MULTITACTIC WEED MANAGEMENT IN ORGANIC SOYBEAN PRODUCTION SYSTEMS. Emily R. Bernstein, David E. Stoltenberg, Joshua L. Posner, and Janet L. Hedtcke, Graduate Research Assistant, Professor, Professor and Senior Research Specialist, Department of Agronomy, University of Wisconsin, Madison, WI 53706.

Organic soybean production has rapidly increased in Wisconsin to meet demand of the expanding organic dairy industry. A major challenge faced in these production systems is the intensive tillage needed for successful weed management, spurring interest in more systems oriented, multitactic approaches to weed management. However, little is known about the effectiveness and risks associated with such approaches. We conducted research in 2008 and 2009 near Arlington, Wisconsin to determine some of the weed management and environmental risks and benefits associated with the use of a winter rye cover crop for no-tillage organic soybean production relative to a tillage-intensive approach (plowing, tine weeding, and cultivation). In the no-tillage approach, rye mulch and soybean competitive ability are the principal tactics relied upon for weed management, whereas in the tillage-intensive approach, tine weeding and cultivation are the principal tactics. As such, our specific objectives were to determine the effect of rye management (plowing, crimping, and mowing), soybean planting date (mid-May or early June), and soybean row spacing (19 or 76 cm) on soybean stand establishment, weed suppression, weed community composition, and soybean yield. Treatment effects on economic gross margins, soil loss, and soil quality were also predicted.

At the time of rye management (plowing, crimping, or mowing), rye mass was 7- to 10-fold greater in no-tillage systems than the tillage-intensive system in each year ($p < 0.0001$). In no-tillage systems, rye mass was 13.3 Mg ha^{-1} in 2008 and 5.3 Mg ha^{-1} in 2009, both years exceeding the minimum (4 Mg ha^{-1}) considered necessary for effective weed suppression. Soybean establishment (stand density as a percent of viable seeding rate) in the no-tillage systems for early-planted soybean (before rye crimping or mowing) was greater (80%) than late-planted soybean (after crimping or mowing, 60%) ($p = 0.0406$) suggesting more uniform depth placement of seed occurred in the early planted treatments. However, soybean establishment did not differ between tillage-intensive and early-planted no-tillage systems, nor was it affected by rye management (crimping or mowing) or row spacing (76 or 19 cm).

Early-season (mid-June) weed densities and community composition among treatments varied by year, except that velvetleaf was more abundant in the tillage-intensive system than no-tillage systems in each year. In 2008, weed densities at VE-V2 soybean were greater in the tillage-intensive system (44 weeds m^{-2}) than across no-tillage systems (0.2 weeds m^{-2}) ($p < 0.0001$). Yellow foxtail (14 plants m^{-2}), velvetleaf (13 plants m^{-2}) and shepard's-purse (13 plants m^{-2}) were the most abundant species in the tillage-intensive system, whereas yellow foxtail (0.1 plants m^{-2}) and common lambsquarters (0.1 plants m^{-2}) were the most abundant species across no-tillage systems. In 2009, weed densities at VC-V3 soybean did not differ among treatments ($p = 0.7938$), and averaged 11 weeds m^{-2}. The most abundant species in the tillage-intensive system were common lambsquarters (5 plants m^{-2}), velvetleaf (2 plants m^{-2}) and shepard's-purse (1 plants m^{-2}). In no-tillage systems, common lambsquarters (5 plants m^{-2}), shepard's-purse (4 plants m^{-2}) and white clover (3 plants m^{-2}) were most abundant. Early-season weed species abundance was not affected by soybean planting date, row spacing, or rye management among no-tillage systems.

Weed suppression was greatest in the no-tillage systems, as late-season total weed shoot mass across years was several-fold greater in the tillage-intensive system than in the no-tillage systems ($p = 0.0058$). Among no-tillage systems, weed mass was less for earlier- than later-planted soybean ($p = 0.0612$) and for narrow- than wide-row spacing ($p = 0.0991$). Abundant species differed between tillage-intensive and no-tillage systems in each year. In 2008, the most abundant species (based on mass) in the tillage-intensive system were velvetleaf (49 g m^{-2}), redroot pigweed (4 g m^{-2}) and barnyardgrass (1 g m^{-2}), compared to common lambsquarters (3 g m^{-2}), barnyardgrass (1 g m^{-2}) and velvetleaf (0.7 g m^{-2}) in the no-tillage systems. Weed species richness (Margalef's index; $p = 0.3099$), evenness (Pielou's index; $p = 0.3253$), and diversity (Shannon's index; $p = 0.9186$) did not differ between the tillage-intensive and no-tillage systems. In 2009, the most abundant species in the tillage-intensive system were common lambsquarters (128 g m^{-2}), velvetleaf (5 g m^{-2}), and ladysthumb (2 g m^{-2}). In contrast, the most abundant species in the no-tillage systems, were common lambsquarters (10 g m^{-2}), ladysthumb (3 g m^{-2}), and white clover (3 g m^{-2}). Weed species richness ($p=0.0007$), evenness ($p = 0.0015$), and diversity ($p < 0.0001$) were greater in no-tillage systems than the tillage-intensive system.

Soybean yield across years was greater for the tillage-intensive system than any of the no-tillage systems ($p = 0.0041$). Among no-tillage systems, soybean yield was greater for narrow- than wide- row spacing ($p = 0.0883$), but yield was not affected by planting date ($p = 0.1636$) or rye management ($p = 0.7667$). The tillage-intensive system was also more profitable than the no-tillage systems ($p = 0.0054$). However, profitability was not affected by rye or soybean management among the no-tillage systems. Predicted soil loss was several-fold greater for the tillage-intensive system than no-tillage systems at both 1 and 4.5% slopes. Soil loss for the no-tillage systems was less than the T-value (11 Mg ha^{-1}) in each scenario. Predicted changes in soil organic matter over time were positive in no-tillage systems and negative in the tillage-intensive system.

Multiple tactics that included winter rye mulch, no-tillage planting, and competitive crop canopies were associated with greater weed suppression and weed community dynamics, less soil loss, and greater soil organic matter than a tillage-intensive approach to organic soybean production. However, these potentially long-term benefits were offset by 24% less soybean yield and 25% less profit. Even so, these rye mulch, no-tillage soybean systems appear to be economically viable alternatives to the tillage-intensive approach; they are particularly attractive to growers due to the reduction in labor requirements, and require less organic matter inputs over the rotation in order to maintain long-term soil quality.