Double-Crop Soybean Production System in the USA – Literature Review

VIRGINIA TECH

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Introduction

- Double cropping is the growing and harvesting of two successive crops on the same land in one year.
- Soybean [*Glycine max* (L.) Merr.] following winter wheat (*Triticum aestivum* L.) is the most prevalent double cropping system in the United States.
- Double cropping increases cash flow and profits and ensures global food security by increasing total food production.

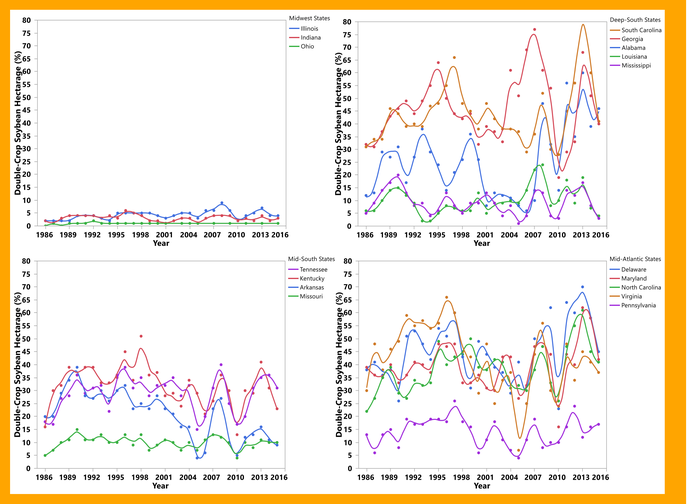
Objectives

- Provide a comprehensive review of environmental and crop management factors affecting soybean yield in double-crop system.
- Summarize the best management practices that may increase double-crop soybean yield and profitability in the United States.

Importance

- Wheat-soybean double-crop systems provide greater net return than full-season soybean even though double-crop soybean yields 10 to 40% less than full-season soybean.
- Improves soil and water quality by reducing soil erosion and nutrient runoff and leaching.
- Improves soil physical, chemical, and biological properties by adding more crop residue.
- Increases the total productivity per unit land area, which can help meet the global food demand for the growing population.

Double-Crop Hectarage



Factors Affecting Double-Crop Soybean Yield

Wheat Cultivar & Harvest Date

- An early wheat cultivar allows soybean to be planted about 5 d earlier.
- Wheat reaches maximum test weight, grade, and acceptable milling quality at ~30% moisture.
- Early wheat harvest increases wheat yield due to high test weight and less shatter loss and helps increase double-crop soybean yield by allowing early soybean planting.

Crop Residues

- **Allelopathy:** Small-grain crop residues reduce soybean seed germination, seedling vigor, and crop growth through allelopathy.
- **Herbicide Activity**: Crop residues prevent herbicides to reach soil surface and thereby reduce herbicide efficiency.
- **Residue Decomposition:** Wheat residue decomposes slowly due to its high C/N ratio, suggesting that additional N application may help decompose wheat straw quickly and enhance early soybean growth.
- **Wheat Stubble Height:** A stubble height of ≤30-cm (12 inch) is ideal for optimum double-crop soybean yield under no-till condition.
- **Wheat Straw Burning:** Decreases water infiltration, hydraulic conductivity, and soil aggregate stability resulting in poor soil structure.
- **Wheat Straw Baling:** An alternative option to overcome the negative effects of shading, allelopathy, or straw burning. But, nutrients content of wheat straw and other soil health benefits must need to be considered.
- **Tillage**: Tillage may increases soybean yield; but, no-tillage improves soil fertility and health.

Planting Date

- Planting date is more important than any single cultural practice and late planting is the main reason of reduced double-crop yield due to early flowering induced by short photoperiod and high temperature, short time to develop optimum LAI of 3.5 to 4.0 at the R2 to R4 stages, and shorter reproductive stages.
- Each day delay planting after mid-Jun. reduces soybean yield by appr. 34 kg ha^{-1} (½ bu $acre^{-1}$).

Row Spacing

- Narrow row spacing increases soybean yield when planted later than optimum dates due to equidistant plant spacing, rapid leaf area development with faster canopy closure, increased radiation interception and crop growth rate, and high plant survival rates.
- Drought stress may overshadow soybean yield benefits from narrow row spacing.

Maturity Group & Growth Habit

- Soybean yield at late planting can be increased from 29-276% through proper cultivar selection. But, it is difficult task to choice a MG for double-cropping system due to lack of research and variable environmental conditions.
- Late maturing cultivars are often recommended for late planting or double-crop soybean to avoid summer drought stress under rainfed condition and to lengthen the growing season.
- Indeterminate soybean may be benefitted more from narrow row than determinate soybean.

Seeding Rate & Plant Population

- Soybean yield is a positive linear-plateau or quadratic function of seeding rate or plant pop^n.
- Double-crop soybean requires more plants for quick attainment of optimum LAI that can capture maximum solar radiation.
- Excessive plant population can decrease soybean yield by reducing individual plant leaf area and hence decrease light interception efficiency.

Soil Fertility

- **Nitrogen Management:** Fertilizer-N consistently increases late-planted soybean yield. Since N_2 fixation does not start until 9 d after soybean emergence, a small amount of starter N may enhance early season growth for rapid canopy closure, maximize solar radiation interception, and increase double-crop soybean yield.
- **Phosphorus Management:** Soybean yield in wheat-soybean system is not influenced by P fertilizer application time.
- **Potassium Management:** Soybean yield may be affected by K application time. Double-crop soybean requires 30-55% less K than full-season.

Water Management

- Double-crop soybean is more susceptible to drought than full-season soybean. Drought can cause complete failure of double-crop soybean.
- Double-crop soybean can yield similar to full-season soybean in years with adequate amount and distribution of rainfall from June to Sep. especially during seed-filling period (R5 to R7).

Pest Management

- Although wheat residues can suppress weed growth significantly through shading, both burndown and post-emergence herbicides are required to establish weed management philosophy of “start clean and stay clean”.
- Double-crop soybean is more susceptible to leaf damage by insect and disease infestation during R3-5 stages, but may assist with SCN control due to delayed planting into wheat stubbles.

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