Weed Seed Bank in Organic Field Crop Transition

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Long-term changes in the weed flora are driven by the interactions between disturbance, the environment, and the timing and type of weed management practices. The species composition and structure of the germinable soil seed bank reflects short and long-term impacts of crop, soil, and weed management, reflecting shifts in the aboveground weed community. In addition, weed seed banks act as reservoirs of inter- and intra-specific genetic diversity and describe the recruitment potential of future weed communities. Studies have suggested that weed seed bank communities are generally more diverse in low-input and organic systems than in conventional systems. However, no studies have documented whether those changes occur during the transition period or whether they are the result of long-term management of diverse rotations. We studied spring seed banks as indicators of weed community composition during the transition from conventional to organic management.

We sampled the soil seed bank in late March of each year of the field crops transition experiment where a conventional corn-soybean rotation was compared with an organic corn-soybean-small grain-hay rotation. Standard herbicides were used in the conventional plots; tillage and cultivation were the only weed control methods used in the organic transition plots. Twenty-four samples per plot (to a depth of 15 cm) were obtained by bulking 6 soil core samples from each of four sub-plots. The soil was screened and placed in trays on an absorbent mat on a greenhouse bench, where they were sub-irrigated to allow weed seedling emergence. Emerged seedlings were identified, counted, and removed. Seedlings that could not be identified initially were transplanted and grown until identification could be confirmed. After seedling emergence ceased (about 4 months), the soil was re-mixed and placed in a cooler for 6 weeks to re-establish springtime conditions and break dormancy in remaining seeds. The soil was returned to the greenhouse for another cycle of emergence.

For data averaged over all crops in the two rotations, the number of seeds in the seed bank generally declined (66 to 76%) over the five years of study (Table 1). This pattern of declining seed abundance over time probably reflects a learning curve for project managers, as weed control generally improved over time. In every year the number of seeds was higher in the transition plots than in the conventional plot, but not dramatically so except for the spring of 2002. The transition plots generally had more weed species (avg. = 31) than the conventional plots (avg. = 25) represented in the seed bank.

Data for the soybean plots represent the best comparison of the two systems, because this crop was preceded by corn in both rotations (Table 1). Since the soil samples were taken before planting, the seed bank reflects the seed return in the previous corn crop. In the spring soybean plots the seed bank was higher in the transition plots than the conventional plots, by a factor of almost 2 in 2001 and 2004, and 3 in 2002. Nevertheless, the general decline in seed density later in the study for both systems suggests that weeds were an increasing management priority. The number of species in the seed bank was generally the same (~23) in both systems in the soybean year.

The most common species in both systems was common lambsquarters (*Chenopodium album*) in 2000-2003 (data not shown). In the spring of 2004, yellow woodsorrel (*Oxalis stricta*) was the most abundant species in the conventional plots and giant foxtail (*Setaria faberi*) in the transitional plots. Several species showed similar changes in abundance over time in both systems, including fall panicum (*Panicum dichooimiflorum*) and green foxtail (*Setaria viridis*), which increased over time, and giant ragweed (*Ambrosia trifida*) and marestail (*Conyza canadensis*), which generally decreased. Changes in abundance over time differed in the two systems for velvetleaf (*Abutilon theophrasti*), which remained fairly constant in the conventional plots and decreased in the transitional plots. This probably reflects the lack of survival of this species in small grain and hay crops in the transitional system compared with its relative good adaptation to corn and soybeans.

Table 1. Average seed number and species abundance in conventional and organic transition plots. Data in the first two groups are averaged over all plots; data in the last two groups are for the seed bank in the spring of the soybean year only.

Year	Avg. Seed No./m^2		Avg. No. Species/Plot		Weeds/m^2 in Soybean Plots		No. Species in Soybean Plolts	
	Conv.	Trans.	Conv.	Trans.	Conv.	Trans.	Conv.	Trans.
2000	7660	7800	25	36	7680	6190	23	23
2001	6600	9070	28	32	8840	14520	26	24
2002	4350	9370	26	38	3510	9210	23	29
2003	3080	4100	23	23	3200	4340	21	19
2004	1800	2650	24	28	1820	3070	19	22

In the spring of the soybean year, Canada thistle (*Circium arvense*) seed density was high in the first two years in both systems, but was absent in the last two sampling years. Dandelion (*Taraxacum officionale*) followed an erratic pattern, with very high density in the second year and declining thereafter, except for the last year in the transition plots. The reason for this pattern is unclear.

Results indicate that similar changes occurred over time in weed seed density and species abundance in the conventional and transition systems. There was no explosive increase in seed bank numbers in the organic plots as has been reported by some researchers. The indications of greater species diversity in the transition system probably reflect the greater diversity of crops and opportunities for weed establishment and seed return in this system compared with the conventional corn-soybean system.