School of Agricultural and Wine Sciences
2009 PHD Student Projects

Nicole Hyde
PhD Student

Opportunities for perennial wheat in Australia: An investigation into aspects of perenniality and root function under differing conditions across the Australian wheatbelt.

Australian farming systems are currently dominated by annual crops, which have been associated with significant environmental and long-term sustainability issues. Perennial wheat represents a potential alternative food crop, which could be incorporated into existing farming systems to provide some of the environmental benefits of perennial plants, while continuing to produce grain and forage. My research will investigate the development and growth of several lines of perennial wheat under Australian conditions. The objective is to determine if perennial wheat performs as desired, through assessments of phenology, and quantification of growth, water use, resource allocation and root dynamics. Measurements will be made across successive seasons, to allow insight into the influence of phase of development, plant age and condition on growth, regrowth and performance. This work will be supported by field trials over different climatic zones and soil conditions, to further investigate the variations in expression of plant traits. The results will be discussed in terms of the suitability and possible role of perennial wheat in Australian farming systems, and the implications for whole-farm performance and environmental impact.

Bree Wilson
PHD Student

Arbuscular mycorrhizal fungi communities in saline soil.

My PhD research is investigating mycorrhizal fungal communities in saline landscapes. Dryland salinity reduces land productivity and biodiversity, though less is known about the affect of salinity on soil microorganisms such as mycorrhizal fungi. Mycorrhizal fungi form symbiotic relationships with the majority of land plants and are thought to be essential for plant establishment and growth. They are also known to improve plant survival under saline conditions. The major components of my research are detailed below.

Genetic diversity of mycorrhizal fungi isolated from saline soil using DNA fingerprinting techniques. This study will investigate the spatial and temporal distribution of mycorrhizal fungi across a salt gradient in salt-affected agricultural land.

The influence of sodium chloride on the germination and hyphal elongation of mycorrhizal fungi spores. The information gained from this study hopes to provide more information about how salinity influences spore germination and thus colonisation of plants.

The infectivity of mycorrhizal fungi isolated from saline soil. Several experiments have investigated the responsiveness of salt tolerant pastures to colonisation by mycorrhizal fungi. Results thus far suggest a high degree of host specificity and this information can be used to better manage and restore land affected by dryland salinity.

Jennifer Spinner
PhD Student

Native parasitic wasps: a new eradication tool against fruit fly incursion management.

Fruit flies (Tephritidae) are arguably the worst pest of edible fruit. Opiine wasps are a group of wasps (Hymenoptera: Braconidae) which parasitise fruit flies. In several regions of the world, inundative releases of opiine braconids as part of an Integrated Pest Management (IPM) program have resulted in the effective management of fruit flies. Despite this, and the importance of fruit flies as pests, parasitoids are not yet used in the management of fruit flies in Australia. This project aims to develop parasitic wasps as an additional tool for the management of fruit flies, in particular Queensland fruit fly ('Qfly'), *Bactrocera tryoni* .

Initial work comprises field surveys of areas in inland New South Wales to determine the identity of fruit fly parasitoid species present and levels of parasitism. Small-scale, laboratory assessment of the ease of culturing each parasitoid species will complement a review of the literature and will allow selection of the superior species for more detailed studies. Following selection of a single species, optimal rearing techniques and strategies for release frequency, rate, location, timing and pre-release feeding of parasitoids will be developed. This phase of the project involves close consultation and hands-on experience in international laboratories with Mexican, Hawaiian & Floridian entomologists experienced in parasitoid rearing and release. The success of the project will be assessed via large-scale field evaluations of Qfly eradication when parasitoids are released either alone or together with the sterile insect technique (SIT).

Vanessa Connick
PhD Student

'Investigating the role of silicon in biological pest control of grapevines (Vitis vinifera); including enhanced natural enemy attraction and improved plant defences against insect and fungal attack, as well as monitoring changes in plant drought tolerance, plant photosynthetic ability and qualitative changes in the wine produced from treated vines.'

Much research has been carried out over the years proving beyond a doubt the beneficial effects of applied silicon to plants affected by herbivore insect attack or abiotic stresses. This research project will be investigating the unproven effects of Si. The role of Si on a tri-trophic level is only beginning to be understood. It is believed that Si alters the quantitative and qualitative properties of herbivore induced plant volatiles (HIPV), increasing the attraction of the attacked plant to predator pests and parasitoids. My research will also investigate the effects of Si on wine quality. Prior research has found increasing levels of Si in the soil resulted in increased baumé and decreased titratable acidity (TA) of grapes. However, composition of grapes is likely to be correlated to a wide range of plant-available cations present in the soil, and therefore, will be particular to an individual site and vineyard. Other factors such as drought tolerance, saline and heavy metal soil tolerance, and altered photosynthetic ability will also be monitored. Further research conducted on vineyards in the Orange area are important to determine the effects of Si in this area and the potential benefits of this study to the wine industry are great.

Navneet Kaur Brar
PhD Student

Nitrogen management of wheat sown into rice stubble in NW India (Punjab)

The main production system of NW India is an annual rice/wheat rotation. While wheat stubble can be used as animal fodder, the management of rice stubble is more problematic. The time between crops is limited and allowing time for the stubble to breakdown delayed the sowing of wheat beyond the optimum sowing date (15 - 20 November), resulting in yield losses of 1% per day delay in sowing (Hobbs and Morris, 1996). To avoid sowing delays and blockage of cultivation implements by rice stubble, farmer's burn rice stubble in the field. However, this resulted in nutrient loss and decreases in soil microbial populations. Burning also produces harmful greenhouse gases and particulate emissions, associated with human health problems. To eradicate the problems of burning residues and late sowing of wheat, a machine called the 'Happy Seeder' has been developed which simultaneously cuts and spreads rice stubble on the soil surface (as mulch) while sowing wheat with zero or strip tillage (Sidhu et al., 2007).

Lauren Forrest
PhD Student

The capacity of private extension to influence land use change
My project is funded by the Future Farm Industries CRC and is concerned with technology development, its extension and ultimate adoption. I have a keen interest in extension (product) delivery, including the development of training packages, and to be associated intrinsically with a project where extension was seen as integral, rather than 'added onto', the project.

I am interested in viewing the user : research interface from a social perspective, providing input into product development while developing a deep understanding of the linkages between decision making, research and

development, and communication and training. What factors drive decision making? What 'shape' does training take to assist industry to gain the most from product development? What does technical research need to better understand and narrow the chasm between early adopters and early majority?

Matthew Gardner
PhD Student

How does Chicory effect the nitrogen cycling of pasture systems?

Growers in the medium and high rainfall zones of southern Australia have few alternatives when it comes to high quality summer forages apart from lucerne. Recently, chicory (*Cichorium intybus*) has been identified as a new perennial forage species that is more tolerant to acidic and waterlogged soils than lucerne.

Chicory is a short term perennial herb which has a high nitrogen (N) requirement. Its responsiveness and recovery of applied N is extremely efficient in comparison to other pasture and crop species currently used in mixed farming systems. In addition to high N recoveries chicory also has high mineral contents, low levels of structural carbohydrates, large taproot systems and active summer growth habits. These properties are hypothesised to significantly affect the processes within the N cycle. In particular, it is expected that mineralisation, immobilisation, plant uptake of inorganic N and biological N fixation would be effected under a chicory-legume pasture mix. These key processes of the N cycle can either reduce or promote the supply of N to pastures and subsequent cropping phases.

Therefore, there are two key objectives of the research. Firstly, to quantify the effect that chicory has on N turnover under a chicory-legume pasture mix. Secondly, is to determine the mechanisms that are responsible for any changes within the N cycle under this pasture mix. Based on the findings best practice N management can be determined for chicory pasture mixes to improve their productivity in mixed farming systems.

Felicity Gummer
PHD Student

The relationship between vigor and earliness in cereals

Amongst the best performing varieties of various cereal species, there is a positive relationship between vigor (or early growth) and the ability to flower quickly. The suggestion that more early, and rapid shoot growth is at the expense of root growth, has been supported by findings that allocation to roots is greater in later maturing varieties. Therefore, it may be that differences in early growth are merely apparent as roots are rarely sampled or taken into account. Overall, the extent to which the relationship between vigor and earliness is a physiological phenomenon or a result of close linkage between the genes involved is unknown. The aim of the project is to explore this relationship by carefully measuring whole-plant growth under controlled conditions as well as monitoring under field conditions. A series of field and controlled environment experiments will be conducted across a range of cereal species (wheat, barley, oats, and cereal rye) using genotypes with known genetic background. The novelty of the work lies in the fact that few vigor measurements take into account the roots - a much under-researched area in crop development.

Karen Kirkby
PHD Student

The role of the grass endophyte Neotyphodium occultans in annual ryegrass (*Lolium rigidum*)

The focus of my PhD research is to examine the relationship and biological significance of the fungal endophyte *Neotyphodium occultans* found in *Lolium rigidum* in Australia. I have commenced a survey of annual ryegrass seed collected from southern Australia. The incidence and frequency of infection within these samples has to be determined. Initial results indicate high selection for endophyte with 100% of seed populations surveyed to date contains infection. The frequency of infection varies greatly from within and between postcodes sampled.

The viability of the endophyte is an important aspect of this research. Experiments have been conducted investigating the effect of storing seed for long periods of time, along with effect of seed burial over time on viability of endophyte in natural field conditions.

Endophytes have been shown to affect the physiological and morphological aspects of host (Latch, G. C. M. 1994; Moon, C. D., Scott, B. D., Schardl, C. L. and Christensen, M. J. 2000). An area of much interest is determining if *N. occultans* has a positive or negative effect on annual ryegrass growth and performance.

A deeper understanding of how this endophyte expresses itself within its host is being gained from glasshouse pot trials and the use of scanning electron microscopy for detailed undisturbed view in the seedling and in dry seeds. Other areas of study include genetic variation and possible links between herbicide resistance and endophyte infection.

Jeff McCormick
PHD Student

Dual purpose canola - prospects and possibilities

Dual purpose crops can be grazed by stock during the vegetative stage and later harvested for an economic grain yield. Winter wheat varieties have been successfully used as a dual purpose crop. Gross margins have been raised by providing valuable feed in the winter time while obtaining comparative yields to un-grazed crops. This research is being undertaken in collaboration with Dr John Kirkegaard (CSIRO) to determine whether the same opportunities exist in canola. Dual purpose canola could benefit the farmer by increasing farm flexibility and improving gross margins. Recent preliminary studies have demonstrated a potential role for dual purpose canola and in contrast to cereals little is known about how canola responds to grazing. To determine the feasibility of dual purpose canola a thorough understanding of the defoliation effect on growth and development are essential for predicting potential yields. The work includes field and glasshouse experiments with a focus on regrowth after defoliation, the relationship between biomass at flowering and final yield, and determining the grazing effects on flowering date.

Pasuquin, Estela
PHD Student

Influence of elevated temperature and dry matter production and partitioning during grain filling in rice

My research is the area of climate change in agriculture particularly on the effect of elevated temperature on the source-sink relations in the rice crop. This research is aimed at understanding the pattern of plant growth (leaf and tiller development, dry matter production) in the different growth stages, and the subsequent partitioning of stored and currently produced assimilates to grains under high temperature conditions. This study will also look at the underlying physiological processes such as respiration, photosynthesis and stomatal conductance. While a broad range of temperature for good biomass production was reported, some scientists showed that 40°C/33°C (day/night) temperature is the limit for rice survival. Others showed that yield start to decline when daily mean temperature exceeds 29°C while changes in dry matter accumulation and partitioning can already be observed between 23°C-26°C. Variations among cultivars in terms of high temperature adaptations will also be observed and subsequent selection for traits and better cultivars will be explored to cope with the negative effects of rising temperature. She is from the Philippines, work as an Assistant Scientist at IRRI Philippines in climate change in rice, are at CSU on an ALA Scholarship (AusAID), and your research is linked with IRRI Philippines, University of Tsukuba in Japan, and DPI rice program in Yanco.

Balwinder Singh
PHD Student

Effect of rice mulch on wheat growth, yield and water productivity

The sustainability of the intensive rice-wheat cropping system in north-west India, and of rice based systems in Australia, is facing the challenge of management of post harvest rice residues. About 90% of rice residues are burnt rather than retained as mulch or incorporated into the soil. Recently, development of the Happy Seeder makes it possible to sow wheat into rice residues with the rice straw retained as mulch on the surface.

My PhD project will investigate the effects of mulching on wheat growth, development and yield, soil temperature, soil evaporation, soil mineral N transformations, water use, and water productivity using field experiments and simulation modeling. The results of the field monitoring, together with findings from the

literature and past experiments, will be used to evaluate and refine the sub-routines in the crop model APSIM-wheat. The refined model will then be used to determine the likely impact of mulching on crop performance; water use, and water productivity using historic weather data sets.

David Waters
PHD Student

The Impact of Biochar on dryland broadacre cropping

The survival of Australian Agriculture is threatened by unsustainable management practices (such as loss of soil fertility due to over cultivation or product removal), long term reductions in farmers' terms of trade (partially due to the rising costs of inputs), and the uncertainty created by greenhouse gas emissions and climate change. Organic soil carbon amendments could be a vital tool utilised by farmers to mitigate these changes. Biochar is a by-product of slow heat pyrolysis, and is increasingly viewed as a stable, carbon-based soil conditioner. Recent research has shown the potential of Biochar for enhancing agronomic fertility, as well as the possibility of sequestering soil carbon. Results from previous Biochar trials have indicated increases in potential soil CEC resulting in lower nutrient leaching, increased soil microbial activity, improved soil structure and greater retention of soil carbon. A unique combination of soil type and climate are contributing factors of the South-eastern dryland cropping zone, and the above threats to the historical capacity of this region to produce a significant proportion of Australia's food will require innovative changes in farm management to enhance industry sustainability. The successful application of organic soil amendments such as Biochar in a broadacre cropping context could have long term beneficial effects on soil productivity, as well as carbon sequestration potential. Previous literature has suggested that the source of material used in producing the Biochar can alter its chemical properties. Therefore different biochars, when combined with fertilisers, could have varying effects on soil productivity and resulting plant yields. Similarly, the increasing scarcity of supply (and therefore the rising cost) of inorganic fertilisers, as well as a greater community perception of the effects of a carbon footprint, are encouraging the trial of organic alternatives. My PhD will focus on the underlying mechanisms of nutrient retention by analysis of the potential cation exchange capacity of the soil. This will involve the determination of the charge density of the biochar particle, as well as its interaction with other organic matter groups in the soil. The impacts of Biochar on plant growth, including yields, biomass and root length, will also be quantified.