Weed seed bank response to 12 years of different fertilisation systems

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Summary Weed seed bank management should be a central component of integrated weed management systems. At present, there are few practical methods for reducing weed seed bank persistence. In addition to improving the soil quality, the use of manures and composts may provide a cultural method to manage weeds. However, their effects on seed survival, emergence, growth and reproduction must be better understood. This study evaluated the effects of different fertilisation systems over a 12 year period on size and composition of the weed seed bank in a conventionally managed maize monoculture field. Fertilisation systems included all factorial combinations of two dairy cattle slurry rates, three vegetable, fruit and garden waste (VFG) compost rates, and three synthetic N fertiliser rates.

A field experiment was established in 1997 on the sandy loam soil of the experimental farm of Ghent University at Melle (Belgium, 50°59'N, 03°49'E, 11 m above sea level). From 1997 until 2008 the field was continuously cropped with grain maize. Two animal slurry rates (0 and 42.3 tonne ha^{-1} dairy cattle slurry, applied each spring), three compost rates (0, 22.5 tonne ha^{-1} applied yearly in spring, and 22.5 tonne ha^{-1} applied tri-yearly in spring) and three mineral N fertiliser rates (0, 100, and 200 kg N ha^{-1} $year^{-1}$, ammonium nitrate 27% applied just before sowing) were factorially combined. The experimental design was a split-plot with three replicates, with the two animal slurry rates in the main plots and the three compost treatments and three mineral N fertilisation rates in the sub-plots. Thirty-six soil cores 0–10 cm depth and 4 cm in diameter were systematically taken on the intersections of a 6 × 6 m area in each subplot in May 2008 after sowing and prior to herbicide application. Soil samples were washed through sieves and the residue was analysed further with the seedling emergence method to evaluate seed banks. Weed seedling density in the field was determined in the fourth leaf stage of the maize (30 days after sowing). Soil carbon content and maize biomass yield were determined per sub-plot. Data were analysed using ANOVA and multivariate techniques.

After 12 years of continuous maize cropping, total weed seed bank density and emergence were affected by mineral N fertilisation but not by animal slurry or compost application. So, the use of composted material and animal slurry is unlikely to increase total weed seed bank abundance or to affect total weed seedling emergence in the long-term as long as the materials are properly composted or stored before application. Total weed seed bank density and weed emergence decreased significantly with increasing mineral N fertilisation. This was attributed to increased crop competitiveness, reducing new weed seed production during the late maize stages. Seed bank size of individual weed species was affected by compost rate and mineral N fertilisation rate but not by animal slurry rate. In most cases, differences in seed bank density between treatments could not be explained by crop competitiveness. Plots receiving mineral N fertilisation showed a lower abundance of *Cerastium glomeratum* Thuill., *Chenopodium album* L. and *Lamium purpureum* L. compared to plots receiving no mineral N fertilisation. This might be explained by the stimulating effect of ammonium nitrate on seed germination in combination with the phytotoxic action of the applied herbicides. Compared to plots receiving no compost, plots annually amended with compost had a lower seed bank density and field emergence for the highly competitive summer germinating weeds in maize (e.g. *C. album* and *Solanum nigrum* L.), but a higher seed bank density of non-seasonal species, *Stellaria media* L. and *L. purpureum*. The lower seed bank densities of *C. album* and *S. nigrum* might be explained by the combined effect of enhanced microbial breakdown of their hard seed coat because of the increased soil carbon content and their weak chemical defence properties.

These results indicate that the weed-suppressive soils created by annual compost amendments represent a promising tool for incorporation into integrated weed control strategies. Weed suppressiveness was found for a limited number of small-seeded species with long-term persistent seeds and hard seed coats.

Keywords Maize monoculture, animal slurry, compost, mineral N, *Chenopodium album*, weed suppression.