HISTORY OF CROP PHYSIOLOGY [1/]

R. L. Warner [2/]

Physiology as a recognized discipline in Agronomy departments does not have a long history, although some early Agronomists could have been considered "physiologists". As the complexity of problems encountered by agronomists and plant breeders increased, the need to understand basic processes also increased. As a result, crop physiologists were brought into many Agronomy departments during the fifties and early sixties to develop a better understanding of plant metabolism, particularly in such areas as photosynthesis, water relations, mineral nutrition, herbicide action, nitrogen metabolism and seed germination.

In the early fifties crop scientists began to lobby the American Society of Agronomy (ASA) for a separate society and journal. As a result, the Crop Science Society of America (CSSA) was formed as an affiliate of the American Society of Agronomy in 1955 followed in 1961 by the journal, Crop Science. The first volume of Crop Science contained articles by scientists destined to become world famous crop physiologists. Although physiology was first recognized by the ASA in 1937 when the Division of Physiology and Ecology was established, the impact made by physiologists was not realized until Crop Science was established.

At Washington State University, physiologists and physiological research became part of the Agronomy Department during the late fifties and early sixties. Since then, physiological research has been conducted on seeds, weeds, photosynthesis and carbon metabolism, nitrogen metabolism and growth regulators.

Seeds and seed production have long been important components of agronomic research at WSU (see history of seed technology). In 1957, J. D. Maguire was placed in charge of the seed laboratory. Although his primary responsibilities were in seed testing and technology, he and his students have conducted research on physiological aspects of seed germination, dormancy and deterioration. At Prosser, R. M. Cressman (seed physiologist, USDA) conducted research on physiological factors affecting seed production of red clover from 1957 to 1967. In 1964, R. Fendall was hired to develop an advanced course in seed physiology and to initiate a research program on seeds. Fendall's research activities included mechanisms governing dormancy, metabolic changes during germination, and chemically induced male sterility. Fendall resigned in 1968 to take a position in the Crop Science Department at Oregon State University. Later that year, R. L. Warner replaced Fendall. Warner has conducted physiological research on nitrogen metabolism with emphasis on genetic and biochemical mechanisms regulating nitrate acquisition and assimilation in barley, wheat and pea.

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USDA scientists have also conducted considerable seed physiology research at WSU. Don George came to Pullman in 1965 as a research agronomist. George conducted research on sprouting resistance and winter survival of wheat until he retired in 1982. In recent years USDA scientists, A. Ciha, K. Walker-Simmons, S. Spaeth and D. Gealy, have initiated research programs on various physiological aspects of seeds. Although Ciha's primary responsibility when hired by the USDA in 1976 was to develop management regimes to minimize erosion, he soon recognized that preharvest sprouting of wheat was occasionally a serious problem in the Palouse. After initiating research on the relationship between phytohormones and sprouting, Ciha resigned in 1984 to join the Monsanto Corporation in St. Louis. In 1984, Kay Walker-Simmons was hired to continue research on the preharvest sprouting of wheat. She is currently investigating the biochemistry and molecular biology of phytohormone regulation of wheat seed dormancy and preharvest sprouting. Spaeth joined the USDA grain legume program in 1983 to study mechanisms causing imbibitional injury and poor stand establishment in legumes. He has recently identified mechanisms causing cotyledon cracking and solute leakage in several legume species. Gealy was hired by the USDA in 1981 to investigate the biology of weed species under conservation tillage, including the physiology of germination of species such as wild oat, mayweed chamomile and jointed goatgrass.

Physiological studies on carbon assimilation began in 1963 with the hiring of I. D. Teare as a forage specialist. Teare's initial interest was in the biophysics of light interception in canopies and mechanisms for estimating forage yields in situ. Later he studied stomatal frequency and distribution in the spike and leaves of wheat. Teare resigned in 1969 to join the Evapotranspiration Laboratory at Kansas State University. The sixties and seventies was a period of considerable research on photosynthesis and it was the expectation of many scientists that photosynthetic efficiency could be used as a selection tool to improve yield. R. E. Witters succeeded Teare in 1971 and continued research on leaf and whole plant photosynthesis in barley and wheat. Witters and his students also conducted extensive growth analyses of wheat growing under different environments in the state. Witters resigned in 1977 to become the associate director of research at Oregon State University. During the seventies many scientists concluded that photosynthetic rate, unfortunately, was not closely correlated to yield. However, research on photosynthesis did lead to a much better understanding of this important process and continues today in many laboratories around the world. These studies also indicated that transport of fixed carbon to storage organs may be a limiting component of yield. In 1978 P. Chevalier replaced Witters and has continued research on carbon metabolism, with particular emphasis on transport of assimilates to and into storage organs. Because water deficits often limit the yield of crop growth in eastern Washington, she has also examined the effects of water stress on carbon metabolism in storage organs.

Physiological aspects of weed growth and development, and mechanism of action of herbicides have been important areas of research activity by WSU and USDA scientists. In 1962 T. J. Muzik was hired to teach and conduct research on weed control. During the late sixties biotypes of several weed species were identified which had considerable resistance to herbicides previously used to control the species. Muzik and his students conducted physiological studies on mechanisms contributing to biotype resistance to growth regulators in several weed species. Muzik retired in 1982. Physiological research dealing with weed species and growth regulators has also been conducted by USDA scientists D. Gealy and L. Y. Marquis. Gealy is conducting basic and applied research on weed biology and interactions with herbicides. He has studied the effects of herbicides on photosynthesis; and collaborated with students to examine herbicide uptake, transport and metabolism in relation to selectivity. Marquis conducted biochemical and physiological research on absorption, translocation and metabolism of herbicides at Prosser from 1976 until he resigned from the USDA in 1985.

Instruction in crop physiology in the Department began in the sixties and has evolved slowly since that time. Formal courses dealing with physiology are limited to senior and graduate levels, and are intended to complement courses taught in Botany and Biochemistry. Teare brought elements of physiology into Agronomy 411 "crop ecology" in the sixties. Witters increased emphasis on physiology and gradually the course was changed to "physiological crop ecology". Chevalier has further increased emphasis on physiology and has retitled the course "environmental crop physiology". Graduate level courses dealing with physiology include Agronomy 508 "seed physiology" and Agronomy 509 "physiology in plant breeding". Seed Physiology was first taught by Fendall in 1965 and has been taught by Warner since 1969. Physiology in Plant Breeding was developed by Chevalier in 1979 to replace a graduate level techniques previously taught by both Teare and Witters. Muzik taught a graduate level course entitled "hormones and herbicides" which covered mechanism of action of various growth regulators. Crop physiology courses taught at WSU and the University of Idaho are cross listed which increases the opportunities for students at both universities.

Physiology and physiologists continue to be important components of most Agronomy departments. Although knowledge of plant physiology and biochemical processes have advanced a great deal, our understanding of how to manipulate metabolic processes is woefully inadequate. At present, plant breeders must continue to develop new varieties based upon morphological and subjective considerations rather than quantitive estimation of biochemical processes. In the next decade geneticists will have the capability to manipulate specific genetic information from plant to plant and species to species. Hopefully plant physiologists and biochemists will be able to identify metabolic targets for genetic modification.