NODONANO

Informe de Vigilancia Estratégica

Nanotecnología aplicada a herbicidas

Mayo 2023

mgp Municipalidad de General Pueyrredon
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Editorial

Tema: *Tendencias en investigación científica, producción tecnológica, financiamiento, innovación de productos y procesos, y perspectivas de mercado, para el segmento de desarrollo de herbicidas mediante liberación controlada desde sustratos de materiales nanotecnológicos*

El presente informe ha sido elaborado a partir de un conjunto de fuentes de información secundaria en las siguientes categorías: publicaciones científicas (Scopus, Pubmed), patentes e información de mercado. Su alcance se limita a la búsqueda y análisis de información relacionada con un conjunto de tecnologías que podrían tener impacto en la generación de tecnologías tendientes a controlar el impacto ambiental de los herbicidas tal como es la ventaja de la liberación sostenida a partir de su encapsulación en matrices orgánicas o inorgánicas.

Un herbicida es un producto químico utilizado para eliminar o controlar plantas indeseadas. Debido al gradual aumento demográfico a escala mundial, la agricultura productivista ha exacerbado el uso de agroquímicos en los cultivos vegetales. Los agricultores y las empresas agrícolas han aumentado las adquisiciones de tierras cultivables para aumentar la producción de cultivos y se espera que esto aumente la demanda de herbicidas e impulse el crecimiento del mercado.

Cuando un herbicida se aplica en el campo, éste se distribuye en las distintas fases del ambiente (suelo, agua, aire, animales y plantas) y tal distribución dependerá, en parte, de las propiedades del herbicida, el suelo y el ambiente. En general, los herbicidas pueden degradarse de forma química y/o biológica, descomponerse, volatilizarse, absorberse por parte de los organismos y en las partículas del suelo. También, se pierden por escurrimiento y lixiviación a lo largo del perfil del suelo contaminando aguas subterráneas. A raíz de ello, los herbicidas sintéticos están dando lugar a diferentes complicaciones tanto en humanos como en animales. Más aún, los problemas desarrollados por humanos y animales debido al uso de herbicidas sintéticos limitan el crecimiento de su mercado.

Por este motivo se ha priorizado conferir valor y generar la mayor eficacia posible en la funcionalidad de dichos plaguicidas. En ese sentido, las formulaciones de plaguicidas encapsulados protegen al ingrediente activo (herbicida) y facilitan su liberación en el tiempo contribuyendo así a su mejor bioeficacia y función en la planta. En conjunto, sus ventajas conducen a una reducción en la dosis de aplicación del herbicida y, por lo tanto, a una disminución de la toxicidad ambiental puesto que resultan menores su evaporación y percolación en el suelo.

En este sentido, la aplicación de nanotecnología está revolucionando el mercado de los agroquímicos, con impacto significativo en el medio ambiente y la eficiencia y especificidad de los tratamientos, reduciendo los efectos nocivos sobre la salud y potenciando la productividad.

Dra. Claudia Casalongue y Dra. Vera Álvarez

Introducción

El presente informe reúne las tendencias en investigación científica, producción tecnológica, financiamiento, innovación de productos y procesos y perspectivas de mercado, para el segmento de desarrollo de herbicidas mediante liberación controlada desde sustratos de materiales nanotecnológicos.

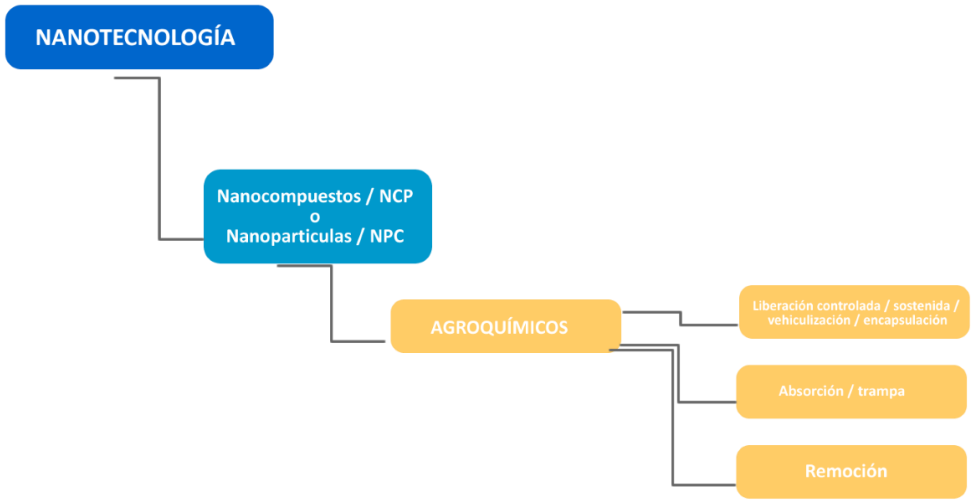
La aplicación de nanotecnología está revolucionando el mercado de los agroquímicos, con impacto significativo en el medio ambiente y la eficiencia y especificidad de los tratamientos, reduciendo los efectos nocivos sobre la salud y potenciando la productividad.

Para el desarrollo del informe se trabajó con un conjunto de fuentes de información secundaria (estructuradas y no estructuradas) en las siguientes categorías: publicaciones científicas (Scopus y Pubmed), patentes de invención (Patent Inspiration), información estadística y de mercado.

Cabe aclarar que se ha llevado adelante el proceso de vigilancia científica en dos bases de datos de corriente principal como son Scopus y Pubmed ya que el tema abordado en este trabajo es transversal a los dos grupos de especialistas que forman parte del Nodo y han considerado la relevancia de contar con el análisis de los recursos recuperados de ambas fuentes de información. Asimismo, el equipo técnico trabajó en la eliminación de resultados repetidos entre ambas bases de datos, así como la unificación de resultados para el diseño y producción de los gráficos de análisis presentados.

Este informe es el primero realizado por el equipo del Nodo territorial de Vigilancia e Inteligencia Estratégica especializada en temas vinculados a la Nanociencia y Nanotecnología luego de su conformación formal e institucional. El mismo se realizó gracias al acompañamiento y asistencia del equipo de especialistas del programa Nacional VINTEC dependiente de la Dirección Nacional de Estudios; Subsecretaría de Estudios y Prospectiva del Ministerio de Ciencia, Tecnología e Innovación, Lic. Angela Fernández y el Dr. Ing. Miguel Guagliano.

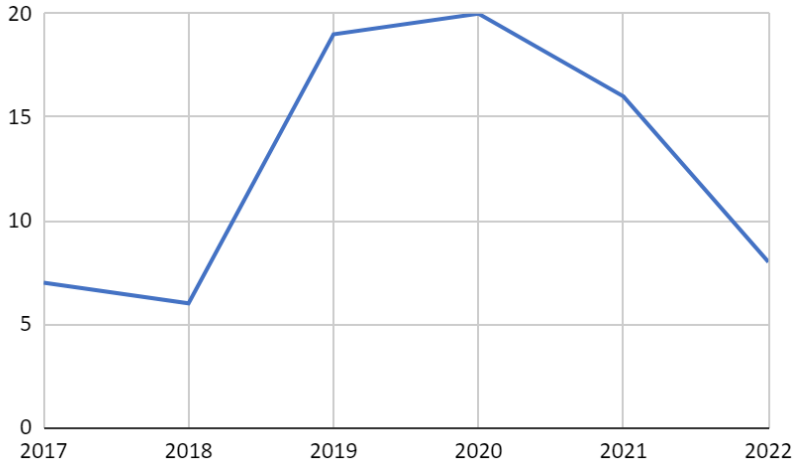
A continuación, se presenta el árbol tecnológico del que se desprende el proceso de vigilancia llevado adelante.



Avances científicos

En este apartado se presentan los resultados de la producción científica relevada en las bases de datos Scopus y Pubmed. El criterio de selección que se utilizó fue a partir de las revistas del primer cuartil (Q1) y de los 3 últimos años (2022, 2021 y 2020). Para conocer el ranking de cada revista se utilizó el indicador Scimago Journal Rank.

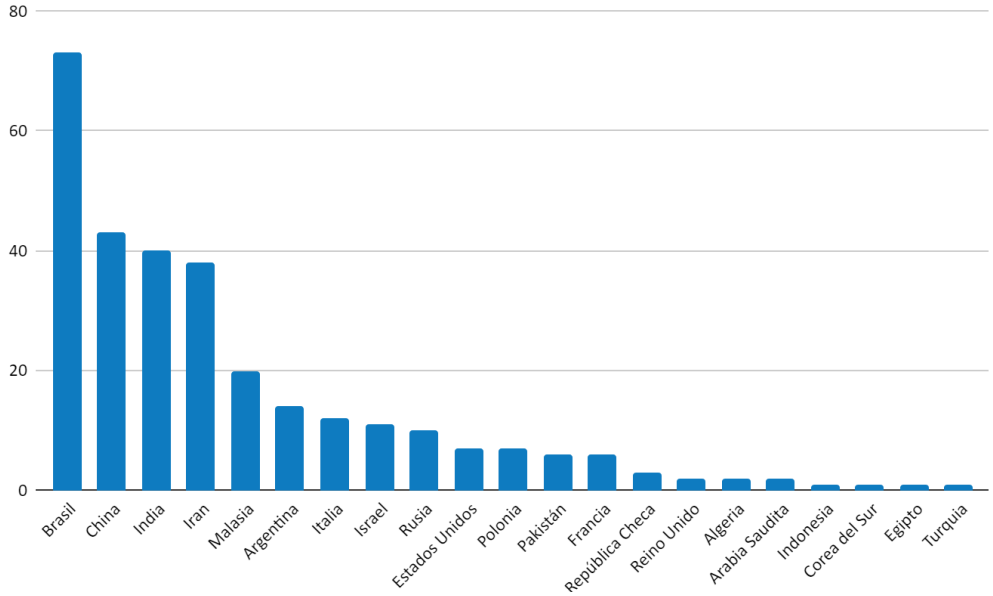
Gráfico 1. Publicaciones por año.



Fuente: elaboración propia.

Se puede observar un incremento de las publicaciones a partir del año 2018 y hasta el año 2021, con una caída para el año 2022. Los países líderes en investigación, a partir de la filiación de los autores, son Brasil, China, India, Irán, Malasia, Argentina, Italia, Israel y Rusia.

Gráfico 2. Publicaciones por país según la filiación del autor.



Fuente: elaboración propia.

Scopus

A continuación, se exponen los 13 resultados más relevantes de Scopus de un total de 59 artículos validados.

Essential oils as natural root-repellent herbicides for drip irrigation systems

2022

Polymers for Advanced Technologies, 33 (9)

Several essential oils (EOs) (Thymol, Carvacrol, Cinnamaldehyde, and Eugenol) were investigated as natural herbicides, and their potential use as a substitute for synthetic and toxic chemicals for preventing roots intrusion in subsurface drip irrigation systems. To overcome their high volatility and to increase their thermal stability during processing, multiphase hybrid blends based on polymer/nanoclays (NCs) were prepared, enabling control of the EOs migration rate from the final active film. Germination experiments on mash bean seeds in open and closed systems have been conducted to evaluate the EOs efficacy as germination inhibitors. The amount of EO remaining in the films, after processing and for varying timepoints, was determined by UV–Vis spectroscopy through extraction. From these two experiment's results, we identified Thymol as the most effective herbicide. The effects of polymers/Thymol affinity and organoclay polarity were investigated to achieve a slow-release effect. Linear low-density polyethylene/polyamide 6 system showed better efficiency compared to the linear low-density polyethylene in retaining Thymol during processing due to the thermodynamic affinity of the polyamide 6 phase with Thymol. NCs have been found to be nuclear foci during the first thermal process to obtain smaller highly surface voids allowing better absorption of the Thymol during the second thermal processing. NC Cloisite 15A showed better dispersion in the polymer matrix and improved chemical affinity between the nanocomposite and the Thymol. As a result, Thymol's desorption was delayed and a controlled release was obtained. Eventually, it was concluded that Thymol could be a natural and environmentally friendly alternative to the synthetic herbicides and use as root-repellent agent.

Enlace al artículo

Interaction of Nanoatrazine and Target Organism: Evaluation of Fate and 3737Photosystem II Inhibition in Hydroponically Grown Mustard (Brassica juncea) Plants

2022

Journal of Agricultural and Food Chemistry, 70 (25)

Poly(epsilon-caprolactone) nanoparticles are an efficient carrier system for atrazine. However, there is a gap regarding the effects of nanoencapsulation on herbicide-plant interactions. Here, we evaluate the fate and photosystem II inhibition of nano and commercial atrazine in hydroponically grown mustard (Brassica juncea) plants whose roots were exposed to the formulations. In addition, to quantify the endogenous levels of atrazine in plant organs, we measured the inhibition of photosystem II activity by

both formulations. Moreover, the fluorescently labeled nanoatrazine was tracked in plant tissues using confocal microscopy. The nanoencapsulation induced greater inhibition of photosystem II activity as well as higher accumulation of atrazine in roots and leaves. The nanoparticles were quickly absorbed by the roots, being detected in the vascular tissues and the leaves. Overall, these results provide insights into the mechanisms involved in the enhanced preemergent herbicidal activity of nanoatrazine against target plants.

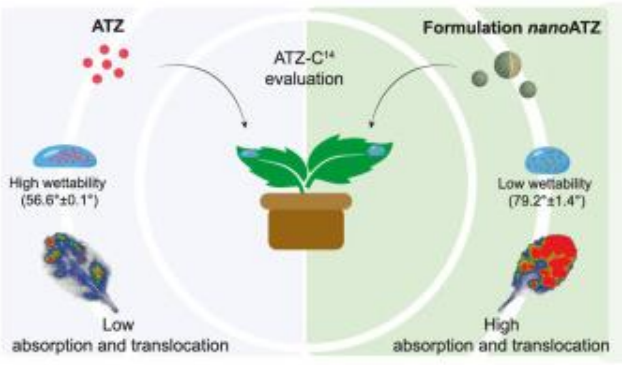
Enlace al artículo

Foliar absorption and field herbicidal studies of atrazine-loaded polymeric nanoparticles

2021

Journal of Hazardous Materials, 418

Nanoparticles loaded with atrazine show weed control efficacy even with lower application doses of the active ingredient. Changes in the mode of action of the herbicide through the nanoformulation are key to understanding the efficiency of post-emergence activity of nanoatrazine. Here, we report the leaf absorption and translocation of nanoatrazine and atrazine employing radiometric techniques and compare their herbicidal effects in greenhouse and field conditions. Compared to the commercial formulation, nanoatrazine showed greater and faster absorption rates in mustard leaves (40% increment in the absorbed herbicide 24 h after application), inducing higher inhibition of photosystem II activity. Assays with fusicoccin-treated leaves indicated that the stomatal uptake of nanoparticles might be involved in the improved activity of nanoatrazine. Nanoencapsulation potentiated the post-emergent herbicidal activity of atrazine and the gain provided by nanoencapsulation was higher in the field compared to greenhouse conditions. Regardless of the dose, nanoatrazine provided two-fold higher weed control in the field compared to commercial atrazine. Thus, the design of this carrier system enables improvements in the performance of the herbicide in the field with less risk of environmental losses of the active ingredients due to faster absorption.



Enlace al artículo

Functionalized dextrin-based nanosponges as effective carriers for the herbicide ailanthone

2021

Industrial Crops and Products, 164

Ailanthone, a quassinoid from Ailanthus altissima (Mill.) Swingle, is a natural herbicide, whose use is limited by its low persistence and rapid degradation in organic substrates. Dextrin-based nanosponges (NSs) are polymers with a cage-like structure that can complex several molecules, acting as carriers or protectors. Their encapsulation efficiency can be exploited in numerous applications. Hence this study explored at first the biological activity of eight different dextrin-based NSs, synthesized with 1,1'-carbonyldiimidazole (CDI) or pyromellitic dianhydride (PYRO) (αNS-CDI, βNS-CDI, γNS-CDI, LC NS-CDI, αNS-PYRO, βNS-PYRO, γNS-PYRO, and LC NS-PYRO), towards two model species (Lepidium sativum L. and Raphanus sativus L.) in filter paper under controlled conditions in laboratory. Then, the selected dextrin-based NSs were loaded with ailanthone and applied in the concentration of 7.5 or 30 mg L−1 of ailanthone in pre-emergence on the same species, initially on filter paper and subsequently on cultivation substrate for horticulture. In all three bioassays, the number of germinated seeds and the length of developed roots and hypocotyls were evaluated. In the first bioassay, the results showed that five dextrin-based NSs promoted the germination and root elongation, thus counteracting the herbicidal effect of ailanthone. Hence, three selected formulations (αNS-CDI, γNS-CDI, and LC NS-CDI) were loaded with ailanthone, with γNS-CDI providing the highest loading capacity (1.36%) and encapsulation efficiency (55.15%). In the second bioassay, the phytotoxic activity of ailanthone was strengthen by dextrin-based NSs, always stronger by at least 58% than the pure compound across 30 days in paper, without differences between formulations. In the third bioassay, loading ailanthone in γNS-CDI also prolonged its herbicidal activity, still reducing to only 20% the germination and growth of garden cress and radish 30 and 20 days after treatment, respectively. Overall, results demonstrated that dextrin-based nanosponges can be proposed as suitable carriers in the formulation of ailanthone-based herbicide. Their use both increased and extended the phytotoxic activity of ailanthone, leading to the possibility of reducing the amount applied for each treatment, or reducing the number of herbicide treatments.

Enlace al artículo

Polymeric Nanocomposite-Based Herbicide of Carboxymethyl Cellulose Coated-Zinc/Aluminium Layered Double Hydroxide-Quinclorac: A Controlled Release Purpose for Agrochemicals

2021

Journal of Polymers and the Environment, 29 (6)

In this work, the use of carboxymethyl cellulose (CMC) is highlighted in enhancing the controlled release behaviour of zinc/aluminium layered double hydroxide-quinclorac (Zn/Al-LDH-QC). The Zn/Al-LDH-QC-CMC nanocomposite were characterised using powder x-ray diffraction, Fourier transform infrared spectroscopy, thermogravimetric and derivative thermogravimetric analysis and field emission scanning electron microscopy. The release study was carried out in an aqueous solution of Na3PO4, Na2SO4 and NaCl, so as to mimic the environmental condition where the QC is frequently used. The Zn/Al-LDH-QC-CMC nanocomposites showed better performance in releasing QC, with prolonged release time ranging from 163–6083 min, compared to 99–2639 min for the uncoated nanocomposites. The hygroscopic nature of the CMC play a critical role in enhancing the release behaviour of the Zn/Al-LDH-QC-CMC. The kinetic study shows that the Zn/Al-LDH-QC-CMC follows the pseudo-second order kinetic model; hence the release mechanism occurred via dissolution of the CMC matrix and the ion exchange process. These results, therefore, indicate the potential of Zn/Al-LDH-QC-CMC in dealing with the downside effect of the excessive usage of herbicide in paddy cultivation.

Enlace al artículo

Nanoparticle tools to improve and advance precision practices in the Agrifoods Sector towards sustainability - A review

2021

Journal of Cleaner Production, 293

Common agricultural pest and pathogen management practices are reliant on agrochemicals (pesticides, herbicides, and fertilizers), drugs and synthetic materials that can lead to contamination of water, soil and food products. Indiscriminate use of agrochemicals has a cost in the form of lost crops, poor food quality and harmful impacts on the environment. The advent of nanomaterial engineering has led to the development of novel 'nano' tools (<1000 nm) with the potential to support sustainable smart agriculture and precision farming practices. Nanoencapsulation, using designed nanoparticles, has offered the opportunity to detect pathogens and deliver nutrients, drugs and agrochemicals in a controlled and targeted manner to improve food production. Future environmentally friendly and food-safe nanoparticle-based technology will be dependent on developing materials that are sustainable and demonstrate efficiency in field conditions. In this review, we provide an overview of the types of engineered and natural nanoparticles, as well as their application in sustainable and precision agriculture. We then assess the safety and efficacy profiles of prospective synthetic and biological nanoparticles.

Enlace al artículo

Recent Trends in Advanced Polymer Materials in Agriculture Related Applications

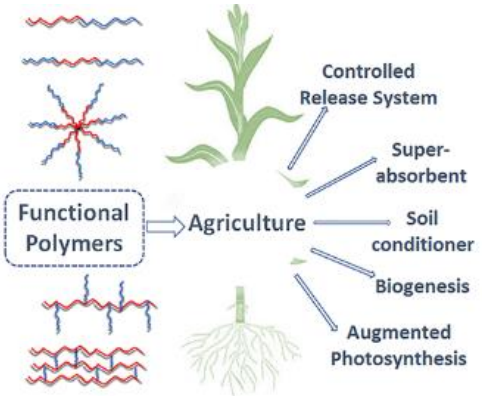
2021

ACS Applied Polymer Materials, 3 (3)

Over the past few decades, advanced polymeric materials have gained popularity in the development of sustainable agricultural applications. Smart polymeric systems have extensively contributed to the agricultural industry by increasing the efficiency of pesticides, herbicides, and fertilizers by facilitating controlled release systems and, therefore, enabling lower doses to be used. Superabsorbent polymeric materials have been used as soil conditioners to control the impact of drought, whereas polycationic polymers have been utilized for plant bioengineering. These functions in the environment are complemented by applications within plants as part of the developing range of tools for genetically transforming plants in order to increase productivity and disease resistance. This Review will summarize and discuss the recent developments in the design and application of advanced polymeric systems for precision agriculture related applications. The design criteria of the polymers employed to date, such as polymer structure, as well as the properties of polymer nanoparticles including shape and size will be discussed, and the key findings in the related area will be highlighted. Finally, we will identify future

directions for the exploration of functional polymers with the ultimate aim of advancing sustainable agriculture.

Enlace al artículo



Fabrication and characterization of a novel herbicide delivery system with magnetic collectability and its phytotoxic effect on photosystem II of aquatic macrophyte

2020

Journal of Agricultural and Food Chemistry, 68 (40)

The use of nano- and microparticles as a release system for agrochemicals has been increasing in agricultural sector. However, the production of eco-friendly and smart carriers that can be easily handled in the environment is still a challenge for this technology. In this context, we have developed a biodegradable release system for the herbicide atrazine with magnetic properties. Herein, we investigated the (a) physicochemical properties of the atrazine-loaded magnetic poly(ϵ-caprolactone) microparticles (MPs:ATZ), (b) in vitro release kinetic profile of the herbicide, and (c) phytotoxicity toward photosynthesis in the aquatic fern Azolla caroliniana. The encapsulation efficiency of the herbicide in the MPs:ATZ was ca. 69%, yielding spherical microparticles with a diameter of ca. 100 µm, a sustained-release profile, and easily manipulated with an external magnetic field. Also, phytotoxicity issues showed that the MPs:ATZ maintained their herbicidal activity via inhibition of PSII, showing lower toxicity compared with the nonencapsulated ATZ at 0.01 and 0.02 µmol L-1. Therefore, this technology may conveniently promote a novel magnetic controlled release of the herbicide ATZ (with the potential to be collected from a watercourse) and act as a nutrient boost to the nontarget plant, with good herbicidal activity and reduced risk to the environment.

Enlace al artículo

Formulation and assessment of nano-encapsulated bioherbicides based on biopolymers and essential oil

2020

Industrial Crops and Products, 149

Excessive uses of chemical pesticides have resulted in the occurrence of a wide array of problems consequently using plant natural products is gaining more attention. In this study, different concentrations of savory (Satureja hortensis L.) essential oil (control, 5, 10 and 15 ml/L) were nano-encapsulated using Arabic gum (AG), Persian gum/gelatin (PGG), Persian gum (PG) as wall materials. The nanocapsules had their herbicidal activity against tomato (Lycopersicon esculentum Mill.) and amaranth (Amaranthus retroflexus L.) evaluated by measuring 18 physiological and biochemical parameters. The average size of the nanocapsules varied between 81 and 208 nm, while polydispersity index showed variation between 0.210 and 0.536. The encapsulation efficiency of nanoparticles varied between 72.1–92.8 %. Nano-encapsulated herbicides (NCHs) stability was investigated for 42 days and a mathematical

model was followed during oil release. Nano-encapsulated herbicides showed considerable herbicidal activity against amaranth while they had a mild effect on tomato. Moreover, herbicidal activity results exhibited the improvement of encapsulated savory essential oil (EO) efficiencies as compared to non-nano EO emulsion (without polymer). The greatest and fastest injury to amaranth caused by encapsulated EO using cross-linked Persian gum at 15 ml/L which asserted 100 % weed control after 48 h. The aforementioned data suggest the encapsulation of essential oils by biopolymers and with the help of cross-linkers can be used as a valuable tool for the production of organic, natural herbicides.

Enlace al artículo

Controlled release formulation of zinc hydroxide nitrate intercalated with sodium dodecylsulphate and bispyribac anions: A novel herbicide nanocomposite for paddy cultivation

2020

Arabian Journal of Chemistry, 13(3)

Bispyribac (BP) anions have been successfully intercalated in the interlayer region of zinc hydroxide nitrate (ZHN) in the presence of sodium dodecylsulphate (SDS) surfactant. The physicochemical properties of the intercalation compound ZHN–SDS–BP have been characterised herein with different instrumental techniques. The intercalation of BP and SDS is clearly reflected in the PXRD analysis, based on the appearance of symmetrical, sharp and intense intercalation peaks at lower 2θ with a basal spacing of 28.2–28.6 Å. The thermal studies show that the ZHN–SDS–BP nanocomposite has better thermal stability than the pristine BP. The intercalation of BP leads to significant changes in the surface area, porosity, and morphology. Nitrogen adsorption–desorption isotherms reveal that both ZHN–SDS and ZHN–SDS–BP are of Type IV. The release and kinetic studies were also carried out on the ZHN–SDS–BP, in aqueous solution of Na3PO4, Na2SO4 and NaCl as the release media. The releases of BP in both aqueous solutions of Na3PO4 and NaCl were found to follow the pseudo second order kinetic model, whereas the releases of BP in the aqueous solution of Na2SO4 obey the parabolic diffusion kinetic model. This study shows that ZHN has the potential to be used as a host material in slowing the release of BP herbicides in the paddy cultivation sector.

Enlace al artículo

Electrical-Driven Release and Migration of Herbicide Using a Gel-Based Nanocomposite

2020

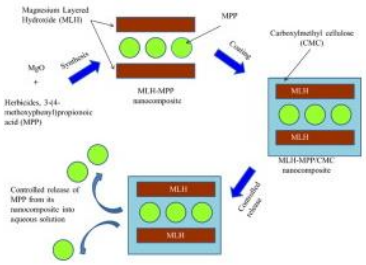
Journal of Agricultural and Food Chemistry, 68(6)

In this work, an electrical-driven release and migration glyphosate (EDRMG) was fabricated using a nanocomposite made up of attapulgite (ATP), glyphosate (Gly), and calcium alginate (CA). Therein, ATP-

CA acted as a nanonetwork-structured carrier to efficiently load plenty of Gly to form porous ATP-Gly-CA hydrogel spheres (actually EDRMG-0.5) via a cross-linking reaction. The pores in EDRMG-0.5 hydrogel spheres were enlarged under an electric field because of the Coulomb force of the anionic CA polymer, and the release of negatively charged Gly from the spheres could be driven by the electric field force. Thus, EDRMG-0.5 exhibited a great electroresponsively controlled-release property, which was confirmed by a pot experiment. Importantly, the EDRMG-0.5 hydrogel spheres had fine biocompatibility on fish and mice, displaying good biosafety. This work provides a low cost and promising approach to control Gly release, deliver Gly precisely, and improve utilization efficiency, which might have a high application value.

Enlace al artículo

Carboxymethylcellulose-coated magnesium-layered hydroxide nanocomposite for controlled release of 3-(4-methoxyphenyl)propionic acid



2020

Arabian Journal of Chemistry, 13(2)

Carboxymethylcellulose (CMC) acts as a coating material for a magnesium-layered hydroxide-3-(4-methoxyphenyl)propionate (MLH-MPP) nanocomposite via spontaneous self-assembly. The resulting product is called a magnesium-layered hydroxide-3-(4-methoxyphenyl)propionate/carboxymethylcellulose (MLH-MPP/CMC) nanocomposite. The XRD pattern of the MLH-MPP/CMC nanocomposite showed that MPP was maintained in the interlayers of the MLH, thus confirming that CMC is only deposited on the surface of the MLH-MPP nanocomposite. These findings were also supported by FTIR spectra, SEM and TEM. TGA data showed that the thermal stability of the intercalated MPP was significantly enhanced compared to pure MPP and uncoated nanocomposite. The release of MPP from the interlayers of MLH-MPP/CMC nanocomposite showed slower release than did uncoated nanocomposite and followed pseudo–second-order kinetics. Since the herbicide, MPP was released from the synthesised nanocomposite in a sustained manner, thus, it has excellent potential to be used as a controlled-release herbicide formulation.

Enlace al artículo

Atrazine nanoencapsulation improves pre-emergence herbicidal activity against Bidens pilosa without enhancing long-term residual effect on Glycine max

2020

Pest Management Science, 76(1)

Poly(ϵ-caprolactone) nanocapsules (NC + ATZ) are an efficient carrier system for atrazine and were developed as an alternative to reduce the harmful environmental effects of this herbicide. Here, we analyzed the pre-emergence herbicidal activity of NC + ATZ against Bidens pilosa and evaluated its residual effect on soybean plants after different periods of soil treatment with the formulations. RESULTS: In contrast to non-nanoatrazine, NC + ATZ treatment led to very high mortality rates of B. pilosa seedlings even after a tenfold dilution, which suggests that atrazine nanoencapsulation improved its pre-emergence

herbicidal activity. In a short-term assay (17 days), soil treatment with all atrazine-containing formulations resulted in intense toxicity to soybean plants. NC + ATZ at 200 g ha−1 had the same inhibitory effects on the physiological and growth parameters of soybean plants compared with non-nanoatrazine at 2000 g ha−1, which suggests that atrazine nanoencapsulation increased the short-term residual effect of the herbicide. In a long-term assay (60 days), a gradual recovery of soybean plants from atrazine phytotoxicity was observed. When comparing the effects of nano- and non-nanoatrazine at the same concentrations, the growth and physiological parameters of soybean plants were mainly affected to the same extent. This indicates that encapsulation of atrazine into poly(ϵ-caprolactone) nanocapsules did not enhance the long-term residual effect of the herbicide on soybean. CONCLUSION: NC + ATZ could be applied for efficient weed control without additional phytotoxicity to susceptible crops compared with non-nanoatrazine, provided that a safe interval is respected from atrazine application to sowing.

Enlace al artículo

Pubmed

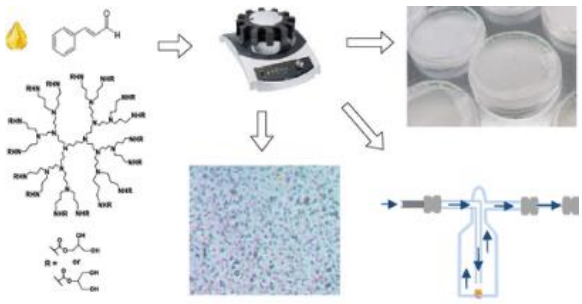
A continuación, se exponen los 11 resultados más relevantes de Pubmed de un total de 25 artículos validados.

Cinnamomum zeylanicum Essential Oil Formulation with Poly(propylene imine) Dendrimers with Surface-Grafted Glycerol: Release Kinetics of trans-Cinnamaldehyde and Germination Inhibition Effects

2022

Journal of Agricultural and Food Chemistry, 70(16), 5177–5185

The Third-generation glycerodendrimer polypropylenimine (GD-PPI-3) can be used in an aqueous formulation of Cinnamomum zeylanicum essential oil (CEO). The purpose was to give an overview of this innovative method of retaining and releasing essential oils. The formulation consisted of 366 min stirring at 1735 rpm of the aqueous solution of 2 mM GD-PPI-3 with CEO. Some physicochemical properties of these formulations, as well as the release of trans-cinnamaldehyde, have been studied. A bimodal distribution and no concentration or aging effect were observed by optical microscopy. Moreover, the release kinetics showed the retention of volatile molecules in solution under various environmental conditions. The release profile was characterized by an initial burst followed by a steady release. The dendrimers allowed us to reduce this initial burst and extended the release by at least 15 h. In addition, the herbicidal effect was evaluated: inhibition of Arabidopsis thaliana seed germination was obtained for 7 days with a formulation of 12.5 mg/L CEO in a closed space and 360 mg/L CEO in an open space.



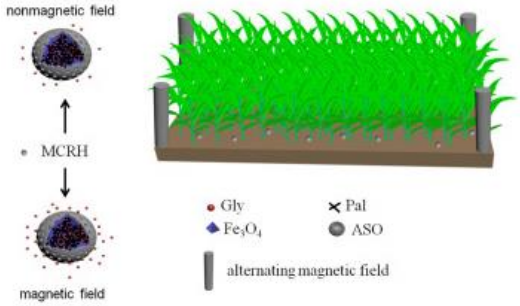
Enlace al artículo

Fabrication of magnetic-responsive controlled-release herbicide by a palygorskite-based nanocomposite

2021

Colloids and Surfaces B: Biointerfaces, 208

In this work, a type of magnetic-responsive controlled-release herbicide (MCRH) was developed using a nanocomposite including palygorskite (Pal), ferroferric oxide (Fe3O4), glyphosate (Gly), and amino silicon oil (ASO). In this system, Pal with the structure of micro/nanonetworks can bind a large quantity of Gly and Fe3O4. The movement of Fe3O4 particles can be driven by a magnetic field to ensure the controlled release of pesticides. Gly, which is a type of nonselective herbicide, is widely used for weed control. In addition, ASO was selected as the coating agent to prevent Gly from rapidly releasing. In this work, the effects of the magnetic field, temperature, and coexisting ions on the release ratio of pesticides were investigated, and the results suggest that MCRH could effectively improve the utilization efficiency (UE) of Gly. In addition, zebrafish experiments indicate that MCRH has better biosafety than Gly.



Enlace al artículo

User-safe and efficient chitosan-gated porous carbon nanopesticides and nanoherbicides

2021

Journal of Colloid and Interface Science, 594, 20-34

Nanopesticides are selected as one of ten chemical innovations that will change our world. Carboxylated porous carbon nanoparticles (PCNs) were used to encapsulate water-insoluble pesticides and subsequently capped with chitosan (CS) to prepare the CS-gated PCN (PCN@CS) nanopesticides for the controlled release of pesticides in response to acidic pH and elevated temperature with good fungicidal efficacy. To resolve the issue of gastrointestinal absorption of PQ upon ingestion of PQ formulation, it is an innovative strategy to select the carboxylated PCNs as the paraquat (PQ) nanocarriers to inhibit PQ release in the gastrointestinal tract from the origin. The PQ-loaded PCN@CS nanoherbicides showed very low cytotoxicity to human normal cells and high survival rate in mice because the strong π-π interactions between the electron-deficient PQ and the electron-rich PCNs almost inhibited the release of PQ at both acidic and alkaline pH values. The controlled release of PQ from the nanoherbicides was realized at elevated temperatures owing to the weakening of the strong π-π interactions, aiming to eliminate weeds via the photothermal effect of PCNs under natural sunlight. The user-safe PCN-based PQ formulation can inhibit PQ release in the gastrointestinal tract and keep the PQ herbicidal efficacy in the practical application.

Enlace al artículo

Pectin/chitosan/tripolyphosphate encapsulation protects the rat lung from fibrosis and apoptosis induced by paraquat inhalation

2021

Pesticide Biochemistry and Physiology, 178

Paraquat poisoning leads to lung injury and pulmonary fibrosis. The effect of paraquat encapsulation by previously described Pectin/Chitosan/Tripolyphosphate nanoparticles on its pulmonary toxicity was investigated in present study in a rat model of poison inhalation. MATERIAL AND METHOD: The rats inhaled nebulized different formulation of paraquat (n = 5) for 30 min in various experimental groups. Lung injury and fibrosis scores, Lung tissue enzymatic activities, apoptosis markers were determined compared among groups. RESULTS: Encapsulation of paraquat significantly rescued both lung injury and fibrosis scores. Lung MDA level was reduced by encapsulation. Paraquat poisoning led to lung tissue apoptosis as was evidenced by higher Caspase-3 and Bax/Bcl2 expressions in rats subjected to paraquat inhalation instead of normal saline or free nanoparticles. Again, nanoencapsulation reduced these apoptosis markers significantly. Alpha-SMA expression was also reduced by encapsulation. Nanoparticles per se have no or little toxicity as was evidenced by inflammatory and apoptotic markers and histological scores. CONCLUSION: In a rat model of inhalation toxicity of paraquat, loading of this herbicide on PEC/CS/TPP nanoparticles reduced acute lung injury and fibrosis. The encapsulation also led to lower apoptosis, oxidative stress and alpha-SMA expression in the lung tissue.

Enlace al artículo

Nanoparticles in sustainable agriculture: An emerging opportunity

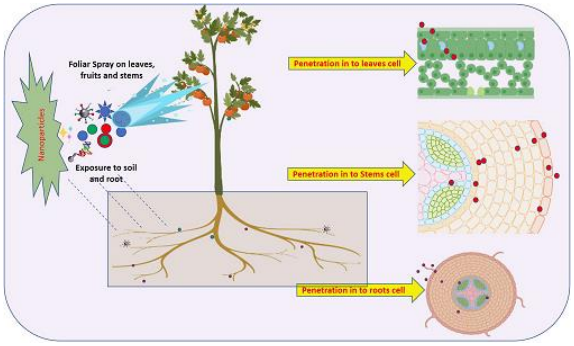
2021

Journal of Controlled Release, 329, 1234-1248

Conventional agriculture often relies on bulky doses of fertilizers and pesticides that have adversely affected the living beings as well as the ecosystems. As a basic tenet of sustainable agriculture, minimum agrochemicals should be used so that the environment can be protected and various species can be conserved. Further, sustainable agriculture should be a low input system, where the production costs are lower and net returns are higher. The application of nanotechnology in agriculture can significantly enhance the efficiency of agricultural inputs and thus it offers a significant way to maintain sustainable development of agroecosystems via nanoparticles. In this regard, nano-plant growth promoters, nanopesticides, nanofertilizers, nano-herbicides, agrochemical encapsulated nanocarrier systems etc. have been developed for the potential applications in agriculture. These can have great benefits for agriculture, including higher production of crops, inhibition of plant pathogens, removal of unwanted weeds and insects with lesser cost, energy and waste production. However, there are several concerns related to the use of nanoparticles in agriculture. These include the approaches for synthesis, their mechanisms of penetration to applied surfaces and the risks involved. Though, advent of new technologies has significantly improved the synthesis and application of nanomaterials in agriculture, there are many uncertainties regarding nano-synthesis, their way of utilization, uptake and internalization inside the crop cells. Therefore, an elaborate investigation is required for deciphering the engineered nanomaterials, assessing their mechanistic application and agroecological toxicity. Hence, this review is

aimed to critically highlight the NPs material application and points towards the vital gaps in the use of nanotechnology for sustainable agriculture.

Enlace al artículo



Engineering and use of proteinoid polymers and nanocapsules containing agrochemicals

2020

Scientific Reports, 10(9171)

To address global challenges such as population growth and climate change, introduction of new technologies and innovations in agriculture are paramount. Polymer-based formulations of agrochemicals have received much attention in recent years, and there is strong motivation to develop agrochemicals that are not harmful to the environment. Proteinoid polymers are produced by thermal step-growth polymerization of natural and unnatural amino acids. Under suitable gentle conditions, the proteinoid polymers may self-assemble to form nano-sized hollow proteinoid nanoparticles (NPs) of a relatively narrow size distribution. Agrochemical molecules may be encapsulated within these hollow proteinoid NPs, integrated in the crude proteinoid shell, or bound covalently/physically to the NP surface. In the present manuscript we prepared and characterized four model proteinoid polymers and NPs: P(KEf), P(KF), P(EWH-PLLA) and P(KWH-PLLA), where Ef denotes the unnatural herbicidal amino acid glufosinate. The NPs were fluorescently labeled and loaded with agrochemicals such as the plant hormone auxin. In addition, the NP surface was hydrophobized by covalent conjugation of dodecyl aldehyde via its surface primary amine groups. Following treatment of the plants with the different fluorescent-labeled NPs, fluorescent microscopic techniques enabled to localize the NPs and observe the accumulation in the plant's vascular system. Next, using genetically modified plants, which express fluorescent protein and are responsive to the level of auxin, we demonstrated the possibility to deliver encapsulated agrochemicals into cells. We also illustrated that the proteinoid NPs are non-toxic to human umbilical vein endothelial cells, and apart from P(KEf) also to lettuce plants.

Enlace al artículo

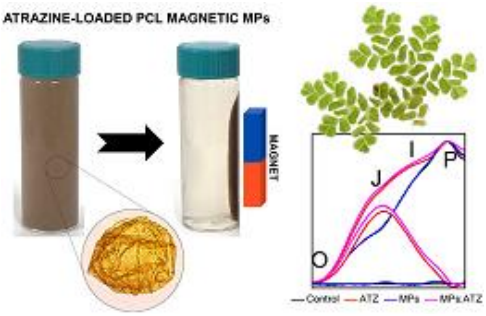
Fabrication and Characterization of a Novel Herbicide Delivery System with Magnetic Collectability and Its Phytotoxic Effect on Photosystem II of Aquatic Macrophyte

2020

Journal of Agricultural and Food Chemistry, 68(40), 11105–11113

The use of nano- and microparticles as a release system for agrochemicals has been increasing in agricultural sector. However, the production of eco-friendly and smart carriers that can be easily handled in the environment is still a challenge for this technology. In this context, we have developed a biodegradable release system for the herbicide atrazine with magnetic properties. Herein, we investigated the (a) physicochemical properties of the atrazine-loaded magnetic poly(ε-caprolactone) microparticles (MPs:ATZ), (b) in vitro release kinetic profile of the herbicide, and (c) phytotoxicity toward

photosynthesis in the aquatic fern Azolla caroliniana. The encapsulation efficiency of the herbicide in the MPs:ATZ was ca. 69%, yielding spherical microparticles with a diameter of ca. 100 µm, a sustained-release profile, and easily manipulated with an external magnetic field. Also, phytotoxicity issues showed that the MPs:ATZ maintained their herbicidal activity via inhibition of PSII, showing lower toxicity compared with the nonencapsulated ATZ at 0.01 and 0.02 µmol•L-1. Therefore, this technology may conveniently promote a novel magnetic controlled release of the herbicide ATZ (with the potential to be collected from a watercourse) and act as a nutrient boost to the nontarget plant, with good herbicidal activity and reduced risk to the environment.



Enlace al artículo

Atrazine nanoencapsulation improves pre-emergence herbicidal activity against Bidens pilosa without enhancing long-term residual effect on Glycine max

2020

Pest Management Science

Poly(ϵ-caprolactone) nanocapsules (NC + ATZ) are an efficient carrier system for atrazine and were developed as an alternative to reduce the harmful environmental effects of this herbicide. Here, we analyzed the pre-emergence herbicidal activity of NC + ATZ against Bidens pilosa and evaluated its residual effect on soybean plants after different periods of soil treatment with the formulations. RESULTS: In contrast to non-nanoatrazine, NC + ATZ treatment led to very high mortality rates of B. pilosa seedlings even after a tenfold dilution, which suggests that atrazine nanoencapsulation improved its pre-emergence herbicidal activity. In a short-term assay (17 days), soil treatment with all atrazine-containing formulations resulted in intense toxicity to soybean plants. NC + ATZ at 200 g ha-1 had the same inhibitory effects on the physiological and growth parameters of soybean plants compared with non-nanoatrazine at 2000 g ha-1 , which suggests that atrazine nanoencapsulation increased the short-term residual effect of the herbicide. In a long-term assay (60 days), a gradual recovery of soybean plants from atrazine phytotoxicity was observed. When comparing the effects of nano- and non-nanoatrazine at the same concentrations, the growth and physiological parameters of soybean plants were mainly affected to the same extent. This indicates that encapsulation of atrazine into poly(ϵ-caprolactone) nanocapsules did not enhance the long-term residual effect of the herbicide on soybean. CONCLUSION: NC + ATZ could be applied for efficient weed control without additional phytotoxicity to susceptible crops compared with non-nanoatrazine, provided that a safe interval is respected from atrazine application to sowing.

Enlace al artículo

Soil mobility of synthetic and virus-based model nanopesticides

2019

Nature Nanotechnology, 14, 712–718

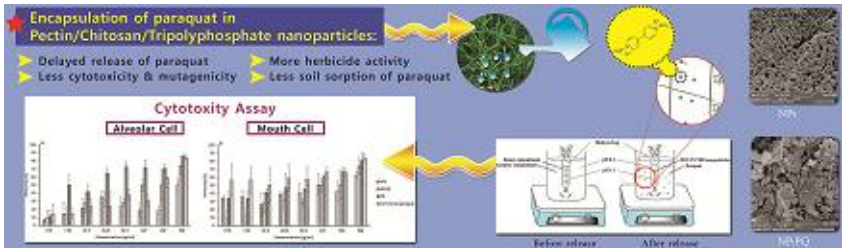
Large doses of chemical pesticides are required to achieve effective concentrations in the rhizosphere, which results in the accumulation of harmful residues. Precision farming is needed to improve the efficacy of pesticides, but also to avoid environmental pollution, and slow-release formulations based on nanoparticles offer one solution. Here, we tested the mobility of synthetic and virus-based model nanopesticides by combining soil column experiments with computational modelling. We found that the tobacco mild green mosaic virus and cowpea mosaic virus penetrate soil to a depth of at least 30 cm, and could therefore deliver nematicides to the rhizosphere, whereas the Physalis mosaic virus remains in the first 4 cm of soil and would be more useful for the delivery of herbicides. Our experiments confirm that plant viruses are superior to synthetic mesoporous silica nanoparticles and poly(lactic-co-glycolic acid) for the delivery and controlled release of pesticides, and could be developed as the next generation of pesticide delivery systems.

Enlace al artículo

Pectin/Chitosan/Tripolyphosphate Nanoparticles: Efficient Carriers for Reducing Soil Sorption, Cytotoxicity, and Mutagenicity of Paraquat and Enhancing Its Herbicide Activity

2019

Journal of Agricultural and Food Chemistry, 67(20), 5736–5745



As a potent herbicide capable of contaminating water and soil environments, paraquat, which is still widely used worldwide, is toxic to mammals, algae, aquatic animals, etc. Paraquat was loaded on novel nanoparticles composed of pectin, chitosan, and sodium tripolyphosphate (PEC/CS/TPP). The size, polydispersity index, and ζ potential of nanoparticles were characterized. Further assessments were carried out by SEM, AFM, FT-IR, and DSC. The encapsulation was highly efficient, and there was a delayed release pattern of paraquat. The encapsulated herbicide was less toxic to alveolar and mouth cell lines. Moreover, the mutagenicity of the formulation was significantly lower than those of pure or commercial forms of paraquat in a Salmonella typhimurium strain model. The soil sorption of paraquat and the deep soil penetration of the nanoparticle-associated herbicide were also decreased. The herbicidal activity of paraquat for maize or mustard was not only preserved but also enhanced after encapsulation. It was concluded that paraquat encapsulation with PEC/CS/TPP nanoparticles is highly efficient and the formulation has significant herbicide activity. It is less toxic to human environment and cells, as was evidenced by less soil sorption, cytotoxicity, and mutagenicity. Hence, paraquat-loaded PEC/CS/TPP nanoparticles have potential advantages for future use in agriculture.

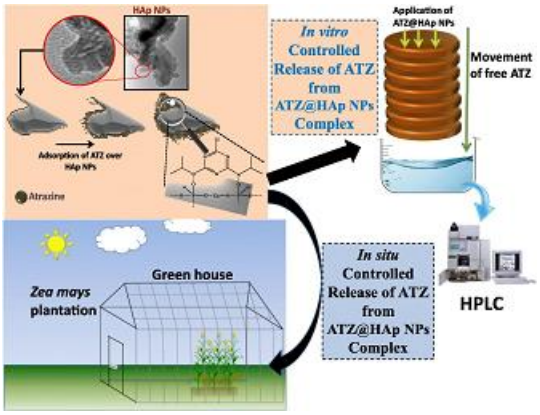
Enlace al artículo

Nanosorbent of hydroxyapatite for atrazine: A new approach for combating agricultural runoffs

2019

Science of the Total Environment, 653, 264-273

The attention of current work was on the fabrication of effective nanoadsorbent of hydroxyapatite (HAp) for the controlled release of atrazine (ATZ) formulation. The ATZ-HAp complex (ATZ@HAp) was able to inhibit the growth of Brassica sp. under in situ conditions. This developed methodology aspires to cease the agricultural runoffs of ATZ applied with the HAp adjuvant and ensure their effective functioning. The efficacy of the protocol was mainly accomplished by adsorbing ATZ over the surface of HAp NPs that restricted its premature runoff and promoted the prolonged herbicidal efficiency. The influence of fundamental parameters i.e., HAp dose, ATZ dose and initial pH on the adsorption process was investigated systematically. The suitability of ATZ@HAp complex for real world application was adjudged after proofing its toxicological behaviour and its role in Zea mays plantations. The complex was found to be non-toxic and nurturing due to its phosphate rich nature. Further investigations of ATZ@HAp complex and its effect on the non-target species will help in establishing an effective framework for their commercial use in agricultural practices.



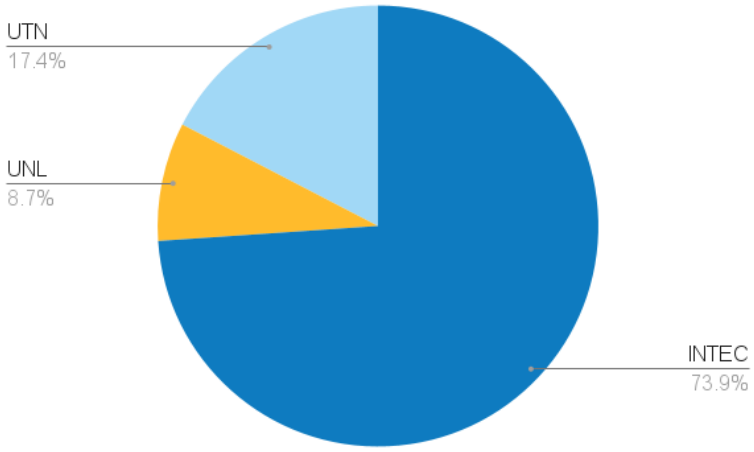
Enlace al artículo

Avances científicos en Argentina

Con el objetivo de visibilizar la contribución de la producción científica de investigadores argentinos, se reúnen en este apartado los 3 artículos científicos de autores nacionales que han sido recuperados en las búsquedas realizadas.

Se identificó la filiación institucional de los 9 autores firmantes de los artículos del presente apartado. Este conjunto de autores está vinculado de manera exclusiva o parcial con 3 instituciones: el Instituto de Desarrollo Tecnológico para la Industria Química (INTEC), de doble dependencia UNL-CONICET; la Facultad de Ingeniería Química de la Universidad Nacional del Litoral (UNL) y la Universidad Tecnológica Nacional Facultad Regional San Francisco (UTN).

Gráfico 3. Filiación institucional de los autores argentinos.

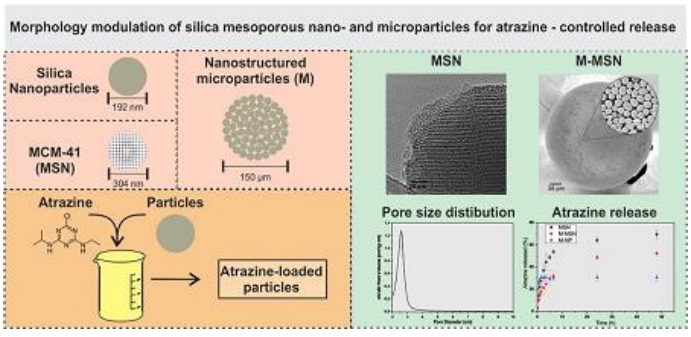


Fuente: elaboración propia.

Morphology modulation of silica mesoporous nano- and microparticles for atrazine - controlled release

2022

Environmental Nanotechnology, Monitoring and Management, 18



Atrazine is a moderately toxic triazine, used as a selective pre- and post-emergence herbicide. After application, it remains in the environment due to its low biodegradability causing severe environmental effects. Several controlled release systems have been proposed in order to minimize the negative impact of the herbicide on the environment. In particular, mesoporous silica nanoparticles have shown great potential in the agricultural area due to their controlled size and porosity, high surface area and non-toxicity. In this work, silica nano- and microparticles were synthesized and evaluated as atrazine

delivery systems. The morphology and size distribution of the particles were characterized using dynamic light scattering (DLS) and scanning electron microscopy (SEM). The release profiles were studied by in vitro assays in water. In addition, phytotoxicity tests were performed using Lactuca sativa seeds. The mesoporous nano- and microparticles exhibited sustained release for at least 24 h and reduced phytotoxicity compared to free atrazine.

Enlace al artículo

Preparation and Characterization of Lignin Microparticles-in-Alginate Beads for Atrazine Controlled Release

2019

Journal of Polymers and the Environment, 27(12)

The use of lignin as polymeric matrices for controlled release systems in agriculture is a promising alternative for its revalorization. In this work, different atrazine delivery systems were studied. Lignin derived from ionic isolation was used for the preparation of atrazine-loaded microparticles by the solvent extraction/evaporation and microfluidic techniques. Microparticles were also encapsulated in sodium alginate beads. Lignin microparticles prepared by microfluidics presented a larger particle size, higher encapsulation efficiency and a narrow size distribution. The in vitro release of atrazine was evaluated in water. Atrazine release from microparticles prepared by the solvent extraction/evaporation technique showed a significant burst release, and this effect was reduced by incorporating microparticles within alginate beads. In addition, the phytotoxicity of the systems was evaluated employing Lactuca sativa seeds. The phytotoxicity results showed that lignin-based formulations are safe according to the parameters evaluated, in contrast with commercial atrazine that resulted phytotoxic.

Enlace al artículo

Microparticles based on ionic and organosolv lignins for the controlled release of atrazine

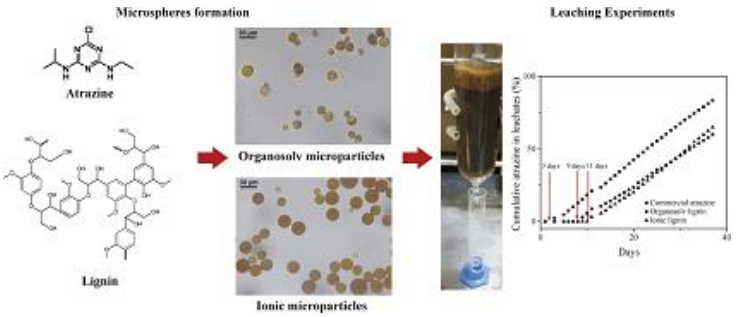
2018

Journal of Hazardous Materials, 359

Lignins are natural polymers of the lignocellulosic biomass. Nowadays, there is a growing interest in developing value-added products based on lignins due to their renewability, low cost and abundance. In this work, lignin microspheres from organosolv and ionic isolation processes were prepared for the controlled release of atrazine. Microspheres were prepared by the solvent extraction/evaporation technique. The controlled release of atrazine from organosolv and ionic lignins microparticles was studied in water. Mobility experiments were performed in an agricultural soil from Argentina. The results showed that microparticles prepared using dichloromethane as the dispersed phase were spherical, while lignins dispersed in ethyl acetate produce irregular microparticles. Organosolv lignin microparticles presented higher encapsulation efficiency for all herbicide loads. About 98% and 95% of atrazine was released in 24 and 48 h approximately from organosolv and ionic lignin microparticles, respectively. The release profiles of atrazine from both lignin microparticles were not affected by the herbicide load. Atrazine mobility experiments in soil showed that about 80% of free atrazine was leached in 37 days, while 65.0% and 59.7%

of the herbicide was leached from ionic and organosolv lignin microparticles, respectively. Thus, atrazine-loaded microparticles could reduce leaching compared to a commercial formulation of free atrazine.

[Enlace al artículo]

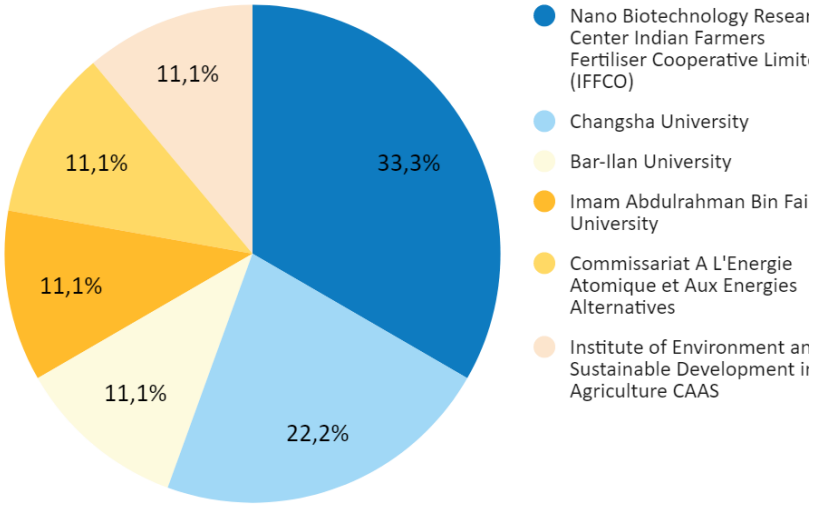


Avances tecnológicos

En este apartado se presentan los avances tecnológicos a partir de la información relevada en la base de datos de patentes de invención Espacenet. Se realizó una exploración para conocer la cantidad de solicitudes y patentes concedidas en el periodo 2021-2022 en relación a herbicidas mediante liberación controlada desde sustratos de materiales nanotecnológicos.

La estrategia de búsqueda implementada arrojó 36 resultados, de los cuales se seleccionaron 10 a partir del trabajo con los expertos que serán referidos a continuación. También se incluyen los gráficos con indicadores que describen la evolución durante el período 2021-2022 en materia de producción tecnológica.

Gráfico 4. Principales solicitantes de patentes.

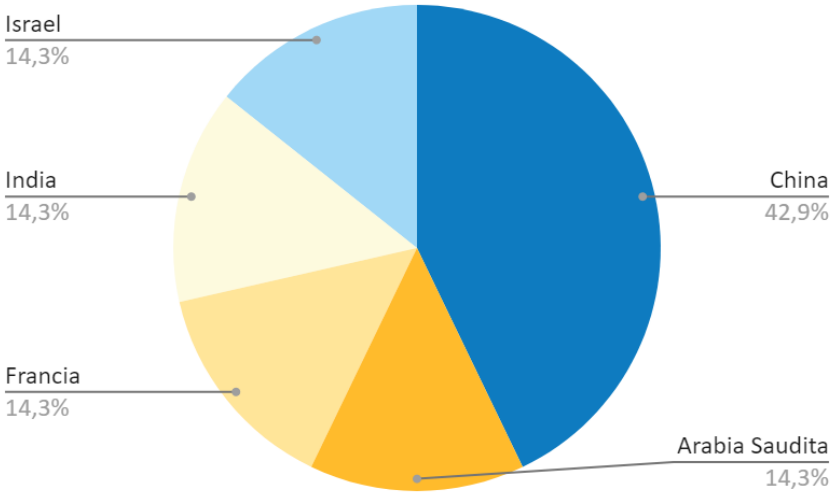


Fuente: elaboración propia.

En el gráfico 4 se observa que los principales solicitantes de patentes son Nano Biotechnology Research Center Indian Farmers Fertiliser Cooperative Limited (IFFCO), Changsha University, Bar-Ilan University, Imam Abdulrahman Bin Faisal University, Commissariat A L'Energie Atomique et Aux Energies Alternatives, Institute of Environment and Sustainable Development in Agriculture CAAS y Hebei Medical University.

En cuanto a los países con mayor cantidad de solicitudes de patentes, se puede apreciar en que China lidera el número de solicitudes, seguido de cerca por Israel, India, Francia y Arabia Saudita.

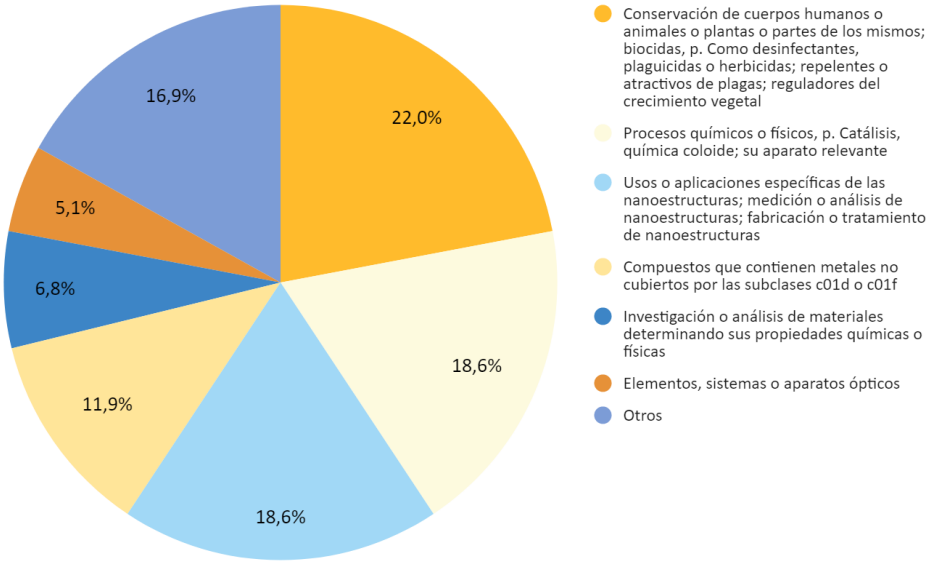
Gráfico 5. Países con mayores solicitudes de patentes.



Fuente: elaboración propia.

Las áreas temáticas con mayor preponderancia son la conservación de cuerpos o plantas; procesos químicos o físicos y usos o aplicaciones de las nanoestructuras, representando el 59,2% de los temas abordados.

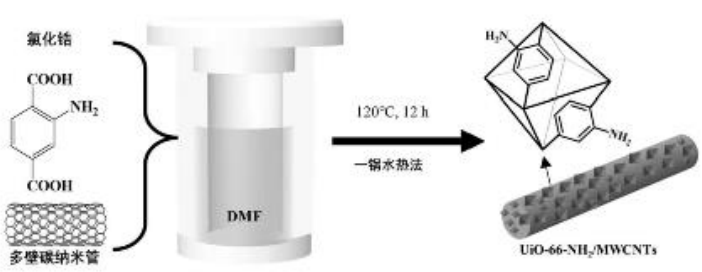
Gráfico 6. Principales áreas temáticas



Fuente: elaboración propia.

Electrochemical sensor for detecting pesticide as well as preparation method and application of electrochemical sensor - CN114839242A

02-08-2022



The invention provides an electrochemical sensor for detecting pesticides as well as a preparation method and application of the electrochemical sensor. The electrochemical sensor is formed by modifying the surface of a glassy carbon electrode with a PtNPs/UiO-66-NH2/MWCNTs nano composite material; the PtNPs/UiO-66-NH2/MWCNTs (multi-walled carbon nanotubes) nano composite material is a nano composite material formed by modifying PtNPs on a UiO-66-NH2/MWCNTs nano composite material; the UiO-66-NH2/MWCNTs nano composite material is a nano composite material formed by modifying the surfaces of the MWCNTs with UiO-66-NH2. When being used for detecting pesticides, the method has the advantages of simplicity and convenience in operation, no need of complex pretreatment on a sample to be detected, low detection cost, rapidness in detection, low requirements on a detection instrument and the like.

Enlace a la patente

Red fluorescent carbon dot and preparation method thereof, fluorescence sensor, construction method and application thereof - CN110423611B

18-02-2022

The invention discloses a red fluorescent carbon point based on fluorescent quenching for detecting alachlor concentration. The red fluorescent carbon point is spherical and straight.

Enlace a la patente

Micron-size plasmonic color sorter - US11249226B2

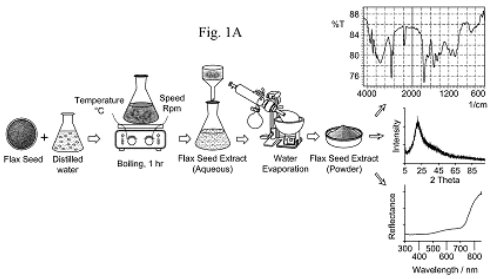
15-02-2022

Provided is an optical device including a dielectric transparent substrate and a metallic layer having a thickness between about 20 nm and about 1000 nm disposed on the transparent substrate. The metallic layer comprises at least one localized group of cavities, each localized group being confined within a diameter smaller than about 5 um, and each localized group comprising at least two cavities, with a distance between two adjacent cavities in the localized group being between about 100 nm and about 2000 nm. Each cavity in the localized group is shaped as a through-hole in the metallic layer, the through hole having a polygonal cross-section having a polygon side length between 50 nm and 2000 nm.

Enlace a la patente

Alpha-FE2O3 nanoparticles and method of making and use thereof in photodegradation of organic pollutants, as a photocatalyst and as an antibacterial composition - US11235983B2

01-02-2022



A method for producing crystalline α-Fe2O3 nanoparticles involving ultrasonic treatment of a solution of an iron (III)-containing precursor and an extract from the seeds of a plant in the family Linaceae. The method involves preparing an aqueous extract from the seeds of a plant in the family Linaceae and dropwise addition of the extract to the solution of an iron (III)-containing precursor. The method yields crystalline nanoparticles of α-Fe2O3 having a spherical morphology with a diameter of 100 nm to 300 nm, a mean surface area of 240 to 250 m2/g, and a type-II nitrogen adsorption-desorption BET isotherm with a H3 hysteresis loop. A method for the photocatalytic decomposition of organic pollutants using the nanoparticles is disclosed. An antibacterial composition containing the crystalline α-Fe2O3 nanoparticles is also disclosed.

Enlace a la patente

Green fluorescence carbon dot, preparation method thereof, fluorescence detection probe, and construction method and application of probe - CN110452693B

21-12-2021

A fluorescence detection probe based on fluorescence quenching detection of trifluralin concentration, comprising a green fluorescent carbon point and a fluralin quenching standard curve, wherein the fluralin quenching standard curve is mixed by the green fluorescent carbon point and different concentrations of trifluralin and then measured by fluorescence intensity, drawing to obtain, the green fluorescent carbon point is obtained by reacting cherry tomato by poly-tetrafluoroethylene stainless steel reaction kettle.

Enlace a la patente

A method of manufacturing of nano nitrogen for slow release, enhanced utilization by the plant and application thereof - WO2021130763A1

01-07-2021

In the present invention we disclose the method of manufacturing nano nitrogen using urea and or ammonia as precursor in the form of solid, liquid or aerosol, The resultant product "nano nitrogen" can be used as agrochemical (i.e. fertilizer, pesticide, herbicide, fungicide, antimicrobial), but also for other applications, such as, pharmaceutical, nutraceutical, catalyst development etc. The bottom up fabrication

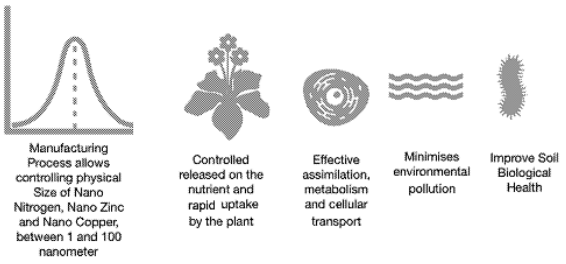
approach allows the size and other nanoscale properties controlled stable clusters using organic (oligo and polymer units) substrates. From the agrochemical perspective, nano nitrogen can be applied to plants by foliar application, root drenching or by amending with soil.

Enlace a la patente

A method of manufacturing of nano nitrogen for slow release, enhanced utilization by the plant and application thereof - WO2021084550A1

06-05-2021

In the present invention we disclose the method of manufacturing nano nitrogen, The resultant products "nano nitrogen is used as agrochemical (i.e. fertilizer, pesticide, herbicide, fungicide, antimicrobial), but also for other applications, such as, pharmaceutical, nutraceutical, catalyst development etc. The bottom up fabrication approach allows the size and other nanoscale properties controlled stable clusters using organic (oligo and polymer units) substrates. From the agrochemical perspective, nano nitrogen, nano zinc and nano copper can be applied to plants by foliar application, root drenching or by amending with soil.



DRAWING 2: Characterization detail of nano nitrogen, nano zinc and nano copper and its impact on the plant and environment

Enlace a la patente

A method of manufacturing of nano copper for slow release, enhaced utilization by plants and application thereof - WO2021084549A1

06-05-2021

Disclosed a method of manufacturing of nano copper for slow release, enhanced utilization by the plants. The resultant products nano copper is used as agrochemical (i.e. fertilizer, pesticide, herbicide, fungicide, antimicrobial), but also for other applications, such as, pharmaceutical, nutraceutical, catalyst development etc. The bottom up fabrication approach allows the size and other nanoscale properties controlled stable clusters using organic (oligo and polymer units) substrates. From the agrochemical perspective nano copper is applied to plants by foliar application, root drenching or by amending with soil.

Enlace a la patente

Method for the production of new nanomaterials - US10960385B2

30-03-2021

A method for producing new nanomaterials, 80 to 100 mol % of which are composed of TiO2 and 0 to 20 mol % are composed of another metal or semi-metal oxide that has a specific surface of 100 to 300 m2·g−1 and 1 to 3 hydroxyl groups per nm2.

Enlace a la patente

Pesticide nanocapsule, and preparation method thereof - CN107347881B

19-03-2021

A pesticide nano-capsule, according to weight, comprising the following components: Pesticidal active ingredients: 0.1-80 parts of capsule wall material: 0.1-40 parts of emulsifying dispersant, 0.2-30 parts of organic solvent: 10-200 parts: 20-350 parts excipient: 0.1-200 parts of adjuvant: wherein 0-20 parts ratio of the pesticide active ingredient to the capsule wall material is 0.1: 1-10: 1; the pesticide active component comprises an inner phase active component A and an outer phase active component B, the ratio of the inner phase active component A and the outer phase active component B is 0.2: 1-4: 1; the capsule wall material is degradable high molecular material; the slow release period of the pesticide nano-capsule is within 3-3 months; the thickness of the wall of the pesticide nano-capsule is 5-50nm; the preparation method of the pesticide nano-capsule comprises the following steps: step a: dispersing or dissolving the internal phase active component A in water; forming suspension or aqueous solution of internal phase active component A as internal water phase; dissolving the external phase active component B in the organic solvent; adding capsule wall material to obtain oil phase; dropping the internal water phase into the oil phase under the emulsifying condition to obtain W/O type emulsion; dissolving the emulsifying dispersing agent in water to obtain the outer water phase; dropping the obtained W/O type emulsion into the outer water phase under the emulsifying condition to obtain W/O/W type primary emulsion; step b: fine emulsifying the primary emulsion obtained in step a by high pressure homogenizing to obtain fine emulsion; step c: stirring the fine emulsion obtained in step b; volatilizing the organic solvent to obtain the nano-capsule mother liquor; step d: mixing the nano-capsule mother liquid obtained in step c with excipient and auxiliary agent to obtain the pesticide nano-capsule; in the step a, under the condition of emulsification under the condition of ultrasonic emulsification, under the condition of shearing and emulsifying or under the condition of grinding and emulsifying, the particle diameter of the droplet of the primary emulsion is 100-900nm; wherein the ultrasonic emulsifying condition is ultrasonic emulsifying by ultrasonic crusher; the power of the ultrasonic crusher is 65-650W, ultrasonic emulsification time is 2-30min; wherein the shearing emulsifying condition is using high speed shearing machine for shearing and emulsifying; the cutting speed of the high speed shearing machine is 10000-28000rmp 3-40min;, the time of shearing and emulsifying is wherein the grinding emulsifying condition is using grinding dispersion machine for grinding and emulsifying, grinding and emulsifying frequency is 30-50Hz, grinding and emulsifying time is 5-60min; the high pressure homogenizing in the step b is carried out by high pressure homogenizer; the pressure of high pressure homogenizing is 100-1200Pa, the time of high pressure homogenizing is 10min-2h, the particle diameter of the liquid drop of the fine 10-500nm; is in the step c, using an electric stirrer to stir, the stirring speed is 500-1500rpm, the stirring time is 5-24h.

Enlace a la patente

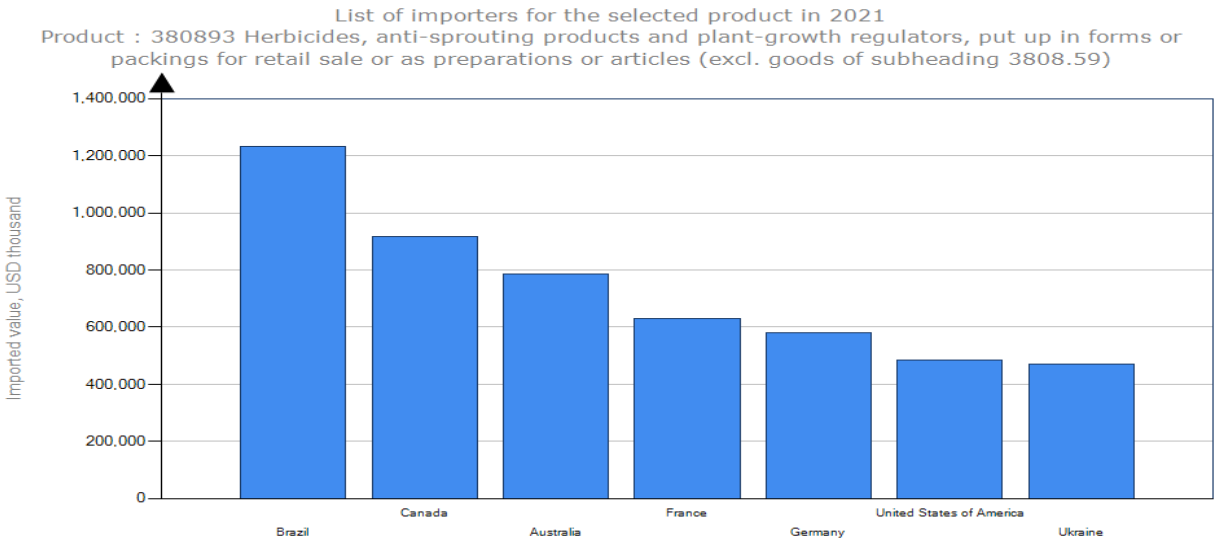
Información de mercado

En este apartado se presenta un estudio de tendencias mediante técnicas de inteligencia de mercado. Fueron seleccionadas las siguientes herramientas de búsqueda de información de mercado: Trade Map[1], Export Argentina, INDEC y CEPALSTAT.

Se realizó una exploración por palabras clave con el objeto de identificar especificidades en el mercado (clientes, competencia, entorno y tendencias) en relación a herbicidas mediante liberación controlada desde sustratos de materiales nanotecnológicos.

El primer registro que se identificó tiene que ver con el principal destino de importación de herbicidas a nivel mundial, y tal como se visualiza en el gráfico 7, se importaron USD 13.970 millones, siendo sus principales destinos Brasil, Canadá, Australia, Francia, Alemania, USA y Ucrania (concentran en conjunto el 36% de las importaciones mundiales).

Gráfico 7: Principales destinos importadores para el año 2021.

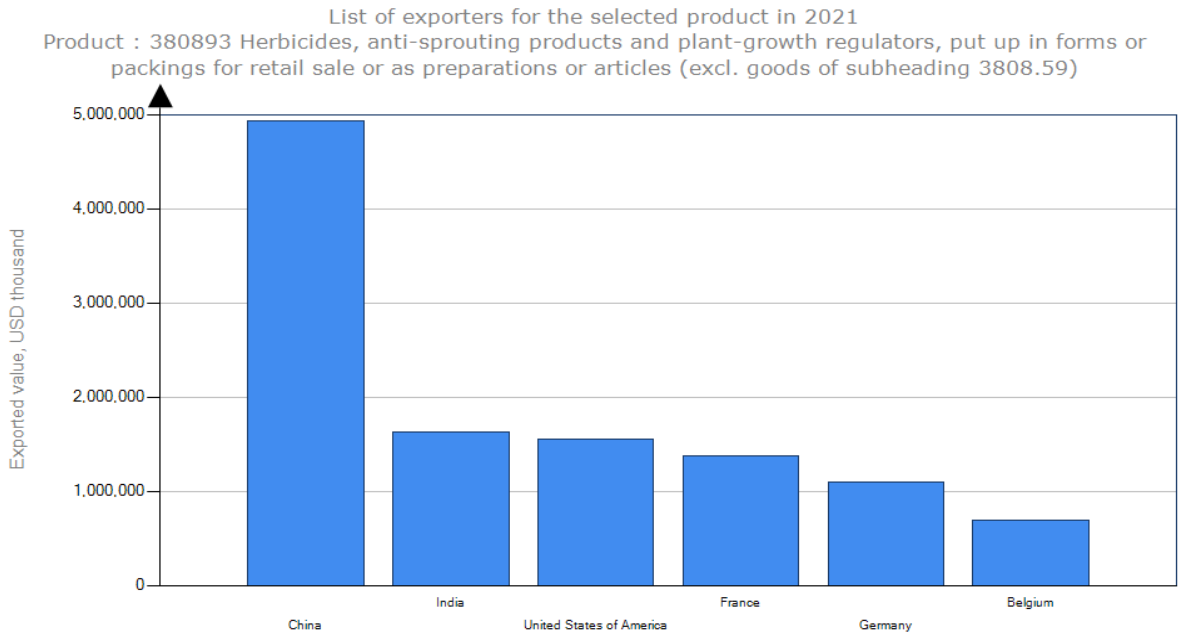


Fuente: Trade Map.

En lo relativo a las exportaciones, los principales países que exportan esta clase de herbicidas mayoritariamente son China, India, Estados Unidos, Francia y Alemania, representando un aproximado de USD 10,2 millones. Se aprecia que China es el principal exportador concentrando el 30% del volumen mundial, seguido por India, USA, Francia, Alemania y Bélgica, que en conjunto aportan un 45% del volumen de exportaciones.

[1] Herramienta desarrollada por el Centro de Comercio Internacional UNCTAD/OMC (CCI).

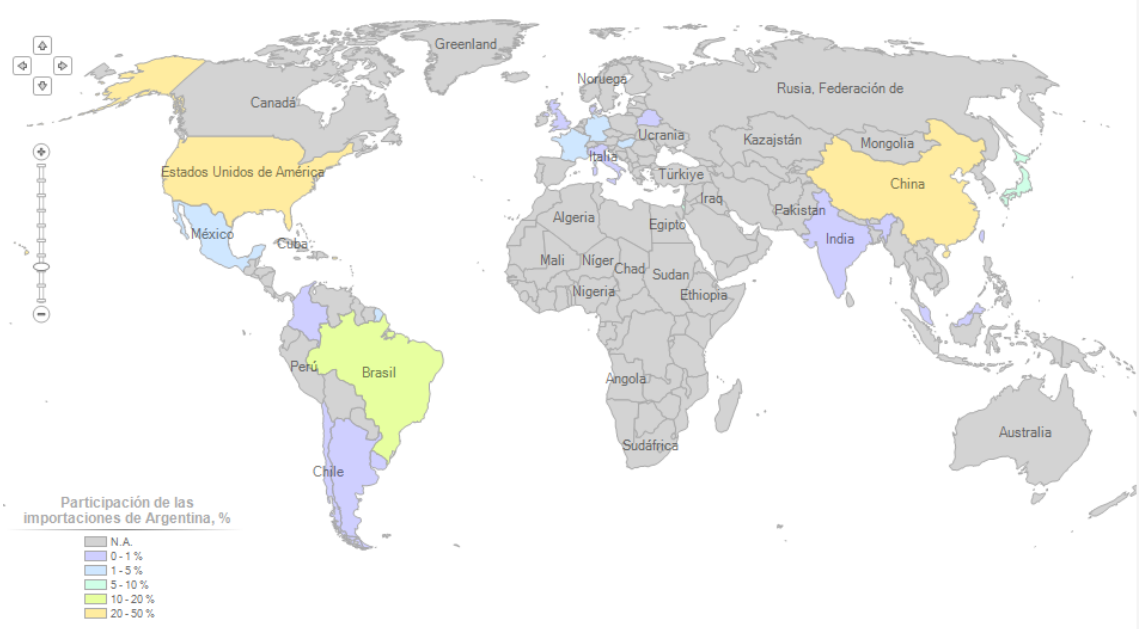
Gráfico 8. Principales países exportadores de herbicidas en el año 2021.



Fuente: Trade Map.

En lo que refiere al mercado argentino, durante el año 2022 se importaron USD 406 millones, aportando China el 45,9% del intercambio, seguido por USA (20,8%), Alemania (8,4%) y Brasil (6,8%).

Gráfico 9. Origen de las importaciones argentinas para el 2021.



Fuente: Trade Map.

Las exportaciones argentinas rondaron en 2022 los USD 109,4 millones, siendo Uruguay el principal destino (38,2%), seguido de Paraguay (23,1%), Chile (15,1%) y Bolivia (17,5%). El nivel más bajo de exportaciones de herbicidas se observó en los años de pandemia (2019 y 2020), con una baja general en el nivel de consumo, y la retirada del mercado de Brasil y Chile. En el último año las exportaciones argentinas alcanzaron un 73% del nivel pre-pandemia y muestran una tendencia de recuperación.

Tabla 1. Exportaciones argentinas de herbicidas (tn).

País	2016	2017	2018	2019	2020	2021	2022
Bolivia	4296,8	6386,7	8056,9	3744,5	271,5	288,8	2523,9
Brasil	13837,2	5532,1	51,8	0,0	0,0	0,0	2296,2
Chile	3568,5	3495,2	4451,8	0,0	0,0	1761,8	2387,3
Paraguay	6874,5	7004,7	7198,3	7557,3	581,6	5375,1	5860,3
Uruguay	5011,3	6103,4	6376,4	4900,3	4822,1	6303,6	5457,3

Fuente: elaboración propia en base a INDEC

Tabla 2. Importaciones argentinas de herbicidas (tn y USD).

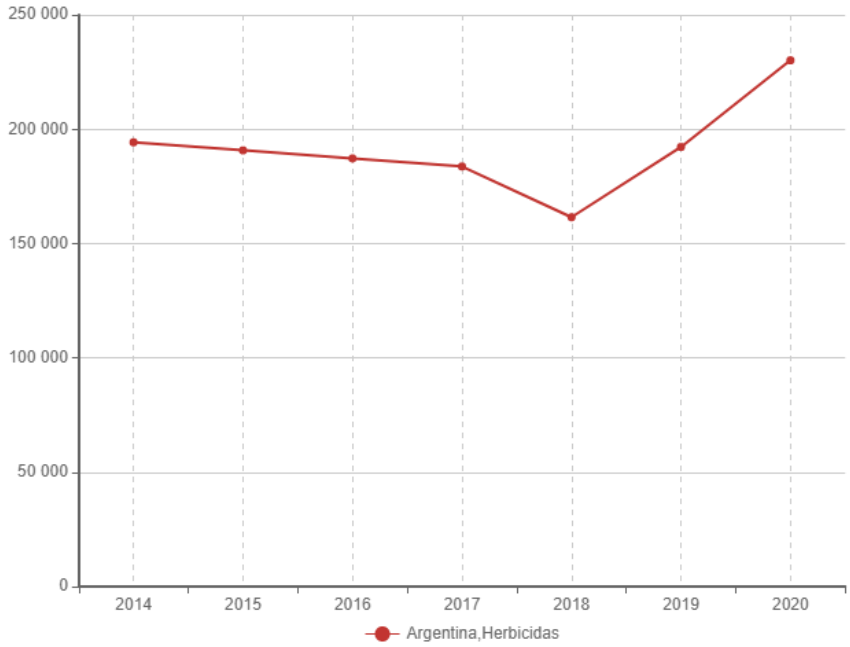
País	tn	Precio CIF (millones de USD)	
China	43564,1	186,6	73,8%
Estados Unidos	7222,7	84,6	12,2%
Israel	2433,2	26,2	4,1%
México	1232,7	4,4	2,1%
Brasil	1222,1	27,8	2,1%
Alemania	1057,8	34,1	1,8%

Fuente: elaboración propia en base a INDEC

En la región, la intensidad de uso de herbicidas viene liderada por Uruguay (8 Kg/ha) y Argentina (7,2 kg/ha), seguidos por Brasil y Chile (6 kg/ha) promedio en la última década, en tanto que en Paraguay y Bolivia se ha incrementado de 3 a 4 kg/ha en el mismo período.

El consumo de herbicidas en 2020 fue de alrededor de 230.000 tn en Argentina y Brasil, seguidos por Colombia (29.200 tn), Uruguay (13.500 tn) y Chile (9.000 tn). Particularmente Brasil y México lideran el consumo de fungicidas y bactericidas con 59.000 tn y 22.000 tn respectivamente.

Gráfico 10. Consumo de herbicidas en Argentina (tn por año).



Fuente: CEPALSTAT

Argentina es uno de los principales importadores de herbicidas de la región y se encuentra entre los 10 mayores importadores mundiales. Las exportaciones de producto se realizan principalmente a países limítrofes (Uruguay, Chile, Paraguay y Brasil) aunque aparece Australia en quinta posición como destino de interés. El destino con mayor tasa de crecimiento es Bolivia (interanual 2021-2022), en tanto que se está recuperando el nivel de exportación anterior a la pandemia en todos los destinos.

El consumo de herbicidas en la región está liderado por Argentina y Brasil, que en conjunto concentran alrededor de 500.000 tn anuales. La producción local de herbicidas ronda las 194.000 tn anuales y la tasa de crecimiento ha sido del 24% en el período 2017-2022.

Anexo metodológico

Como se indicó previamente, para el desarrollo del informe se trabajó con un conjunto de fuentes de información secundarias tanto estructuradas como no estructuradas en publicaciones científicas (Scopus y Pubmed), patentes de invención (Espacenet), información estadística y de mercado (Trade Map, Export Argentina, INDEC y CEPALSTAT). A continuación se muestran las sentencias de búsquedas elaboradas para campo técnico:

SCOPUS

TITLE-ABS-KEY ((herbicide OR weedkiller) AND ("controlled release" OR "sustained release" OR vehicleization OR encapsulation) AND (nanocomposites OR ncs OR nanoparticles OR nps OR microparticles OR microcomposites OR nanotechnology)) AND (LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2017)

Resultado total: 83

Validados: 59

PUBMED

(herbicide OR weedkiller) AND ("controlled release" OR "sustained release" OR vehicleization OR encapsulation) AND (nanocomposites OR ncs OR nanoparticles OR nps OR microparticles OR microcomposites OR nanotechnology)

Resultado total: 45

Validados: 25

ESPACENET

(ctxt = "Herbicide" OR ctxt = "weedkiller") AND (ctxt = "controlled release" OR ctxt = "sustained release" OR ctxt = "vehicleization" OR ctxt = "encapsulation") AND (ctxt = "nanocomposites" OR ctxt = "NCS" OR ctxt = "Nanoparticles" OR ctxt = "NPS" OR ctxt = "microparticles" OR ctxt = "microcomposites" OR ctxt = "nanotechnology")

Resultado total: 36

Validados: 10

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Municipalidad de General Pueyrredon

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Universidad Nacional de Mar del Plata

Fundacion Argentina de Nanotecnologia

Ministerio de Ciencia, Tecnología e Innovación
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