I. Introduction

A. Soybean in the world

The soybean, Glycine max (L.) Merrill (Fabaceae: Phaseoleae), was domesticated by farmers in the eastern half of northern China during the Shang dynasty (ca. 1700-1300 B.P.) or perhaps earlier For several thousand years, people in eastern Asia have used the soybean for food and animal feed and as a medicine to treat a number of human disorders. Reviews of the origin and early history of this crop have been published (Hymowitz, 1990, 1995; Hymowitz and Bernard, 1991; Kollipara et al., 1997).

B. World production of soybean

During the 1993-94 season, soybean was grown in at least 45 countries with a production of 113,069,000 metric tons. The major producers of the crop are the USA (44%), Brazil (21%), People's Republic of China (12%) and Argentina (11%) (Soytech, Inc., 1995). Soybeans are a primary source of vegetable oil and protein. The oil is used in cooking oil, margarine, salad oils, and shortening. The soy meal or cake which remains after oil extraction is used for animal feed and in producing textured protein, that is used as a meat extender and a thickener in prepared foods. The soybean can be used in the formulation of new, low-cost, nutritionally balanced, high-protein foods and beverages for human consumption. Recent studies suggest that certain components in soybeans may be beneficial to human health. Various industrial uses, such as biodiesel fuels, paints, plastics, insecticides, and adhesives, also are under investigation.

C. Soybean growth and development

The moisture, soil, and temperature requirements of the soybean are similar to those of maize (Zea mays L.), which accounts for the major producing areas being in temperate and subtropical areas. Soybean seeds require a moisture content of 50% (dry weight basis) for germination. Therefore, a good supply of moisture is critical at planting time. Soybean flowers over a 3- to 4-week period and can resist short periods of moisture stress. The crop grows best between soil pH 5.8 and 7.0, with an optimum between pH 6.3 and 6.5. Soybean grows well in a range of soil types, with the type determining which specific practices obtain maximum yield. Soil temperature should be 10°C or above before planting and about 25°C for germination and rapid emergence, but other factors may determine planting date. The ideal temperature for growth is 30°C. Sustained temperatures below 24°C will delay the onset of flowering. Successful seed set occurs when nighttime temperatures are below 2 1°C, followed by daytime temperatures of at least 27°C (Scott & Aldrich, 1987). A standard method for reporting soybean growth stages has been devised (Fig. 1) (Fehr et al., 1971). This terminology should be used in reporting data associated with growth stages.

Because of their photoperiod response, soybean cultivars are placed in 13 maturity groups designated 000 to X. Cultivars in the 000 group are the earliest in maturity and are adapted to the northern- and southern- most world production areas; groups IX and X are used primarily in the semi-tropical or

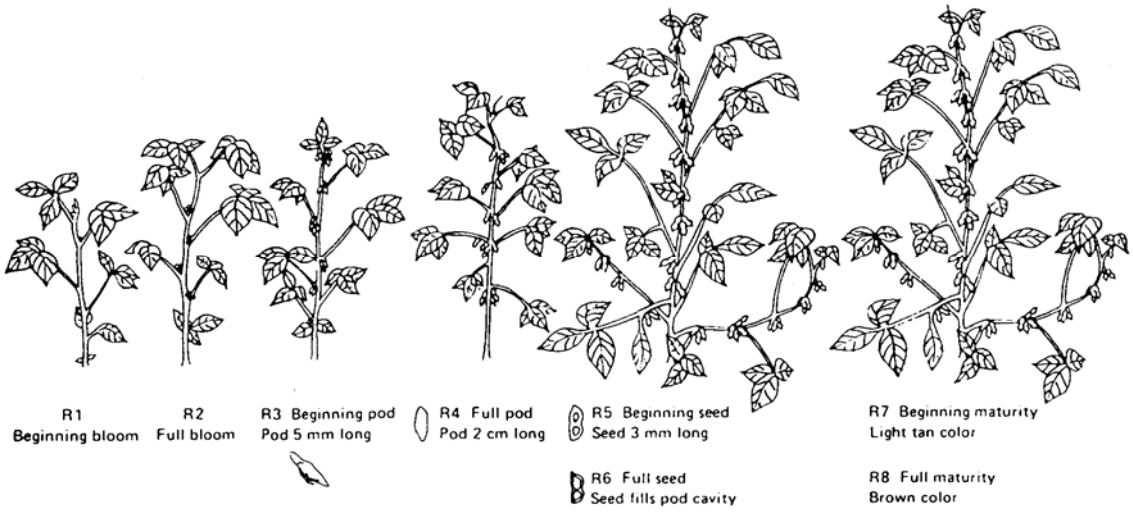

Figure 1. Reproductive stages of soybeans. (Reprinted by permission of the Southern Soybean Disease Workers, from W. J. Walla, ed., 1978. Soybean Disease Atlas).

tropical areas of low altitudes. Most soybean cultivars are adapted for full-season growth in rows no wider than 160 to 240 km (Scott & Aldrich, 1983).

Since the early 1970's, several developments have influenced soybean management. Plant breeders continue to release improved, higher—yielding cultivars for all maturity groups. Cultivars must continually be evaluated under different cropping systems to determine the best cultivars for use in each cropping system. Development of improved herbicides, as well as improved tillage and planting equipment, has allowed increased adoption of conservation tillage. These same developments also have allowed the increased use of narrow row widths. As further improvements occur in chemical pesticides and farm equipment, there will be greater adoption of these two important production practices (Johnson, 1987).

Strong evidence has developed supporting the need to rotate soybean with other crops. Double—crop production of soybean grown as a second crop has become as significant as crop rotation in many southern USA areas. Several innovations in headers for combines have resulted in reduced harvest losses. Nitrogen fertilization and growth regulators are two areas of management research that have received attention yet remain elusive in terms of providing any additional new tools to increase yields. As soybean plantings have increased and management tools available for production have become more complex, a greater need has developed for educational efforts that carry these management alternatives to the producer. Future gains in soybean productivity will become even more dependent on imaginative, interdisciplinary research (Johnson, 1987).

The International Soybean Program (INTSOY) is a unique program that developed during the 1970's. This program of the University of Illinois at Urbana—Champaign and the University of Puerto Rico, Mayagüez Campus, cooperated with international and national organizations to expand the use of soybean. Since the inception of the INTSOY cultivar testing program in 1973, more than 250 soy bean cultivars have been tested in over 100 countries by some 500 cooperators. An issue of the INTSOY Newsletter summarized a number of generalizations that can be drawn from these tests (Johnson, 1987):

(i) yields tend to be higher in the tropics from later-maturing cultivars;
(ii) yields are somewhat lower in tropical and subtropical regions than in temperate regions;
(iii) plants are affected more by changes in altitude than in latitude;
(iv) lodging and shattering are seldom serious problems;
(v) the size of seeds is not related to yield;
(vi) yield from a newly introduced crop usually is good;
(vii) poor nodulation is a major problem in popularizing soybean cultivation in the tropics;
(viii) chemical composition of seeds is comparable in all environmental zones;
(ix) seed quality is a universal problem, but small-seeded cultivars have better seed quality than large-seeded ones; and
(x) the oil and protein concentration of any one cultivar usually remains stable when grown in different sites and environments.

D. Computer programs related to soybean pests

1. StratSoy

StratSoy is a state-of-the-art electronic information and communications system developed by the University of Illinois to improve the efficiency and competitiveness of the U.S. soybean industry. The system is a gateway to information from around the world on the most current soybean research, resources, and organizations that serve the industry. In addition, StratSoy provides a way for producers, industry leaders, growers' organizations, and the public to communicate with each other and with experts in soybean related fields. The system is located on the Internet at http:soy.ag.uiuc.edu/stratsoy.htmml.

Funding for StratSoy was provided by the United Soybean Board and the Illinois Soybean Checkoff Board. The University of Illinois and the Agricultural Market Research Center at Texas A&M University collaborated in development of StratSoy. The system is coordinated by a team from the Office of Research and the Department of Agricultural and Consumer Economics in the College of Agricultural, Consumer, and Environmental Sciences at the University of Illinois.

2. Other programs

a. Diseases

AUSIMM (Backman, et al.,1989)
Soybean Disease Diagnosis (Illinet) (Micha et al., 1983)

b. Arthropods

Numerous models, developed to describe growth and development of specific arthropod pests, their population dynamics, and the effects of natural enemies, have been coupled with soybean growth models in decision making for soybean pest management (Jones et al., 1984). Two examples are SOY- GROW 5.0 (Mishoe et al., 1985) and AUSIMM (Herbert et al., 1992). Other models have been developed to integrate 1PM into crop production models (Jones et al., 1985; Hutchins et al., 1986; Szmedra et al., 1987; and Nagarajan et al,, 1994).

c. Weeds

HERB
North Carolina State University
(Wilkerson et al., 1991)

OSU HERBICIDE SELECTOR
Ohio State University (Loux, 1966)

SOYHERB
Michigan State University
(Renner et al., 1991)

HERBICIDE GUIDE
University of Illinois, Urbana-Champaign
(Todd & Pike, 1996)

WEEDIR
University of Minnesota
(Miller et al., 1990)

WEEDSIM
NC-202 (Swinton & King, 1994)

WEEDSOFT
University of Nebraska
(Martin & McNamara, 1995)