Soil Fertility Research and Extension in Oregon

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Abstract

This report describes our approach to and philosophy behind development of soil fertility research and Extension programs at Oregon State University since 1980. Three examples describe how fertilizer management was used to minimize crop loss to a plant disease, protect groundwater quality, and enhance crop production efficiency. Instead of presenting data, we reference published research and management recommendations.

Introduction

Oregon State University has a long history of applied research and Extension programs designed to benefit agricultural producers. The authors have had the privilege of directing soil fertility teaching, research and Extension programs at OSU for the past three decades. The purpose of this report is to summarize the challenges and opportunities we faced and the approaches we employed. This retrospective examines the importance of a shared philosophy of research and Extension and the role of collaboration in contributing to the success of agronomic research and education programs.

Oregon Agriculture

Oregon exhibits a wide range of soils and climates as a consequence of its physical geography. While the climate is characterized by wet winters and dry summers, the amount of annual precipitation is governed largely by topography and elevation. Dominant among the topographic features is the Cascade mountain range that divides Oregon into a “wet” western one-third and a “dry” eastern two-thirds (Figure 1). Important crop production areas include the Willamette Valley (W.V.) in western Oregon where precipitation ranges from 100 to 150 cm annually and both non-irrigated and irrigated crops are grown. Non-irrigated crop production in eastern Oregon occurs primarily on the Columbia Plateau (C.P.) where annual precipitation ranges from 30 to 60 cm, depending upon elevation. Areas dominated by irrigated agriculture include the Columbia Basin (C.B.), Central Oregon (C.O.), Klamath Basin (K.B.), Grande Ronde Valley (G.R.), and Snake River (S.R.). The Columbia Basin in Oregon / Washington and the Snake River in Oregon / Idaho have the longest growing seasons.

The wide variety of soils, climates and cropping systems allow over sixty-six commercial crops to be grown in Oregon (Agripedia, 2010-2011). Among those are a variety of crops ranking high in USA national importance (Table 1).

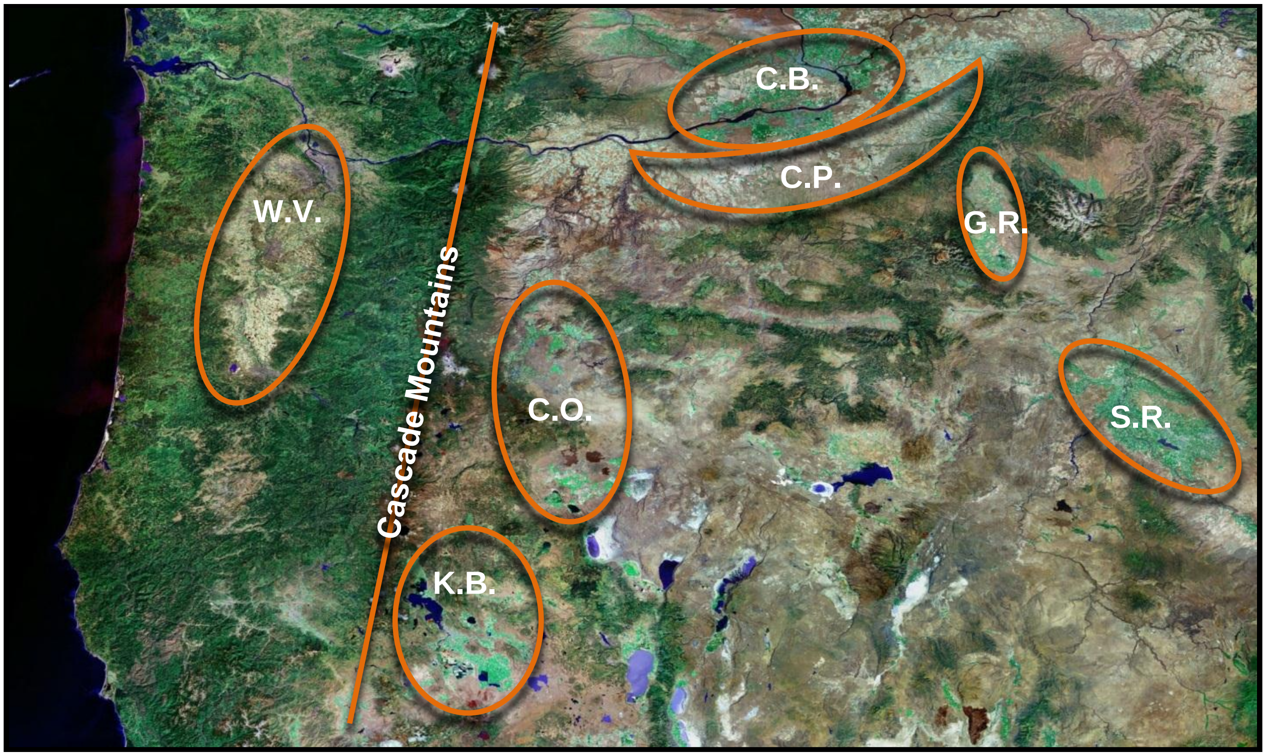

Figure 1. Satellite view of the state of Oregon illustrating the location of some of the major agricultural areas; Willamette Valley (W.V.), Klamath Basin (K.B.), Central Oregon (C.O.), Columbia Plateau (C.P.), Columbia Basin (C.B.), Grande Ronde (G.R.) and Snake River (S.R.)

Table 1. Major Oregon crops with national rank shown in parentheses

Field crops	Seed crops	Vegetables & Berries	Trees
Peppermint (1)	Ryegrass seed (1)	Onions (1)	Christmas trees (1)
Hops (2)	Fescue seed (1)	Sweet corn (5)	
Potatoes (2)		Blueberries (1)	
Wheat (12)		Cranberries (4)	

Research and Extension Project Selection, Philosophy and Approach

The wide variety of crops, soils and production systems makes Oregon an interesting place to be a soil scientist, but the many opportunities for investigation can be distracting if one does not have a clear sense of purpose. For that reason we found it helpful to ask ourselves several questions before embarking on a new project: (1) will it create new knowledge?, (2) will it solve a specific production problem?, (3) will it improve crop production efficiency?, (4) will it protect the environment?, (5) will it foster collaboration?, and (6) will it generate financial support?

The authors share the philosophy that effective programs must address real issues affecting growers and that research results must be extended in ways that encourage adoption. Consequently, our soil fertility programs have been farm oriented, science based, collaborative, and integrated. Focusing on the needs of agricultural producers insured that research and education programs were relevant. With numerous crops and a wide range of soil conditions, climates and cropping systems, a strong science based approach was essential in understanding cropping systems and solving complex problems. A collaborative approach that involved professional colleagues, farmers and the agri-business community was necessary to access the knowledge held by others, share resources across locations and regions, and gain recognition and credibility among growers. Finally, an integrated approach insured that research efforts were informed by knowledge gained from Extension programs, and vice versa.

Our programs included research in the laboratory, growth chamber, greenhouse and field to investigate crop production limitations and/or soil processes. Promising results from fundamental research were explored, refined, and demonstrated using applied field experiments. Small-plot replicated experiments were used to study interactions and to scale and refine treatments. When promising management practices were identified, large-scale, on-farm replicated experiments were conducted to assess and demonstrate recommended practices under growers' conditions. Articles in refereed journals conveyed knowledge to professional peers. Practical findings were conveyed to farmers and the agri-business community through tours of small- and large-scale field experiments, educational meetings and workshops, and management guides available online for download.

Program Examples

The following examples illustrate a variety of soil fertility management projects designed to minimize a crop loss to disease, protect groundwater quality, and enhance crop production efficiency. Success of these projects required an understanding of soil N dynamics as well as N demand by the crop (Sullivan et al., 1999).

<u>Take-all Root Rot of Wheat</u>

Take-all root rot of wheat is caused by the soil borne pathogen *Gaeumannomyces graminis* var. *tritici* (Ggt). The disease is common in western Oregon when consecutive crops of wheat are grown and can substantially reduce grain yield when environmental conditions favor disease development. A serendipitous observation in the late 1970s showed that Take-all severity and grain yield loss were reduced when chloride (Cl^-) containing fertilizers (NH_4Cl, KCl) were applied. It was known that disease development was also influenced by soil pH and the form (NH_4-N, NO_3-N) of applied N fertilizer. Armed with this information, we studied the main effects and interactions among soil pH, chloride salts, and N fertilizer sources as they affect disease development and yield loss. Field research revealed that soil pH, chloride, and form of applied N interact to influence the N form available to plants (Christensen and Brett, 1985; Roseberg et al., 1986). Results showed that disease development and severity could be related to the $NH_4^+ : NO_3^-$ ratio in soil for up to ten weeks after N fertilizer application in the spring (Christensen et al., 1987; Christensen et al., 1990). Knowledge gained was used to develop management practices to minimize yield loss to Take-all (Christensen and Hart, 2008 revised). Recommended practices were adopted by wheat growers in the 1980s and again in recent years when Take-all again became common because with the planting of consecutive wheat crops.

Nitrogen Management for Hops and Peppermint

In Oregon, hops (*Humulus lupulus*) and peppermint (*Mentha piperita*) are high value, perennial crops grown under irrigation on well drained soils. Hops are grown exclusively in the northern Willamette Valley while Peppermint is grown in the Willamette Valley, Central Oregon, the Grande Ronde Valley and the Klamath Basin. Both crops receive liberal applications of N fertilizer and soil sampling to a depth of 150 cm revealed that residual soil NO_3-N remaining after harvest leached from the soil profile over the winter, especially in the Willamette Valley (Christensen et al., 2003). Elevated levels of NO_3-N in groundwater and the establishment of a groundwater protection district prompted research to measure crop demand for N (Hart et al., 2003) and develop N fertilizer management practices to minimize leaching losses of NO_3-N (Gingrich et al., 2000; Hart et al., 2010).

Nitrogen Mineralization Soil Test for Wheat

Soft white winter wheat (SWWW) grown without irrigation in the Willamette Valley has a grain yield potential approaching 10 Mg ha^{-1}. Nitrogen fertilizer requirements range from 90 to 225 kg N ha^{-1} and are a function of soil supplied N which is strongly influenced by the previous crop (Hart et al., 2009). A mid-winter soil test consisting of a 7-day anaerobic incubation to assess mineralizable soil N was used in the 1990s and found to improve the accuracy of N fertilizer recommendations. After the soil test had been adopted, some growers began direct-seeding (no-till) of wheat and noted that mineralizable soil N was higher than it had been with conventional tillage, especially where wheat was direct-seeded into grass sod. On-farm, large scale field experiments using growers' machinery were conducted to verify the accuracy of recommendations based on the Nmin soil test (Christensen and Mellbye, 2006; Anderson et al., 2010).

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