Office of Commercialization

WASHINGTON STATE UNIVERSITY

AGRICULTURAL TECHNOLOGIES

Washington State University’s Office of Commercialization is a non-profit corporation responsible for commercializing Washington State University (WSU) technologies and supporting university research.

This packet contains some WSU technologies related to agriculture and plant sciences. It also highlights some of our WSU faculty and researchers behind these inventions.

HIGHLIGHTED RESEARCH PROGRAMS

JOHN BROWSE, PHD	AMIT DHINGRA, PHD
SCOTT HULBERT, PHD	B. MARK LANGE, PHD
MICHAEL NEFF, PHD	QIN ZHANG, PHD

The Browse Group

Research in the Browse Lab encompasses a diverse set of projects in the investigation of biosynthesis and function of membranes and storage lipids in plants using *Arabidopsis* as a model. These projects include the isolation and characterization of genes that control elongation, desaturation or other modifications of fatty acids. The genes are used to produce transgenic plants with altered membrane compositions for improved vegetable oils. The lab also focuses on the roles of membrane lipids in plant cell biology and physiology using a large number of mutants with membrane lipid composition alterations.

A second research program uses mutational analysis and molecular genetics to investigate lipid structure and membrane function in the model nematode *C. elegans*. Mutants deficient in polyunsaturated fatty acid synthesis have been isolated and several of these display growth and neurological defects. The mutants provide new tools to understand the roles of polyunsaturated fatty acids in membrane biology and cell function in an animal model.

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Specific Opportunity

Castor oil contains ricinoleic acid, a hydroxylated fatty acid with value as a petrochemical replacement in a variety of industrial processes. The main commercial source of ricinoleic acid is castor bean seeds. However, castor is poorly suited to large-scale agricultural production due to seed toxicity. Two important genes were identified in the pathway of ricinoleic acid metabolism resulting in enhanced production of ricinoleic acid in plants.

Applications and Advantages:

- Improvement over traditional methods of processing castor bean.
- Increasing a much needed supply of ricinoleic acid
- Elimination of processing barriers associated with castor beans for better quality ricinoleic acid.

Intellectual Property Status:

US patent issued, European patent applications pending

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The Dhingra Group

Genomics research in perennial crops is quickly gaining momentum. The state of Washington produces some of the best fruit crops globally. WSU has expertise in horticultural genomics and is uniquely positioned to advance fruit improvement.

Fruit development is accompanied by changes in pigment and several secondary metabolic processes at this transitional phase. Chloroplasts and mitochondria are the major centers of activity during this period.

Dr. Dhingra's lab is working to identify and functionally characterize organelle-targeted genes in fruits in a developmental context. These researchers hope the knowledge gained from this research will help to discover specific key players in metabolic processes related to fruits' nutritional qualities.

Green light signaling is another research project pursued through this program. Green light is considered to be a benign component of the light spectrum. Researchers recently demonstrated that plants do not ignore this signal and adjust the plastid transcriptome, especially during early development. We are interested in dissecting the signal transduction pathway by first identifying specific DNA elements that respond to the green signal.

Recently, our researchers developed a simple, cost-effective, time saving method for rapid sequencing of chloroplast genomes to provide hands-on training to horticulture undergraduate students, exciting them about genomics research. The long-term goal is to integrate a bioinformatics component to establish a portal for comparative sequencing of chloroplast and other small genomes.

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Specific Opportunity

1-Methylcyclopropene (1-MCP) is used in various agricultural commodities to slow the ripening process of fruit while in storage and therefore extend the shelf life. MCP sometimes works in pears and sometimes does not, because pears oftentimes never resume ripening. Studies on d'Anjou pears showed they could be kept immature (maintaining the brix and firmness levels) on a post-harvest basis by spraying them with a particular organic compound. Initial studies on the Bartlett pear, sprayed post-harvest, showed similar results. The benefits of spraying with the organic compound were effective without any special handling of the pears in storage. Even after three months out of storage, pears sprayed pre-harvest with the compound retained almost constant firmness, with lower brix than in untreated pears. The organic compound protected pear degradation with treated pears eventually returning to normal maturation. The compound does not block the pears from ripening, but it keeps them immature and firmer for a longer time. This technology may or may not work with apples. Further research is proposed.

Intellectual Property Status:
Patent pending

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The Hulbert Group

Bacteria and fungi secrete proteins to utilize plant substrates or they may directly secrete them into the plant cells. Most of these effector protein roles are to overcome plant defenses. These are also detected by plant resistance gene products that have roles in pathogen recognition. One of the research programs in the Hulbert lab utilizes a genomics approach to identify and characterize effector proteins from the stripe rust fungus, an important pathogen that affects wheat worldwide. Characterization of these effector proteins is a key to understanding the basic mechanisms of pathogenicity in these biotrophic fungi. Their goal is to elucidate why some cereals, like rice, are not attacked by rust fungi while most other cereals are.

Some cultivated species (e.g. wheat) have little variation in their resistance to certain important pathogens, so sources of genetic resistance are not available. They therefore are trying to find resistance in related species and transfer this resistance to the cultivated types. Another approach particularly for soil borne pathogens include identification of genotypes or cultural conditions that favor microbes that suppress the pathogenic microbes. Using high throughput DNA pyro-sequencing approaches to characterize microbial populations in soil they hope to identify the microbes that are most important.

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Specific Opportunity

Camelina, a biofuel and a vegetable oil crop, is extremely sensitive to residual activity of commonly used Group 2 herbicides (e.g. imazethapyr and imazamox), also known as acetolactate synthase (ALS) inhibitors. This sensitivity is hindering the adoption of *Camelina* for crop rotations because of a lack of flexibility, and adequate chemical weed control inputs. Through induced mutation, and with physical mutagen ethane methyl sulfonate (EMS), The Hulbert lab identified putative mutants that confer tolerance to imazethapyr (Pursuit brand herbicide) and imazamox (Beyond brand herbicide).

Applications and Advantages:

- *Camelina* varieties with reduced sensitivity to Group 2 herbicides imazethapyr and imazamox.
- Commercialization of these mutants will enable fuller exploration of this crop as a biofuel and an oil crop.

Intellectual Property Status:
Patent pending

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The Lange Group

Plant natural products are better known for their utility as dyes (e.g., indigo), fibers (e.g., cellulose), flavors (e.g., d-limonene from citrus), fragrances (e.g., geraniol from Damask rose), and drugs (e.g., morphine). Research in the Lange laboratory is aimed at characterizing the interface between primary and secondary metabolic pathways using functional genomics and systems biology approaches.

The current projects in the Lange lab includes studying the crosstalk between cytosolic and plastidial pathways of isoprenoid biosynthesis . They are also interested in studying metabolism in specialized cells in particular: glandular trichomes and soybean paraveinal mesophyll. In addition, they hope to develop metabolite profiling assays, tools for the integration of post-genomic data sets and generate mathematical models for metabolic pathways.

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Specific Opportunity

While the concept of utilizing plants as "green factories" for the production of small molecules has been of great interest, several issues have plagued plant metabolic engineering efforts thus far: (1) terpenoids are accumulated in a non-specific fashion and their accumulation causes cytotoxicity; (2) terpenoids are produced but are converted to conjugates for storage; this usually results in low accumulation levels; and (3) terpenoids are produced but are emitted as volatiles. For the first time, WSU scientists have successfully transformed a plant species that has evolved the capacity to store large amounts of essential oil and have demonstrated that even novel terpenoids can accumulate at high levels in the essential oil. The process involves expressing one or more transgenes in a plant to enrich for a terpene of interest in the essential oil of the plant. Storage of the essential oil in the glandular trichomes of the plant will reduce the volatility and cytotoxic capacity of the terpene.

Intellectual Property Status:
PCT application pending

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The Neff Group

Michael Neff's research allows us to gain a better understanding of how multiple signaling pathways converge to regulate seedling responses to light as well as adult plant development. This research also addresses the biological mechanisms controlling multiple traits which have been proposed as targets for enhanced plant biomass production including: photoreceptor-mediated shade avoidance, leaf senescence, leaf size, flower/fruit size and stem diameter. By understanding these mechanisms, we are likely to generate leads for the transfer of fundamental knowledge learned using *Arabidopsis* towards applications that will develop increased biomass in crops.

Each of the lines of research in the Neff' lab comes from a mutant screen designed to uncover novel and potentially redundant components involved in signal transduction downstream of a major photoreceptor controlling plant development, phytochrome B (PHYB). This screen has allowed his team to identify components missed by other genetic approaches and has led his team toward studying how interactions between light and hormone signaling affect seedling and adult plant development.

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Specific Opportunity

Camelina is one of the crops that is being actively explored and researched in recent days for its potential use as a biofuel crop. Value-added traits that would reduce input costs should aid in exploiting this crop as an alternative fuel crop. This particular technology relates to the use of *Arabidopsis*/*Camelina* derived AHL genes and gene products for modulation of cell growth in plants. Our WSU investigators have discovered that mutations within the A-T hook domain confer a dominant negative phenotype to the plants resulting in longer hypocotyls and taller seedlings.

Applications and Advantages:

The practical utility of this discovery is that *Camelina* can be planted deeper enabling the growing seed to tap into deeper water sources. This should make it particularly attractive and useful in dryland agriculture. In addition to its utility in *Camelina*, the mutants can be exploited in other crops of commercial value.

Intellectual Property Status:
Patent pending

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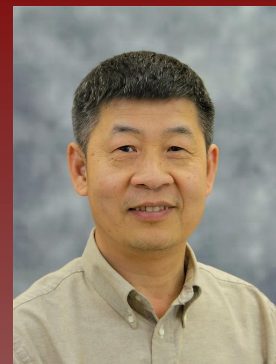
The Zhang Group

Harvesting labor accounts for 50% of the total tree fruit production cost. This labor cost continues to rise as a labor shortage developed over the last several decades in agriculture. Labor issues will remain the biggest challenge for the tree fruit industry in the near future.

Mechanical or mechanical-assist harvesting technologies can increase the harvesting efficiency and reduce the labor dependency, a promising solution for solving the labor issue. Currently there are no commercial mechanical harvesters for fresh market tree fruit harvesting, mainly because most fruits, such as apple and pear, are easily bruised during harvesting. Bruise damage can reduce the fruit quality and cause a major profit loss, which obstructs the application of mechanical harvesting technologies in fresh-market tree fruit production.



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Specific Opportunity

Bruise damage of tree fruit is mainly caused by the excessive mechanical impact from fruit-to-fruit, fruit-to-tree, or fruit-to-catching frame when they are removed by a mechanical harvester and captured by a fruit catcher. The key factors to avoid or reduce mechanical-impact induced bruise damage include:

1) reduction of apple dropping distance;
2) deceleration of fruit to reduce impact force;
3) singulation of fruit from each other to avoid impact between fruits, and
4) covering the catching surface with padding to avoid impact from catching surfaces.

This invention provides a novel method to reduce fruit bruise damage with an insertable catching, a singulation, and a deceleration system during harvest. It is designed to satisfy all the requirements for minimal bruising, catching, and transporting mechanically harvested fruit from tree to the bin.

Intellectual Property Status:
Provisional patent filed

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