UC San Diego

Plant Sciences

2008

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presented in the order listed

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Technology Transfer is Beneficial

Technology transfer complements the university's education, research, and public service mission. UC San Diego Technology Transfer & Intellectual Property Services (TechTIPS) manages, protects, markets, and licenses intellectual property developed on campus and owned by the university.

TechTIPS also acts as a catalyst for transforming early-stage academic research into marketable products and processes. UC San Diego intellectual property includes inventions, discoveries, technologies, patents, copyrightable works–-such as computer software–-selected trademarks**.**

Plant CO2 Sensors that Regulate Water Use Efficiency in Plants

SD2007-209

Background: It is currently unknown how plants sense the level of CO2 in the atmosphere. Previously, no CO2 sensors have been identified in plants. Knowledge of how atmospheric CO2 is perceived could be used to manipulate plant CO2 responses so that the carbon and water use efficiency during plant growth could be optimized. The water use efficiency defines how well a plant can balance the loss of water through stomata with the net CO2 uptake for photosynthesis, and hence biomass accumulation.

UCSD investigators have found a new method to manipulate exchange of water and CO2 through stomata by controlling newly discovered CO2 sensor genes. One can thereby modify net CO2 uptake and water use efficiency in plants by modulating expression of these genes in guard cells. These findings suggest a potentially vital role for the identified genes in the sensing/signaling of CO2 in plants.

Commercial Applications: Manipulating how plants sense CO2 will aid in the production of crops with altered and improved CO2/gas exchange and water use efficiency and may also improve plant growth of different plant species at a higher atmospheric CO2 concentration. This could have commercial utility by creating plants that are useful in

- Improved water use efficiency of crops
- Creating drought resistant crops
- Optimizing plant growth in higher CO2 conditions
- Biomass accumulation / Biofuel production

The plants with mutated CO2 sensor genes show a stomatal response as measured by real-time gas exchange analysis to changes in CO2 concentration. The proteins encoding the CO2 sensing genes can bind CO2.

Status: patent pending, world-wide rights available

UC San Diego

The Biological Sciences Division at UC San Diego works closely with many other research units on campus, including the School of Medicine, the Jacobs School of Engineering, the Rady School of Management, the Division of Physical Sciences, and Scripps Institution of Oceanography. Collaborations extend off campus as well. The graduate program is a mutual effort with the Salk Institute for Biological Studies. In addition, The Scripps Research Institute, The Burnham Institute for Medical Research, and the San Diego Zoo are several of the many local private and public research organizations with which they collaborate in research and education. These close ties benefit researchers, graduate and undergraduate students, providing them with a wide range of opportunities and exposure to some of the best scientific minds in the country.

Control of Peroxisome Turnover

SD2006-225

Background: Peroxisomes are organelles that contain enzymes involved in many aspects of lipid metabolism. The homeostasis of peroxisomes is tightly controlled by maintaining the balance between biogenesis and degradation. Only recently have the mechanisms involved in the selective degradation of peroxisomes by autophagy-related pathways (pexophagy) been elucidated and described. While peroxisome degradation is related to the better characterized autophagic processes, there are genes unique to pexophagy that may provide opportunities to adjust the homeostasis of this organelle, particularly in plants and fungi. Many plant species are susceptible to pathogenic fungi, including much of the world's food crops. An economically important example is rice, 20-30% of which is susceptible to just one type of fungus.

Technology: UCSD researchers have discovered that overexpression of a cytosolic protein will target peroxisomes for degradation by pexophagy. Controlled overexpression of this protein may provide the ability to modulate or halt fungal infections that have severe consequences in plants of economic importance. Although the sequence of the protein, now called pexophagin or Atg30, was previously described, its function was unknown. Recent studies have uncovered a role for this protein in pexophagy in two species of yeast.

Stage of Development: This is an early stage invention that has elucidated the role of pexophagy in pexophagy in Pichia pastoris and Saccharomyces cerevisiae. Work is continuing to verify functionality in other species. Mechanisms for role of this protein in micropexophagy and macropexophagy have been proposed and are being investigated in further detail. The researcher will be happy to consider research support to continue confirmation and validation in plant models such as Arabidopsis.

Commercial Application and Advantages: May provide the opportunity to control pathogenicity of fungal infections solely or in conjunction with chemical fungicides.

Related Information: Peroxisome turnover by micropexophagy: an autophagy-related process; Farre and Subramani in TRENDS in Cell Biology; Vol. 14, No. 9 September 2004
Web Site: Peroxisome Biogenesis and Degradation:
http://www.biology.ucsd.edu/labs/subramani

UCSanDiego TechTIPS
...pipeline to innovation

The TechTIPS Mission

- Facilitate the transfer of UCSD innovations for the public benefit

- Enhance the research and education experience of the UCSD community

- Promote and target economic development by leveraging UCSD innovations

- Provide incentives to researchers to stimulate technological innovations

Seedless Fruits and Flower Control Through Controlled Auxin Biosynthesis

SD2006-223

Consumer demand for seedless fruits is evidenced by the success of such varieties as seedless watermelons, navel oranges and clementines. However, as the creation of these seedless fruits relies on parthenocarpy, it has not always been feasible to create seedless fruits in other species. Parthenocarpic fruit can grow if the plant hormone auxin is produced early in ovule development.

UCSD investigators now have identified the essential plant genes responsible for regulating the production of auxin, thus affecting many aspects of plant growth and development such as formation of floral organs, fruit development and vascular tissues. This work for the first time unambiguously identifies where auxin is synthesized in plants, thereby allowing the control of auxin gradients, a key in developmental regulation.

In the absence of auxin biosynthesis, plants do not form normal amounts of vascular tissues and flowers. The bacterial auxin biosynthesis gene iaaM has been widely used to increase auxin levels in plants, but understanding the endogenous plant auxin biosynthetic pathway has been elusive.

Precise temporal and spatial expression of plant auxin genes can increase or decrease endogenous auxin levels in plants, and thus regulate development in a particular organ. Furthermore, controlling endogenous plant auxin genes may modulate developmental regulation in ways not achievable by the application of exogenous auxin or by the expression of iaaM.

The method can be used to regulate fruit opening, leaf shape, architecture of flowers, the development of plant reproductive organs and production of seeds through auxin biosynthesis. This could be used to make male sterile plants or seedless fruits. It could also be used to regulate flower shape and the number of floral organs or in ornamental plants for which altered leaf shape or flower architecture may be desirable. This could also be used to make plants without flowers, or to affect plant stature.

Patent status: patent pending, worldwide rights available

UC San Diego TechTIPS
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Visit our website at http://invent.ucsd.edu for a listing of available technologies and patents, and for more information about licensing technologies from UCSD.

A Bt Crystal Protein for Treatment of Human Helminth Diseases

SD2006-049
See also SD2004-035

Bacillus thuringiensis (Bt) insecticidal crystal proteins are now widely used in crop protection as biocontrol agents for agricultural nematode pests, replacing hazardous chemical pesticide approaches. However, nematode infestations of cattle, other farm animals, and pets remains a serious problem worldwide. These infestations also are a cause of many human diseases, particularly in the Third World. Over 4 billion cases of human nematode infection are estimated to occur annually, including multiple infestations. Current treatments for human parasitic nematodes include albendazole, mebendazole, levamisole, and ivermectin.

Heretofore, a Bt crystal protein biocontrol approach has not been deemed useful for control of human or animal parasites. Recently, UCSD investigators have demonstrated in an animal model that select Bt crystal proteins are highly effective against animal nematode pathogens. Bt crystal proteins have no known toxic effects to humans or animals.

Since the mechanism of action of Bt crystal proteins is very different from that of currently used compounds, a major advantage is that nematode pests resistant to the current treatments will not be resistant to crystal proteins.

Relative to current treatments for nematode diseases, this approach has the potential to be cheaper. Since the therapy is a protein, it can be expressed in transgenic plant crops, making it possible to deliver the therapy as part of the diet. Use of modified Bt crystal proteins in this way could provide convenient oral and dietary dosing of anti-parasitic therapy. Transgenic expression of these Bt crystal proteins in fruits and vegetables could provide an efficient and cost-effective approach to controlling filariasis, leshmaniasis and other nematode infestations in human populations. Crystal proteins could provide an alternative therapy for animal parasitic nematode infections in those cases where resistance to currently used compounds has occurred.

Stage of development: animal model tested

Control of Crop Fungal Disease

SD2005-143

Background: Brassica crops, such as broccoli, canola, cauliflower, cabbage, Chinese cabbage, lettuce, and mustard, are susceptible to fungal diseases. Although using fungicides could be a quick solution to contain the infection, there are always concerns over the emergence of new fungicide-resistant strains as well as the potential environmental and health hazards after fungicides have been continuously administered. Therefore, it is desirable to develop a genetically modified crop that is highly resistant to fungal infections.

Technology: UCSD investigators have created transgenic Brassica plants with increased ability to resist fungal diseases. For example, when grown adjacent to each other, wild type plants are seriously attacked by powdery mildew, whereas the multiple transgenic lines are not. In addition to increasing disease resistance to pathogens, these transgenic Brassica plants showed significant reduction of pod shatter, thus preventing premature release of seeds prior to harvest and increasing the yield of ripe seed.

Advantages:
- Resistance to fungal infection
- Reduction of seed loss

A Super-strong Guard Cell Promoter

SD2005-027

UCSD investigators have identified a guard cell-specific promoter that drives higher levels of expression than any other promoter in guard cells. Plant guard cells control CO2 uptake and water loss and are critically important for drought tolerance. This promoter has strength and specificity allowing effective transgene expression or silencing. Compared with other well-known guard cell promoters, this super-strong guard cell promoter is around 20 times stronger.

Compared with the commonly used universal strong cauliflower mosaic virus 35S promoter, this super-strong guard cell promoter drives much higher expression of reporter genes specifically in guard cells with a minimum background expression in the surrounding cells.

The regulation of stomata openings could help plants resist drought or help them become less susceptible to drought stress. This promoter can be used for engineering water loss from crop plants during drought periods.

Control Premature Seed-Pod Breakage In Crop Species

SD2004-178

Oil seed crops such as canola (Brassica) often break their seed-pods prematurely. This premature seed release can be a result of harvesting techniques or adverse weather conditions. Premature release can cause from 10-50% crop loss in canola, using current harvesting techniques.

UCSD investigators have found a way to prevent the premature release of seed-pods from the crop species canola. Scientists have discovered the genes necessary for seed-pod breakage, and devised ways to control them. These Brassica genes, when introduced into Arabidopsis mutants with seed-pod defects, can fully rescue the Arabidopsis mutants. This technique also has been proven to work in canola.

Patent pending

Automated Pollen Collection and Analysis System (APCAS)

SD2004-069

Summary of the Invention: Pollen collection systems have been in use for many years, with numerous evolutions in their design (see http://www.beesource.com/plans/pollentrap.htm). Given here however is the first real-time system for pollen collection and analysis which can be readily adapted to existing hive entrances using commercially available exclusion grids.

The purpose of this new device is to collect, analyze and preserve pollen from social bee nests. The APCAS will 1) collect and preserve pollen for later analysis of quality and species and, 2) in real-time measure, record and transmit the amount and color of pollen collected by bees.
(continued next page)

Automated Pollen Collection and Analysis System (APCAS)

SD2004-069

contined

The commercial benefit of this device is its ability to assure growers and bee keepers that pollination has occurred; at what efficiency the pollination service took place; and to determine the origin of the honey product. This inexpensive, efficient and real-time device for pollen collection and analysis will address these issues.

Aside from its commercial applications, this device is also of value to researchers who will value the ability to monitor pollen availability and usage by pollinators. By creating a permanent archive of insect-collected pollen, the development of a long term database is possible, giving a valuable reference collection and baseline data that do not currently exist for most ecosystems.

Commercial Opportunities: The University of California San Diego is currently seeking a partner to manufacture and sell the APCAS under license to the University's patent rights.

Treatment of Intestinal Animal Parasitic Diseases in Veterinary and Human Medicine

SD2004-035
See also SD2006-049

Bacillus thuringiensis (Bt) insecticidal crystal proteins are now widely used in crop protection as biocontrol agents for agricultural nematode pests, replacing hazardous chemical pesticide approaches. However, nematode infestations of cattle, other farm animals, and pets remains a serious problem worldwide. These infestations also are a cause of many human diseases, particularly in the Third World. Over 4 billion cases of human nematode infection are estimated to occur annually, including multiple infestations. Current treatments for human parasitic nematodes include albendazole, mebendazole, levamisole, and ivermectin.

Heretofore, a Bt crystal protein biocontrol approach has not been deemed useful for control of human or animal parasites. Recently, UCSD investigators have demonstrated in an animal model that select Bt crystal proteins are highly effective against animal nematode pathogens. Bt crystal proteins have no known toxic effects to humans or animals.

Since the mechanism of action of Bt crystal proteins is very different from that of currently used compounds, a major advantage is that nematode pests resistant to the current treatments will not be resistant to crystal proteins.

Relative to current treatments for nematode diseases, this approach has the potential to be cheaper. Since the therapy is a protein, it can be expressed in transgenic plant crops, making it possible to deliver the therapy as part of the diet. Use of modified Bt crystal proteins in this way could provide convenient oral and dietary dosing of anti-parasitic therapy. Transgenic expression of these Bt crystal proteins in fruits and vegetables could provide an efficient and cost-effective approach to controlling filariasis, leshmaniasis and other nematode infestations in human populations. Crystal proteins could provide an alternative therapy for animal parasitic nematode infections in those cases where resistance to currently used compounds has occurred.

Stage of development: animal model tested

Use of AGL 11 Gene to Suppress Seed Pod Shatter in Commercially Important Plants

SD2001-025

Background: In many agricultural seed products such as oilseed crops, grains and legumes, and seeds harvested specifically for planting, premature release of seeds prior to harvest results in serious losses. Swathing and other methods for minimizing harvest loses add to overall production costs. In addition, regardless of cost factors, the need for positive control of seed release may in future years become a desirable capability when Genetically Modified (GMO) crops become widespread, in order to assure satisfactory containment.

Description: UCSD investigators have discovered a novel mode of pod shatter control. A genetic technology is utilized to prevent detachment of the ripening seeds from the funiculi within the pod. Thus, even when the pod valves are allowed to open naturally, the seeds contained within are retained, and must be harvested by manual detachment. This also affords a facile visual means of assessing ripeness, since the pods can be allowed to open, without risk of loss. Seeds in these opened pods may be dried in the field, and harvested by conventional mechanical combining.

Floral Manipulation by Overexpression of SEPALLATA Genes

SD2000-167

The differentiation of the major floral organs (petals, sepals, stamens, carpels) can be usefully manipulated by transgenic modification, as a result of discoveries involving the Arabidopsis SEPALLATA genes (see NATURE 405:200-203 (2000)). By this approach, according to the well-established "ABC model" of flower organ identify, deletion of the 3 SEPALLATA genes produces flowers in which all 4 floral organs develop as sepals. Similarly, selective over-expression of appropriate SEPALLATA genes using constitutive promoters results in sepal replacement by petals. These genetic manipulations can product unique and exotic ornamental flower forms. Production of additional petals can also be useful in the production of certain petal-derived fragrance extracts. The genes appear highly conserved across species of flowering plants. Use of constitutive-expressing SEPALLATA constructs for floral manipulation are being licensed exclusively by individual plant species.

Transgenic Cereal Plants Expressing Pigmented Seed Endosperm Tissues

SD2000-090

Genes have been introduced into maize plants that result in red, blue or purple pigmented kernel tissue while the hulls remain uncolored. This method can also be used in other cereal grains for permanent coloration. The invention would be highly useful as an indelible warning "marker" for transgenic cereal grains that are intended for use only as crop seeds, animal feed or other restricted or special uses. It could also provide for a variety of novel "naturally" colored cereal grain products including: popping corn, flour for preparation of bread or tortilla products, snack foods, and grain-based beverages.

The invention has been reduced to practice in maize and in arabidopsis. Transgene-derived pigments are localized only in the endosperm tissues in high concentrations and there are no apparent untoward effects on the plant.

Methods to Improve Drought Tolerance in Plants

SD2000-061

Background: A number of novel methods have been developed to control water metabolism in commercially useful plants by artificial regulation of stomatal opening, thus imparting drought resistance. Control of signal transduction pathways function have been used successfully.

Description: The current invention describes the use of genetic techniques to suppress stomatal potassium transport as an additional method for creating drought-resistant plants.

Advantages: Interestingly, plants containing the modified stomata-specific K+ channel displayed both decreased transpirational water loss and improved growth and maturation under conditions of restricted watering. No untoward effects of selective modification of this K+ channel were observed, suggesting a general method for creating drought resistant variants of many commercially useful plants.

Together with other inventions we offer for license describing both transgenic methods and applied chemical methods for altering stomatal signal transduction to control water loss, a palette of techniques are now available that should allow creation of drought-resistant versions of almost any plant.

Patent Number: 6,635,803

Plant Dehiscence Zone-Specific Promoter and Methods of Using Same

SD2000-009

Background: Full realization of the potential of many transgenes depends on selective expression in tissues of interest. The following describes a plant promoter isolated from Arabidopsis thaliana that is operative only in the dehiscence zone tissues of plants, and is suitable for driving the expression of genes desired to operate only in this tissue.

Description: A promoter has been isolated from Arabidopsis which upregulates transferred gene expression only in the dehiscence zone on the valve margins, and in no others, when placed upstream of a transgene in a construct of interest. The promoter can also be used to identify and recover orthologues in plant species of interest.

Advantages: This promoter may have value in the expression of genes intended to control seed pod shatter

Stage of Development: Dehiscence zone-specific expression driven by this promoter has now been demonstrated in species other than Arabidopsis.

Floral Promoters

SD1999-121

A wide variety of promoters for more than 30 MADS box regulatory genes of Arabidopsis thaliana (e.g., AGL1 to AGL24, AP1, AP2, SEPALLATA1-3) are available for non-exclusive licensing. They are useful for expressing ectopic proteins selectively in various floral organs and tissues, as well as in leaves and other regions of the plant, and in identifying orthologs from other flowering plants.

Method for Rational Induction of Drought Resistance in Plants by Suppression of an NMDA-like Receptor

SD1999-112

Background: A major influence on the successful harvest of nearly every type of crop is adequate rainfall or irrigation. Particularly at critical phases in crop life cycle, drought conditions can delay, diminish or destroy productivity. Naturally drought resistant arid zone plants acutely control water metabolism through modification of stomatal opening. A simple and robust technology has now been developed which imparts exceptional drought resistance to any crop plant through manipulation of an NMDA-like receptor. This receptor plays a key role in mediating the hormonal regulation by Abscisic Acid (ABA) of stomatal opening and moisture retention during light and dark cycles. Inhibition or suppression of the receptor results in prolonged stomatal closing and water retention.

Description: Non-toxic chemical inhibitors of the enzyme originally developed for pharmaceutical use have been demonstrated to effectively impart drought resistance when applied to plants (wheat, arabidopsis). Block of NMDA affinity has a protective CNS activity in animals. The technology thus can be used to impart temporary drought resistance as needed by spray application to the crop.

Advantages: For the first time, it should be possible to protect from transient drought conditions any crops, ranging from grains to high value ornamentals, to forestry species. The approach would involve an inhibitor spray or an activatible transgene incorporated into the plant. Both approaches have been tested successfully.

Technology Transfer on the UC San Diego Campus . . .

UC San Diego recognizes the importance of fostering the commercial development and utilization of technologies that result from research activities on campus for the public good. In November 1994, UC San Diego established its campus Technology Transfer and Intellectual Property Services (TechTIPS) to promote and facilitate this process. With its close proximity to UC San Diego researchers, TechTIPS is ideally positioned to manage the intellectual property developed at UC San Diego and to provide educational and information services on intellectual property matters to the UC San Diego community. It is the goal of the university to nurture a highly proactive culture committed to transferring innovations from campus to the private sector for the benefit of society.

Improved Pod Shattering and Controlled Seed Release Properties

SD1999-100

Background: In many agricultural seed products such as oilseed crops, grains, and legumes, as well as seed for planting, premature release of seeds prior to harvest results in serious losses. Prior to this invention, visual examination of the crops and other agricultural techniques such as determination of moisture content have been the primary means to indicate timing of the seed harvest. This invention uses antisense genetic manipulation to achieve rational control of the natural regulatory mechanism of seed release.

Description: UCSD investigators have discovered that blocking expression of certain floral organ genes prevents the normal senescence of replum cells required for pod valve release and seed dispersal. Plants bearing this transgene construct do not release their otherwise normal, mature seeds without external applied mechanical effort. Thus, complete control of shattering in the field is achieved. Since premature seed dispersal can lead to serious losses of yield, it would be beneficial for producers of agricultural seed crops to gain control of the process using this technology.

Advantages: Faster, more efficient seed harvesting will result from controlling seed pod shattering. The technology has advantage both for direct seed products such as oilseeds, and for seeds to be used for propagation.

Stage of Development: Studies have focused primarily on Arabidopsis genes that are strongly expressed in the valve/replum boundary and a gene that is involved in fruiting body size. Mutant alleles of these genes have been characterized and transgenic plants show a complete lack of replum structures, thus assuring that the valves cannot come apart and disperse seeds.

Patent Number: 6,998,517

Plant Epidermis-Specific Promoter and Methods of Using Same

SD1999-088

Background: Full realization of the potential of many transgenes depends on selective expression in tissues of interest. The following describes a plant promoter isolated from Arabidopsis thaliana that is operative only in the epidermal tissues of plants, and is suitable for driving the expression of genes desired to operate only in this tissue.

Description: A promoter has been isolated from Arabidopsis which upregulates transferred gene expression only in epidermal tissues, and in no others, when placed upstream of a transgene in a construct of interest. The promoter can also be used to identify and recover orthologues in plant species of interest.

Advantages: There are several instances in which selective epidermal expression of foreign genes could prove useful, including: pest resistance, pigmentation, fragrance, wax synthesis, water metabolism or energy metabolism.

Stage of Development: Epidermal-specific expression driven by this promoter has now been demonstrated in species other than Arabidopsis.

Patent Pending

Improved Bioremediation of Soils Contaminated with Toxic Metals Using Transgenic Plants Overexpressing Phytochelatan Synthetase

SD1999-007

Background: There are currently few satisfactory choices for the rectification of toxic or radioactive metal contamination of soils. On a small scale, contaminated areas may be restored by physical removal of surface layers, followed by appropriate disposition (usually remote burial) of the material and re-landscaping to restore the site. On a large scale, this approach is unfeasible, and the alternative is to abandon the land for a prolonged period or permanently, restricting access or uses. The current invention offers a means of safely and economically depleting soils of metal contaminants through a bioremediation approach that preserves the original structure of the land and eventually restores its utility.

Description: A gene encoding a novel cation transporter having broad specificity for metals has been isolated and characterized. Clones incorporating this ion uptake transporter can be transferred to species of plants having deep root systems and rapid growth on a variety of soils. With the metal transporter over-expressed in specific plant tissues, these transgenic plants can be made capable of accumulating a variety of toxic metals from the soil and concentrating them on leaf surfaces or internally.

Metal ions targeted by this system include: cadmium, lead, zinc, nickel, antimony, mercury, silver, tin, copper, cobalt, cesium, strontium, radium, uranium and osmium. Beryllium and aluminum are not effectively transported by this system. By a repetitive process of extensive planting, harvesting and incineration of the contaminated biomass, the metal toxicant in the soil can be reduced to acceptable levels.

Advantages: This method of bioremediation is of particular use in removing heavy metals and certain radioactive metals that could be associated with industrial or nuclear mishap contamination of wide areas. Bioremediation systems using plants are often restricted to certain species -- this approach allows the combining of the most suitable plant for the task/environment with overexpression of the high-capacity metal uptake transporter.

Stage of Development: The process has been demonstrated at laboratory scale using transgenic yeast to remove cadmium and lead. The constructs are suitable for use in transforming higher plant species of interest using established protocols.

Patent Number: 6,489,537

Prevention of Floral Petal Abscission in Transgenic Plants

SD1998-123

Description: Chemical retardants and genetic manipulation of the ethylene pathway have proven only partially successful in preventing flower wilt and loss and prolonging flowering duration and shelf life. The current invention involves the use of certain genes that control floral organ expression. By causing the over expression of these genes using transgenic technology, the process of floral petal abscission is blocked down stream of the regulatory point involving ethylene. This abscission is much sought after in the ornamental flower industry, as well as oil seed production and in many vegetable crops.

Advantages:
- Trait is genetically engineered into the plant
- No need for external chemical application
- Widely applicable to many species
- Other phenotypic aspects not altered

Selective Control of Lignin Biosynthesis in Transgenic Plants

SD1998-117

Background: Lignin biosynthesis control is a much sought-after objective in forest products and paper production, in grain quality improvement and in many other crops. Unfortunately, rational control of lignin biosynthesis has proved elusive. Alteration of the first enzyme in the pathway, phenylalanine-ammonia lyase (PAL) has not proven practical due to the role of this enzyme in many aromatic pathways. Conventional genetic techniques have proven only partially successful in altering lignin content of plants. This approach is too slow to be practical in trees, especially. There has been no report of practical alteration of the lignin pathway starting with the first committed enzyme, cinnamoyl CoA reductase, using either transgenic or genetic approaches.

Description: UCSD investigators have found that a key gene, not previously thought to be involved, plays a central role in regulating lignin accumulation within plant cells. Specifically, mutants in this gene produce excess lignins in “ectopic” positions, while transgene constructs incorporating a constitutive promotor nearly abolish lignin biosynthesis. Furthermore, we have found that certain cells that would normally become lignified show a complete absence of lignin in double mutants for this and a related gene, suggesting that these two genes act redundantly to positively regulate lignin production. These results suggest that these genes can be used to regulate lignification of plant cells.

Advantages: This approach provides greatly improved selectivity and specificity in controlling lignin content without harming normal growth and reproduction, or interfering with fruiting body or seed production. This combination of traits has heretofore not been achieved.

Patent Numbers:

6,906,240
6,846,677
6,841,721
6,781,036
6,768,042
6,410,826

Improved Method for Rational Control of Flowering From Meristem Shoots in Commercially Important Plants

SD1998-069

Transgenes Combining AP1 & New Floral Genes Inducing Exceptionally Early Flowering

Background: Prior to this invention, to optimize flowering in plants, horticulturists had to exercise strict control over a plant's environment. This environmental control included manipulating light and dark cycles, changing the soil nutrient mix, and varying temperature, water, fertilizers and other factors which often interact in a complex and synergistic fashion highly specific for each plant. These environmental conditions limited the geographical areas where various plants could be grown or even bred on a small scale for genetic purposes. Even under ideal growing conditions, many types of plants such as trees can be used in plant genetic studies only with difficulty because of their slow flowering time.

Decription: Recently isolated genes combined in a transgenic plant with AP1 can turn stem-producing, shoot-producing and other non-flowering tissue into normal, healthy blossoms earlier than any previous genetic or horticultural technique, independent of environmental factors normally coupled to flowering. Scientists at UCSD anticipate that the genes are able to cause plants to flower significantly faster than was previously thought possible, with more fruiting bodies per stem, and more flowers per stem. The amount of speed-up in cycle time is a factor of the plant's normal breeding cycle time. The early flowering response in the new constructs occurs far earlier even than has been shown with constitutively expressed AP1 (see attached diagram)

Advantages: The most immediate advantage is the faster breeding cycles permissible with these new genes. Fertile seed is produced almost immediately after sprouting. Because of the speed advantage, new plant breeding programs are available now that were never before practical. Scientists at UCSD anticipate that converting non-flowering tissue into flowering tissue will improve the yield of many basic crops such as tomatoes, garlic, corn, wheat, and broccoli. The strength of the early flowering response, when combined with proprietary controllable promoters, should make more practical chemically-induced flowering of select crops.

Patent Number: 6,828,478

UC San Diego

- UCSD's research engine generated over 300 innovations in each of the last 6 fiscal years
- 1400+ technologies available for licensing
- UCSD is credited with the formation of over 200 startups to date, over 100 start-up companies formed with UCSD licensed innovations to date
- Over 230 commercial products introduced to the market by licensed UCSD innovations

Method for Improving Cuphea Oil Seed Production by Eliminating Premature Pod Shattering

SD1998-063

Background: Cuphea is a tropically grown flowering plant which is known as a rich source of medium-chain fatty acids having high commercial value. However, this plant is not commercially utilized in large-scale agriculture due to its characteristic, sequential maturation and release of oil seeds from the seed pods, which precludes mechanized harvesting. Cuphea is generally harvested by hand at present. Technology which would allow the cultivation and harvesting of Cuphea using modern agricultural methods and equipment would have the potential to create a new, high-value, oil-seed crop of major industrial importance.

Description: A UCSD scientist has discovered a transgenic construct that suppresses seed pod shattering in the laboratory by constitutively expressing a gene in arabidopsis thaliana that appears to be necessary and sufficient expression of the dehiscence zone and subsequent valve opening.. The gene is fully expressible in other species. Seed release (shattering) can be delayed or stopped completely by altering the expression of this gene. Applied specifically to the construction of transgenic Cuphea displaying severe delay of natural pod shattering, this invention has the potential to yield for the first time a practical crop technology for modern commercialization of this species, and economical exploitation of its high-value oil.

Advantages: In the control of shattering generally, substantial losses of yield occur every year from premature seed dispersal, so delaying or halting seed release could allow for much greater seed recovery, to boost yields. In the case of Cuphea bearing this transgene, this invention creates a new crop plant for the production of medium-chain fatty acids. This technology has the added advantage of increasing seed size as well as delaying or preventing natural pod shattering. Shatter-resistant transgenic Cuphea may provide an important new source of income for Third World countries where it is currently harvested by hand on a small scale.

Transgenic Plants Having Improved Pod Shattering and Controlled Seed Release Properties

SD1998-043

Background: In many agricultural seed products such as oilseed crops, grains, and legumes, as well as seed for planting, premature release of seeds prior to harvest results in serious losses. Prior to this invention, visual examination of the crops and other agricultural techniques such as determination of moisture content have been the primary means to indicate timing of the seed harvest. This invention is the first that uses genetic manipulation to achieve rational control of the natural regulatory mechanism of seed release.

Description: A scientist at UCSD has discovered that overexpression of certain floral organ genes prevents the normal senescence of replum cells required for pod valve release and seed dispersal. Plants bearing this transgene construct do not release their otherwise normal, mature seeds without external applied mechanical effort. Thus, complete control of shattering in the field is achieved. Since premature seed dispersal can lead to serious losses of yield, it would be beneficial for producers of agricultural seed crops to gain control of the process using this technology.

Advantages: Faster, more efficient seed harvesting will result from controlling seed pod shattering. The technology has advantage both for direct seed products such as oilseeds, and for seeds to be used for propagation.

Patent Numbers: 6,288,305 and 6,198,024

Method for Increasing Fruiting Body Size and Controlling Seed Release in Commercially Important Plants

SD1997-105

Background: Prior to this invention, if increased fruiting body size was desired, multiple generations of plants had to be carefully bred to produce larger fruits with success far from certain. Research at UCSD into the regulation of flowering genes has uncovered a control point in fruiting body expression. When under the control of a constitutive or regulated promoter for this gene, a transgenic plant with greatly enlarged fruit results. Many kinds of significant commercial crops may now be induced to produce far larger than normal fruiting bodies, apparently, with no loss in fruit quality.

Description: A UCSD scientist has discovered a transgenic construct that increases fruiting body size in the laboratory by constitutively expressing a gene in arabidopsis thaliana that appears to be necessary and sufficient in regulating fruiting body elongation. The gene is fully expressible in other species. Additionally, for the first time, seed release (shattering) can be delayed or stopped completely by altering the expressions of this gene.

Advantages There are several varieties of important commercial crops that could benefit from enhanced size. Plants such as cotton, wheat, linseed, coffee beans, cocoa beans, cherries, apples, and grapes may have several commercial advantages such as ease of harvest. For example, fewer coffee beans would need to be picked for the same yield. High value fruiting bodies such as avocado, figs, dates, blueberries, and kiwis may yield more edible fruit for the same sized seeds. In the control of shattering, substantial losses of yield occur every year from premature seed dispersal, so delaying or halting seed release could allow for much greater seed recovery, to boost yields.

Patent Numbers: 6,541,683 and 6,229,068

UC San Diego

UC San Diego boasts top-rated programs at the School of Medicine, Jacobs School of Engineering, the Division of Biological Sciences, the Division of Physical Sciences, Scripps Institution of Oceanography, the School of Pharmacy and Pharmaceutical Sciences, the Rady School of Management, and the UCSD Medical Center.

UC San Diego TechTIPS evaluates, patents, markets, and licenses universities-developed technologies for commercial applications in the global market. Part of TechTIPS' mission includes enhancing the research experience for faculty and students. In addition, our activities promote the economic development of the Greater Southern California region by out-licensing the fruits of UC San Diego research. The products of this research are also disseminated throughout the world. Companies from North America, Europe, Asia, and Australia license UC San Diego technologies to commercialize in their business ventures.

As part of our educational mission, TechTIPS organizes the Pipeline Events Series providing an educational outreach to the greater UC San Diego community on intellectual property issues. This series includes informative seminars, symposia, and workshops that foster innovation flow from the benchtop to the marketplace.

Bioremediation of Soils Contaminated with Toxic Metals Using Transgenic Plants Overexpressing a Cation Transport Pump

SD1996-102

Background: There are currently few satisfactory choices for the rectification of toxic or radioactive metal contamination of soils. On a small scale, contaminated areas may be restored by physical removal of surface layers, followed by appropriate disposition (usually remote burial) of the material and re-landscaping to restore the site. On a large scale, this approach is infeasible, and the alternative is to abandon the land for a prolonged period or permanently, restricting access or uses. The current invention offers a means of safely and economically depleting soils of metal contaminants through a bioremediation approach that preserves the original structure of the land and eventually restores its utility, even when many square miles are involved.

Description: A cDNA encoding a novel cation pump having broad specificity has been isolated and characterized from a wheat root library. Clones incorporating this ion uptake pump can be transferred to species of plants having deep root systems and rapid growth on a variety of soils. With the ion pump over-expressed throughout the plant tissues, these transgenic plants are capable of accumulating a variety of toxic metals from the soil and concentrating them on leaf surfaces or internally.

Metal ions targeted by this system include: cadmium, lead, zinc, nickel, antimony, mercury, silver, tin, copper, cobalt, cesium, strontium, radium, uranium and osmium. Beryllium and aluminum are not effectively transported by this system, nor are metal ions existing as tightly-bound complexes. By a repetitive process of extensive planting, harvesting and incineration of the contaminated biomass, the metal toxicant in the soil can be reduced to acceptable levels.

Advantages: This method of bioremediation is of particular use in removing heavy metals and certain radioactive metals that could be associated with industrial or nuclear mishap contamination of wide areas. Bioremediation systems using plants are often restricted to certain species -- this approach allows the combining of the most suitable plant for the task/environment with overexpression of the high-capacity metal pump.

Patent Number: 5,965,792

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Transgenic Plants Incorporating a High-Affinity Potassium Nutrition Transporter: Method for Facilitating Commercial Cultivation in High-Saline Environments

SD1993-394

Background: Potassium is the major cationic nutrient required for the commercial cultivation of plants, and is a main component (potash) of crop fertilizers used worldwide. Further, Na+ competes for K+ transport in plants, and annual crop losses due to NaCl stress in soils contaminated by use of high-salinity irrigation water are over $200 million in California's Imperial Valley alone. Salt invasion of croplands worldwide is well-recognized as a growing threat to the worldwide food supply, with total annual production losses ranging from 30-60%.

Description: Researchers at UCSD have been the first to isolate and characterize a novel gene coding for the high-affinity potassium transporter protein from plant cells that is responsible for nutritional uptake of potassium from the environment. The HKT1 gene encodes a membrane high-affinity K+ transport system. Transgenic plants designed to overexpress this gene have greatly enhanced ability to pump K+ from low potassium soils and especially from high sodium soils. This capability could especially benefit Third World countries.

Advantages: Genetic manipulation of plants through incorporation of this gene has the potential to greatly enhance growth rate on low-potassium soils while allowing a reduction in the use of costly fertilizers. Equally important, these transgenic plants have been shown to possess a enhanced ability to grow on soils with high levels of NaCl contamination. This is made possible by the very high density of K+ transporters, permitting more effective uptake of potassium ions in preference to transporter competition by the high environmental sodium. Genetic manipulation of the HKT1 gene may provide for further K+/Na+ selectivity.

Patent Number: 5,608,145

UC San Diego

UC San Diego Faculty Winners of the Nobel Prize

Currently, we have eight UCSD faculty who are recipients of the Nobel Prize.

Year Won	Recipient	Department
2002	Sydney Brenner	School of Medicine
1995	Paul Crutzen	Scripps Institution of Oceanography
1975	Renato Dulbecco	School of Medicine
2003	Robert Engle	Economics
2003	Clive Granger	Economics
1990	Harry Markowitz	Economics
1995	Mario Molina	Chemistry & Biochemistry
1974	George Palade	School of Medicine

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