PatentNexus

Patentability Assessment Report

Standard Report

Invention: *A biodegradable polymer coating for agricultural seeds that releases micronutrients based on soil moisture levels using a pH-responsive hydrogel matrix with embedded slow-release fertilizer nanoparticles...*

1. Executive Summary: Patentability Assessment: Biodegradable Polymer Seed Coating with pH-Responsive Micronutrient Release

The invention presents a biodegradable polymer coating for agricultural seeds that releases micronutrients based on soil moisture levels using a pH-responsive hydrogel matrix with embedded slow-release fertilizer nanoparticles. This technology combines multiple established concepts including seed coatings, controlled-release fertilizers, and pH-responsive polymers, but the specific integration of pH-responsive hydrogels with moisture-triggered micronutrient release represents a potentially novel approach. The prior art landscape reveals extensive activity in biodegradable agricultural films, seed treatments, and controlled-release fertilizers, particularly from Chinese inventors and agricultural companies. While individual components exist in the prior art, the specific combination of pH-responsive hydrogel matrix with embedded nanoparticles for moisture-triggered micronutrient release from seed coatings appears to offer sufficient differentiation for patent protection, provided the claims are carefully crafted to emphasize the unique technical integration and functional advantages.

2. Technology Classification

CPC Classification Codes

Code	Description	Confidence
A01C 1/06	Seed treatment; Seed coating	95%
C08L 101/00	Blends of polymers not provided for in groups C08L 1/00-C08L 99/00	85%
A01N 25/00	Preparations for use in agriculture, veterinary medicine or hobby-horticulture	80%
C08J 3/00	Processes or apparatus for modifying the properties of macromolecular compounds	75%
B82Y 30/00	Nanoparticles and nanostructured materials	70%

Related Domains: Agricultural biotechnology, Controlled-release systems, Smart materials, Nanotechnology in agriculture, Biodegradable polymers, Hydrogel applications

This invention operates at the intersection of agricultural technology, materials science, and nanotechnology. The primary classification under A01C 1/06 reflects its core application in seed treatment and coating technologies, which represents a well-established field with significant commercial importance. The secondary classifications highlight the multidisciplinary nature of the technology, spanning polymer science (C08L 101/00), agricultural preparations (A01N 25/00), and nanotechnology (B82Y 30/00). The technology domain encompasses smart agricultural materials that respond to environmental conditions, representing an emerging area of innovation where traditional seed coating technologies are being enhanced with responsive materials and nanotechnology. This convergence of disciplines suggests both opportunities for patent protection and challenges in demonstrating novelty across multiple established fields.

3. Prior Art Analysis

The prior art landscape reveals extensive activity in related technologies, particularly in biodegradable agricultural films, controlled-release fertilizers, and seed coating systems. Chinese patents dominate the field, with significant contributions from agricultural equipment manufacturers and research institutions. The analysis of key patents shows that while individual components of the invention exist in the prior art, the specific combination presents potential novelty. Several patents describe biodegradable polymer films for agriculture (CN-103289134-B, CN-108901515-A) and controlled-release fertilizer systems, but these focus primarily on mulching films rather than seed coatings. The hydrogel-based systems in the prior art (CN-114258836-B, LT-2024003-A) are primarily designed for soilless culture substrates or bulk fertilizer applications, not seed coatings with pH-responsive properties. Seed coating patents in the database (CN-119344332-A, AU-2020316943-A1) focus on film-forming properties and dust reduction rather than responsive nutrient release systems. The nanoparticle fertilizer patents (US-2021368786-A1, CN-113105604-B) describe coating technologies but lack the specific pH-responsive hydrogel matrix integration proposed in this invention.

Analyzed Patents

Patent	Comparison	Score
CN-103289134-B Multifunctional ground-covering film of fully biodegradable	Describes biodegradable films with embedded fertilizers but focuses on mulching films rather than seed coatings with pH-responsive properties.	75/100
CN-114258836-B Nitrogen-phosphorus-containing biodegradable polymer double-	Features hydrogel systems for nutrient release but designed for soilless culture substrates, not seed coatings with moisture-triggered mechanisms.	80/100
CN-119344332-A Film-forming seed coating agent for improving sesbania germi	Addresses seed coating with biodegradable polymers but lacks pH-responsive hydrogel matrix and nanoparticle integration.	70/100
AU-2020316943-A1 Seed coatings compositions and methods for use	Covers seed coating with rosin-based resins and biodegradable polymers but focuses on dust reduction rather than responsive nutrient release.	65/100
US-2021368786-A1 Non-Aqueous Organo Liquid Delivery Systems containing disper	Describes coating fertilizer granules and seeds with polymer systems but lacks pH-responsive hydrogel matrix functionality.	60/100
CN-113105604-B Bio-based polymer coating material, coating controlled-relea	Presents bio-based polymer coatings for controlled-release fertilizers but applies to bulk fertilizer particles, not seed coatings with pH-responsive mechanisms.	72/100
LT-2024003-A Sapropel based organic fertilizer using hydrogel	Incorporates hydrogel in fertilizer formulations but for bulk organic fertilizers, not seed coating applications with pH-responsive properties.	55/100
CN-112852172-B Full-biodegradable multi-crosslinked gelatin-based agricultu	Describes biodegradable agricultural films with crosslinked structures but focuses on mulching applications without pH-responsive nutrient release functionality.	50/100

4. Patent Landscape

The patent landscape analysis reveals a rapidly growing field with filing activity peaking in 2017-2018 before stabilizing at high levels, indicating continued innovation in agricultural technology. Chinese inventors and institutions dominate the field with over 78,000 filings, reflecting China's significant investment in agricultural innovation and food security technologies. Major agricultural equipment manufacturers like Deere & Co, Amazonen Werke, and Precision Planting LLC lead in patent filings, alongside chemical companies like Monsanto, BASF, and Syngenta, demonstrating the convergence of mechanical and chemical agricultural technologies. The geographic distribution shows strong activity in major agricultural markets including the US, Europe, and emerging economies, suggesting global commercial interest in advanced seed treatment and agricultural coating technologies. The sustained high filing rates in recent years indicate that this remains an active area of innovation with significant commercial potential, supporting the recommendation to pursue patent protection for novel technological combinations in this space.

Top Assignees

Assignee	Patents
DEERE & CO	4988
AMAZONEN WERKE DREYER H	4904
PREC PLANTING LLC	2465
CNH IND AMERICA LLC	1487
LELY NV C VAN DER	1298
CNH IND CANADA LTD	1066
KUBOTA KK	732
MONSANTO TECHNOLOGY LLC	709
AMAZONEN WERKE H DREYER SE & CO KG	686
RAUCH LANDMASCHFAB GMBH	606

Geographic Distribution

Country	Patents
CN	78259
US	31749
DE	13148
EP	11016
KR	9247
FR	6616
WO	5808
CA	5383

AU	4653
GB	4620

Filing Trends

Year	Filings
2004	1512
2005	1369
2006	1523
2007	1591
2008	1820
2009	1901
2010	2082
2011	2346
2012	2721
2013	3468
2014	4631
2015	6179
2016	12251
2017	14284
2018	15462
2019	11471
2020	13485
2021	11389
2022	9562
2023	8446
2024	8914
2025	1740

5. Novelty & Claim Gap Analysis

The novelty analysis reveals that while the individual components of the invention exist in the prior art, their specific integration presents potential patentable subject matter. The key novel aspects appear to be the combination of pH-responsive hydrogel matrix with embedded slow-release fertilizer nanoparticles specifically designed for seed coating applications that respond to soil moisture levels. Existing seed coating patents focus primarily on physical protection, germination enhancement, or dust reduction, but do not describe pH-responsive systems that modulate nutrient release based on environmental conditions. The hydrogel systems in the prior art are predominantly designed for bulk applications such as soilless culture substrates or mulching films, not for the specific constraints and requirements of seed coatings. The integration of nanoparticle fertilizers within a pH-responsive hydrogel matrix for seed applications represents a technical advancement that addresses the challenge of providing controlled nutrient release during the critical germination and early growth phases. The moisture-triggered release mechanism specifically tied to soil conditions rather than simple time-based release also appears to be a distinguishing feature not clearly described in the prior art.

Identified Claim Gaps

1. pH-responsive hydrogel matrix specifically formulated for seed coating applications with controlled swelling properties
2. Integration of slow-release fertilizer nanoparticles within the hydrogel matrix with specific size and distribution parameters
3. Moisture-triggered nutrient release mechanism that responds to soil moisture levels rather than time-based release
4. Biodegradable polymer coating system that maintains seed viability while providing environmental responsiveness
5. Specific pH range responsiveness optimized for soil conditions during seed germination and early plant growth

6. Recommendations

Assessment: RECOMMENDED: File patent application

Based on the analysis, filing a patent application is recommended with careful claim drafting to emphasize the novel integration of technologies. The invention should focus on the specific combination of pH-responsive hydrogel matrix with embedded nanoparticles for seed coating applications, as this represents the strongest differentiation from existing prior art. The claims should emphasize the functional advantages of moisture-triggered nutrient release and the specific technical parameters that enable this functionality in seed coating applications. Priority should be given to filing in key agricultural markets including the United States, Europe, and potentially China, given the high activity in this field. The application should include detailed experimental data demonstrating the pH-responsive behavior, nutrient release profiles, and seed performance benefits to strengthen the technical foundation and support the novelty arguments.

Suggested Claim Angles

1. A biodegradable polymer seed coating comprising a pH-responsive hydrogel matrix having a pH transition range of 5.5-7.5 and embedded slow-release fertilizer nanoparticles with particle sizes of 10-500 nm, wherein the coating releases micronutrients in response to soil moisture levels

2. The seed coating of claim 1, wherein the hydrogel matrix swells by 200-800% in response to moisture contact and exhibits controlled nutrient release over a period of 2-8 weeks

3. A method of treating seeds comprising applying the biodegradable polymer coating to form a uniform layer of 10-100 micrometers thickness that maintains seed viability while providing pH-responsive nutrient release

4. The seed coating system wherein the pH-responsive hydrogel matrix comprises crosslinked polymers selected from polyacrylic acid, polyvinyl alcohol, or chitosan derivatives with specific crosslinking densities optimized for soil pH conditions

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