a confidence level of 95%, respect to the control without treatment and with the same maintenance and conditions.

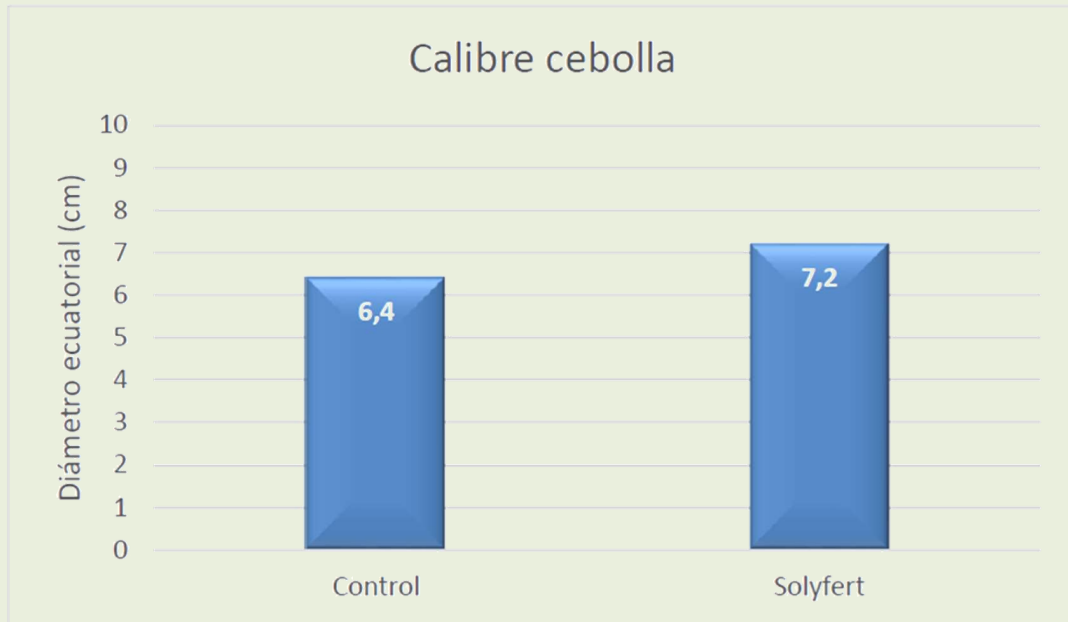
The increase is a 166.3% increase in harvest weight over the control. On the day of harvest, 81 days after transplanting, it was observed: Mayor tamaño medio del bulbo (diámetro en cm).

Higher average weight per bulb, which translates into an increase in kg/block in plots treated with SOLYFERT at 4 L/ha.

The product SOLYFERT at a dose of 4L/ha and applied at two times throughout the cycle, shows statistically significant differences in the calibre (equatorial diameter of the bulb) with a confidence level of 95%, with respect to the control without treatment and with the same maintenance and conditions.

The increase represents a 13% increase in the size of SOLYFERT-treated onions compared to the control onions.





Picture 3. Picture of the harvest day of SOLYFERT-treated onions.



Image 4. Comparison of bulb diameter. Left: control, Right: SOLYFERT

EFFICACY TRIALS SUBMITTED TO THE SPANISH MINISTRY OF AGRICULTURE FOR REGISTRATION (CHARD VEGETABLES)

According to the test carried out by the company NEVALGRUPO FARMALENTS.L. (not belonging to TAVAN), the product Solyfert, at a rate of 4 l/ha and applied at two different times throughout the crop cycle, showed statistically significant differences in the harvest (Kg/ha) with a confidence level of 95% with respect to the untreated control.

The difference was an increase of 13% in the harvest of chard treated with the SOLYFERT product compared to the control, as can be seen in the following images of the test carried out and in the graph of the results obtained.





Control: left column of chard Treatment with SOLYFERT: right column of chard.



Imagen 5. Detail of the weight of a bunch of chard with SOLYFERT treatment.

EFFICACY TRIALS SUBMITTED TO THE MINISTRY OF AGRICULTURE OF SPAIN FOR REGISTRATION (LETTUCE HORTICULTURE)

According to the test carried out by the company NEVALGRUPO FARMALENTS.L. (not belonging to TAVAN), the product Solyfert, at a rate of 4 l/ha and applied at two different times throughout the crop cycle, showed statistically significant differences in the harvest (Kg/ha) with a confidence level of 95%, compared to the untreated control.

The increase meant an increase of 52% in the commercial harvest of lettuces treated with the Solyfert product compared to the control, as can be seen in the following images of the trial carried out and in the graph of the results obtained.

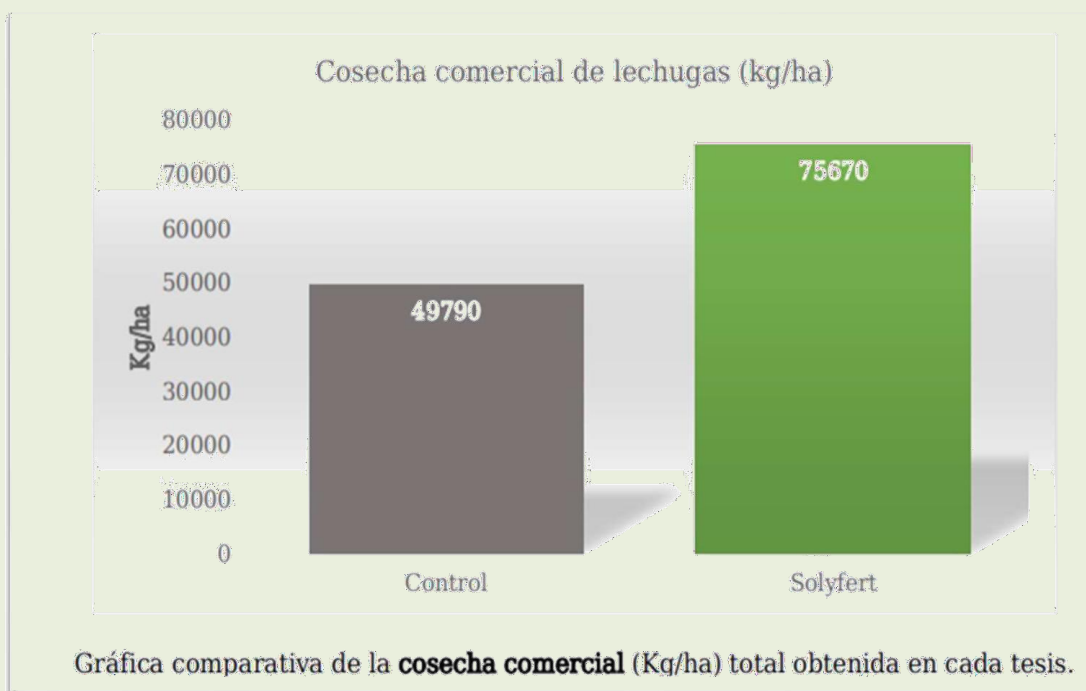




Imagen 5. Detail of the individual weight per lettuce with SOLYFERT treatment.

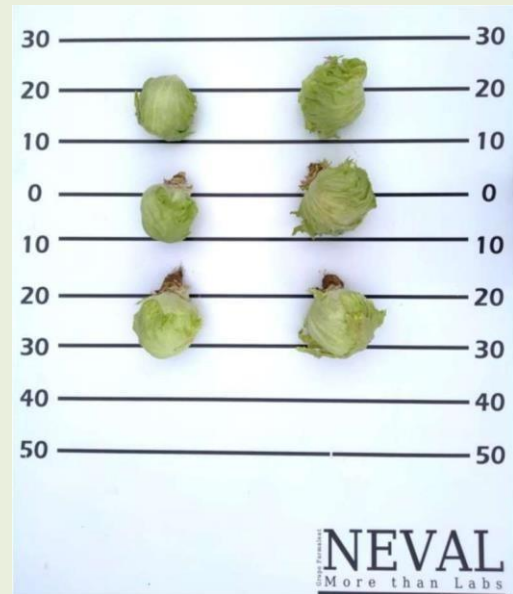


Imagen 7. Comparative picture of 3 lettuces of each treatment. Left: control, Right: SOLYFERT.



Imagen 8. Left: box with 10 control lettuces. Right: box with 10 lettuces with SOLYFERT treatment..

FINAL TECHNICAL RECOMMENDATIONS

Before using SOLYFERT, it is recommended to carry out a soil analysis to check the levels of nitrogen, phosphorus and potassium present in the soil. This product does not provide N, K₂O or P₂O₅, but is capable of transforming the existing N into a soluble form that can be assimilated by the plant.

It is recommended to follow the guidelines dictated by TAVAN's technical department. Respect the doses and application rates in order to maintain the microbiological activity of the soil and to ensure that it supplies the plant with the necessary minerals.

This product can be used on any type of crop (fruit trees, horticultural, tropical) and for any type of agronomic management, both conventional and organic production.

As general recommendation:

- In Woody crops, fruit trees, tropical trees... 60-100 litres/HA/year distributed in 8 to 12 times.
- In horticultural crops... 30-100 litres/Ha/year depending on the type of crop, distributed in 3 to 12 times.

CONCLUSIONS

This report demonstrates in relatively fast growing crops the effectiveness of the product in nutrient solubilisation and fixation with significant differences in yield at a 95% confidence level compared to the untreated control.

In addition to this report, the effectiveness has been demonstrated in tree crops such as avocado, mango and olive groves, among many others, significantly reducing the synthetic fertilisers normally used on these crops (between 30-70%), increasing not only production but also the final quality of the product obtained.

It should also be noted that with the application of solyfert, a new form of agriculture is implemented on the farm, which is more sustainable, less polluting, and in balance with the biosphere, contributing to the continued maintenance of biodiversity.

THE FOLLOWING IS THE REGISTRATION OF THE PRODUCT BY THE MINISTRY OF AGRICULTURE, FISHERIES AND FOOD.



MINISTERIO
DE AGRICULTURA, PESCA
Y ALIMENTACIÓN
DIRECCION GENERAL DE PRODUCCIONES Y MERCADOS AGRARIOS
Registro de Productos Fertilizantes

Resolution on entry in the Register of Fertiliser Products

FABRICANTE:

(Responsable de la puesta en el mercado)

**TECNOLOGÍAS AVANZADAS AGRÍCOLAS,
S.L.
C/ BUITRERA 3
46180 BENAGUACIL (VALENCIA)**

Nombre comercial del producto:

SOLYFERT

Tipo de producto: 4403 Microorganismos no micorrícicos

Número de Registro: F0005387/2032

De conformidad con el artículo 21 del Real Decreto 506/2013, de 28 de junio, se resuelve autorizar la inscripción en el Registro de productos fertilizantes del producto arriba referenciado, requisito necesario para su puesta en el mercado y su utilización en la agricultura. La presente autorización solo hace referencia al producto fertilizante, no eximiendo a su titular de la obligación de recabar y obtener cuantas licencias, permisos o autorizaciones puedan ser exigibles, en virtud de disposiciones legales vigentes, para la realización de su actividad.

En su fabricación y comercialización se cumplirán las exigencias de puesta en el mercado y sobre las materias primas que se indican en los capítulos III y IV del Real Decreto 506/2013, de 28 de junio.

El etiquetado del producto deberá ajustarse a las disposiciones generales y específicas que se indican en el Anexo II del Real Decreto 506/2013, de 28 de junio, sin perjuicio de las que pudiera establecer cualquier otra norma que fuese de aplicación.

De acuerdo con lo establecido en el artículo 22 del R.D. 506/2013, de 28 de junio, la inscripción tiene una validez de diez años. La fecha de inscripción coincide con la fecha de firma electrónica del presente documento y puede ser consultada en la página oficial del Registro.

La presente resolución no agota la vía administrativa, de conformidad con el artículo 112 de la Ley 39/2015, de 01 de octubre, del Procedimiento Administrativo Común de las Administraciones Públicas y podrá recurrirse en alzada ante el Sr. Secretario General de Agricultura y Alimentación, en el plazo de un mes, contando a partir del día siguiente a aquel en que tenga lugar su notificación, de acuerdo con lo establecido en los artículos 121 y siguientes de la Ley 39/2015, de 01 de octubre.

LA DIRECTORA GENERAL DE PRODUCCIONES Y MERCADOS AGRARIOS

CSV : GEN-67e2-d77f-7015-7579-dad8-cf04-773d-2c98

DIRECCIÓN DE VALIDACIÓN : <https://sede.administracion.gob.es/pagSedeFront/servicios/consultaCSV.htm>

FIRMANTE(1) : MARIA ESPERANZA DE ORELLANA MORALED A | FECHA : 28/09/2022 11:42 | NOTAS : F

Firmado electrónicamente por:
María Esperanza de Orellana Morales

TOMATO (GREENHOUSE)

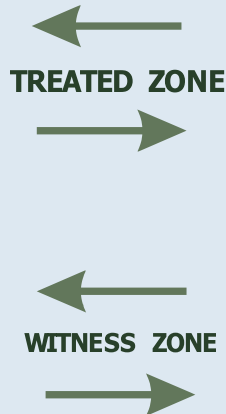
In the province of Almeria, a trial was carried out with applications of solyfert every 15 days at 5 L/Ha with the following results:

SAP ANALYSIS

| | WITNESS ZONE/TREATED | |
|------------------------------|----------------------|------|
| NO₃ (ppm) | 2000 | 2900 |
| K⁺ (ppm) | 3100 | 3600 |
| °BRIX | 3,5 | 5 |
| Ca⁺² (ppm) | 210 | 310 |
| Na⁺² (ppm) | 220 | 290 |

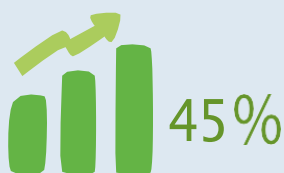
PRODUCTION DATA

- ✓ Increased crop yields
- ✓ Savings in fertiliser costs for the synthesis fund.
- ✓ Higher crop quality with less crop damage in the treated area.
- ✓ More vigorous plants with a proper nutritional balance.
- ✓ Increase of cations, reducing sensivity to pathogenic fungi



PORCENTAJE DE INCREMENTO

NO₃



K



°BRIX

