Twin Cities Campus

Applied Plant Sciences Ph.D.

Agronomy & Plant Genetics, Horticultural Science

College of Food, Agricultural and Natural Resource Sciences

Link to a list of faculty for this program.

Contact Information:
Department of Agronomy and Plant Genetics, 411 Borlaug Hall, 1991 Upper Buford Circle, St. Paul, MN 55108-6026 (612-625-4742; fax: 612-625-1268)
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- Program Type: Doctorate
- Requirements for this program are current for Fall 2019
- Length of program in credits: 54
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Applied plant sciences is an interdisciplinary program for educating students to become professional scientists well grounded in the applied disciplines of agronomy/agroecology, horticulture, and plant breeding/molecular genetics. Graduates of the program are able to provide innovative leadership and contribute to problem solving within their disciplines in the public or private sector and within society at large. The program develops the quantitative and qualitative research skills necessary to conduct high quality research and scholarship. Students choose from among four specialization tracks: agronomy/agroecology, applied plant sciences, horticulture, or plant breeding/plant molecular genetics. Students gain broad familiarity with all of the disciplines within the program and gain in-depth knowledge within their area of expertise. The program's graduate faculty is drawn primarily from the Department of Agronomy and Plant Genetics and the Department of Horticultural Science; but also from the Departments of Plant Biology; Plant Pathology; Soil, Water, and Climate; Ecology, Evolution and Behavior; and Fisheries, Wildlife and Conservation Biology. The faculty embrace the University of Minnesota's position that promoting and supporting diversity among the student body is central to our academic mission.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission

The preferred undergraduate GPA for admittance to the program is 3.00.

Other requirements to be completed before admission:
Students entering the program should have a foundation in the physical and biological sciences, preferably with some emphasis in plant science. A minimum of 10 credits of math and physics, 12 credits of chemistry and biochemistry, and 15 credits of biological and/or agricultural sciences are recommended for admission. In addition, students should have completed a BS or BA degree in agriculture, biology, or other related life science. Students with a BS or BA degree outside these areas may be admitted with the requirement that they take the prerequisite courses noted above at the undergraduate level in addition to their graduate coursework.

Special Application Requirements:
Applicants must submit scores from the General (Aptitude) Test of the GRE; three letters of recommendation from persons familiar with their scholarship and research potential; a complete set of official transcripts; and a clearly written personal statement of career interests, goals, and objectives as part of the online application. Students should apply by December 1 for admission into fall semester of the following year. Students should apply by October 1 for admission into spring semester of the following year.

Applicants must submit their test score(s) from the following:

- GRE

International applicants must submit score(s) from one of the following tests:

- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550

- IELTS
  - Total Score: 6.5
- MELAB
  - Final score: 80

Key to test abbreviations(GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

30 credits are required in the major.
0 credits are required outside the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 1 semesters must be completed before filing a Degree Program Form.

PhD students must complete the core curriculum, requirements for their specialization, and present one graduate seminar. Additional course requirements are flexible and determined in consultation with the students advisor(s) and advisory committee.

Required Courses

Take the following courses:
AGRO 5311 - Research Methods in Crop Improvement and Production (1.0 cr)
APSC 8123 - Research Ethics in the Plant and Environmental Sciences (0.5 cr)
APSC 8270 - Graduate Seminar (2.0 cr)
Take one of the following courses:
AGRO 5121 - Applied Experimental Design (4.0 cr)
or BIOL 5272 - Applied Biostatistics (4.0 cr)
or ENT 5126 - Spatial and Temporal Analysis of Ecological Data (3.0 cr)
or ESPM 5211 - Survey, Measurement, and Modeling for Environmental Analysis (3.0 cr)
or FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
or GIS 5555 - Basic Spatial Analysis (3.0 cr)
or NR 5021 - Statistics for Agricultural and Natural Resource Professionals (3.0 cr)
or PUBH 6450 - Biostatistics I (4.0 cr)
or STAT 5021 - Statistical Analysis (4.0 cr)
or STAT 5201 - Sampling Methodology in Finite Populations (3.0 cr)
or STAT 5302 - Applied Regression Analysis (4.0 cr)
or STAT 5303 - Designing Experiments (4.0 cr)
or STAT 5401 - Applied Multivariate Methods (3.0 cr)
or STAT 5421 - Analysis of Categorical Data (3.0 cr)
or STAT 5601 - Nonparametric Methods (3.0 cr)
Take one of the following courses. Consult with the advisor regarding number of credits to take if APSC 8280 is selected.
APSC 8280 - Current Topics in Applied Plant Sciences (1.0 - 3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)
Take one of the following courses:
GRAD 8101 - Teaching in Higher Education (3.0 cr)
or CFAN 8101 - Professional Skills for Scientists (2.0 cr)

Electives

Select courses, in consultation with the advisor, to complete 30 course credits.

Thesis Credits

Take at least 24 doctoral thesis credits.
APSC 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Program Sub-plans

A sub-plan is not required for this program.
Students may not complete the program with more than one sub-plan.

Agronomy and Agroecology

Students conduct research to increase their knowledge of cropping systems and weed science, including alternative approaches and management strategies. Emphasis is on improving production efficiency and profitability in an environmentally sound approach that benefits society. Mechanisms of crop physiology and ecology underlying plant responses to the environment are a particular emphasis of this track.

Students pursuing the agroecology/agronomy specialization track must complete at least two agroecology/agronomy courses, one plant biology course, and one ecology course.

Courses listed within agroecology/agronomy, plant biology, and ecology/plant pathology/soil science groups are provided as a guide for students and faculty. Other specialization courses can be substituted with agreement of the advisor, the advisory committee, and director of graduate studies.

Agronomy/Agroecology

Take two courses from the following list. Consult with advisor to determine number of credits to take if AGRO 5999 is selected.
AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 4605 - Strategies for Agricultural Production and Management (3.0 cr)
or AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)

Plant Biology

Take one of the following courses or another course selected in consultation with the advisor:
PMB 5516 *{Inactive}*(3.0 cr)
or PMB 5412 - Plant Physiology and Development (3.0 cr)

Ecology/Plant Pathology/Soil Science

Take at least one course from the following list:
BIOL 5407 *{Inactive}*(3.0 cr)
or EEB 4068 - Plant Physiological Ecology (3.0 cr)
or EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
or EEB 5609 - Ecosystem Ecology (3.0 cr)
or ESPM 5108 - Ecology of Managed Systems (4.0 cr)
or ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
or SOIL 5611 - Soil Biology and Fertility (4.0 cr)

Horticulture

Students conduct research related to fruits, vegetables, potatoes, flowers, ornamental trees and shrubs, or turf; and on the physiology, production, environmental impact of cropping systems, and use of horticultural crops. Research areas include the effect of horticultural commodities on human health, hormonal, and stress physiology; flower development and flowering physiology; integrated pest management; post harvest physiology; and cropping system strategies. Students get a broad range of experiences in the field, greenhouse, and/or laboratory using genetic, molecular, biochemical, and ecological tools to answer research questions.

Students pursuing the PhD with a horticulture specialization track must take at least one course from each area; four courses in total from Areas 1 and 2.

Area 1 - Cross Commodity Horticulture

Students must complete at least one Area 1 course.
HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (3.0 cr)
or AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or HORT 4461 - Horticultural Marketing (3.0 cr)
or HORT 4850 *{Inactive}*(3.0 cr)
or HORT 5007 - Advanced Plant Propagation (3.0 cr)

or HORT 5023 - Public Garden Management (2.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or MKTG 6051 - Marketing Research - Rapid Insights (2.0 cr)
or MKTG 6055 - Buyer Behavior (2.0 cr)
or MKTG 6082 - Brand Strategy (2.0 cr)
or MBA 6211 - Marketing Management (3.0 cr)
or HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)

Area 2 - Commodity-based Horticulture

Students must complete at least one Area 2 course.
HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
or HORT 4063 - Turfgrass Science (3.0 cr)
or HORT 5011 *{Inactive}*(3.0 cr)
or HORT 5012 *{Inactive}*(3.0 cr)
or HORT 5031 *{Inactive}*(3.0 cr)
or HORT 5032 *{Inactive}*(3.0 cr)
or HORT 5061 *{Inactive}*(2.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)

Area 3 - Related Fields

Students must complete at least one Area 3 course. Courses other than those listed below can be substituted with agreement of the advisor, advisory committee, and director of graduate studies.
AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)
or BIOL 5407 *{Inactive}*(3.0 cr)
or EEB 4068 - Plant Physiological Ecology (3.0 cr)
or EEB 5053 - Ecology: Theory and Concepts (4.0 cr)
or EEB 5609 - Ecosystem Ecology (3.0 cr)
or ESPM 5108 - Ecology of Managed Systems (4.0 cr)
or ESPM 5245 - Sustainable Land Use Planning and Policy (3.0 cr)
or ESPM 5295 - GIS in Environmental Science and Management (4.0 cr)
or HORT 5058 *{Inactive}*(3.0 cr)
or HORT 5059 *{Inactive}*(1.0 cr)
or HORT 8201 *{Inactive}*(3.0 cr)
or PMB 5412 - Plant Physiology and Development (3.0 cr)
or PMB 5516 *{Inactive}*(3.0 cr)
or PMB 5601 - Topics in Plant Biochemistry (3.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or SOIL 4111 - Introduction to Precision Agriculture (3.0 cr)
or SOIL 5611 - Soil Biology and Fertility (4.0 cr)

Plant Breeding and Plant Molecular Genetics

This track allows students to select from genetic research projects ranging from applied plant breeding projects emphasizing breeding procedures and methodologies to molecular genetic projects doing biotechnology, genetic engineering, and genomic research in agronomic and horticultural crops. These research projects give students the opportunity to integrate the latest developments in the laboratory with applied applications in the field to reach the overarching goal of developing new germplasm that will improve the sustainability of our food/feed/fiber/fuel systems.

Students pursuing the PhD with a plant breeding and plant molecular genetics track must complete at least one course from the Plant Breeding area and at least two courses from the Genetics & Genomics area. PhD students are required to complete a minimum of 30 course credits including the program-wide required courses.

Plant Breeding

Take at least one course from the following:
AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)

Genetics and Genomics

Take at least one course from the following:
AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
or EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)

or HORT 5058 *{Inactive}*(3.0 cr)
or HORT 5059 *{Inactive}*(1.0 cr)

Other Suggested Courses

Courses other than those listed below can be substituted with approval of the advisor, advisory committee, and director of graduate studies.

Agroecology and Cropping Systems

Consult with the advisor regarding number of credits to take if AGRO 5999 is selected.
AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or AGRO 5999 - Special Topics: Workshop in Agronomy (1.0 - 6.0 cr)
or HORT 5011 *{Inactive}*(3.0 cr)
or HORT 5012 *{Inactive}*(3.0 cr)
or HORT 5023 - Public Garden Management (2.0 cr)
or HORT 5031 *{Inactive}*(3.0 cr)
or HORT 5032 *{Inactive}*(3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)

or **Biochemistry**

BIOC 8001 - Biochemistry: Structure, Catalysis, and Metabolism (3.0 cr)
or BIOC 8002 - Molecular Biology and Regulation of Biological Processes (3.0 cr)
or PMB 5601 - Topics in Plant Biochemistry (3.0 cr)

or **Biotechnology/Genetics/Genomics**

GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
or HORT 4071W - Applications of Biotechnology to Plant Improvement [WI] (3.0 cr)
or HORT 5007 - Advanced Plant Propagation (3.0 cr)
or PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)

or **Computational Biology/Bioinformatics**

Consult with the advisor regarding number of credits to take if CSCI 5980 is selected.
BIOC 5361 - Microbial Genomics and Bioinformatics (3.0 cr)
or CSCI 4041 - Algorithms and Data Structures (4.0 cr)
or CSCI 5461 - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
or CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
or CSCI 5980 - Special Topics in Computer Science (1.0 - 3.0 cr)

or **Evolution**

EEB 5221 *{Inactive}*(3.0 cr)

or **Physiology**

PMB 5412 - Plant Physiology and Development (3.0 cr)
or PMB 5516 *{Inactive}*(3.0 cr)

or **Plant Pathology**

PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 8104 - Plant Virology (2.0 cr)
or PLPA 8105 - Plant Bacteriology (3.0 cr)

Applied Plant Sciences

Students who choose to pursue the PhD without a specialization track must complete the APS required core curriculum and at least one course from these three areas: genetics and plant breeding; organismal biology; and cropping systems, communities, and commodities.

Genetics and Plant Breeding

Take at least one course from the following:
AGRO 5021 - Plant Breeding Principles (3.0 cr)
or AGRO 5431 - Applied Plant Genomics and Bioinformatics (3.0 cr)
or AGRO 8023 - Evolution of Crop Plants (3.0 cr)
or AGRO 8202 - Breeding for Quantitative Traits in Plants (3.0 cr)
or AGRO 8241 - Chromosomal and Molecular Genetics of Plant Improvement (3.0 cr)
or APSC 8201 - Advanced Plant Breeding (3.0 cr)
or EEB 5042 - Quantitative Genetics (3.0 cr)
or GCD 4034 - Molecular Genetics and Genomics (3.0 cr)
or GCD 8131 - Advanced Molecular Genetics and Genomics (3.0 cr)
or HORT 5058 *{Inactive}*(3.0 cr)
or HORT 5059 *{Inactive}*(1.0 cr)
or PLPA 5301 - Large Scale Omic Data in Plant Biology (3.0 cr)

Organismal Biology

Take at least one course from the following:
HORT 5007 - Advanced Plant Propagation (3.0 cr)
or HORT 8044 - Manipulation of Plant Growth and Reproduction (2.0 cr)
or PMB 5412 - Plant Physiology and Development (3.0 cr)
or PMB 5516 *{Inactive}*(3.0 cr)
or PMB 5601 - Topics in Plant Biochemistry (3.0 cr)
or PLPA 5103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 8103 - Plant-Microbe Interactions (3.0 cr)
or PLPA 5203 - Introduction to Fungal Biology (3.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or PLPA 5480 - Principles of Plant Pathology (3.0 cr)
or PLPA 5660 - Plant Disease Resistance and Applications (3.0 cr)
or PLPA 8104 - Plant Virology (2.0 cr)
or PLPA 8105 - Plant Bacteriology (3.0 cr)

Cropping Systems, Communities, and Commodities

Take at least one course from the following:
AGRO 4505 - Biology, Ecology, and Management of Invasive Plants (3.0 cr)
or AGRO 5321 - Ecology of Agricultural Systems (3.0 cr)
or HORT 4062 - Turfgrass Weed and Disease Science (3.0 cr)
or HORT 4063 - Turfgrass Science (3.0 cr)
or HORT 4141W - Scheduling Crops for Protected Environments [WI] (4.0 cr)
or HORT 5031 *{Inactive}*(3.0 cr)
or HORT 5032 *{Inactive}*(3.0 cr)
or HORT 5071 - Ecological Restoration (4.0 cr)
or HORT 5131 - Student Organic Farm Planning, Growing, and Marketing (3.0 cr)
or PLPA 5202 - Field Plant Pathology (2.0 cr)
or PLPA 5444 - Ecology, Epidemiology, and Evolutionary Biology of Plant-Microbe Interactions (3.0 cr)
or SAGR 8010 - Colloquium in Sustainable Agriculture (2.0 cr)