Crop rotation is gaining increasing research- and policy attention as an environmentally friendly way to manage weeds. In such rotations, crops are introduced that release chemicals into the environment known to inhibit weed germination or growth (so-called allelopathic crops). Previous studies have identified *Cynara cardunculus* L, a perennial thistle, including varieties of globe artichoke and cardoon, as a potential allelopathic candidate. This study conducted field experiments using three botanical varieties of *C. cardunculus* to evaluate their effect on weeds within an ecosystem. The results confirm that *C. cardunculus* has an allelopathic effect in monoculture, reducing the amount of weed seeds present in soil. This paves the way for its inclusion in crop rotation as part of eco-friendly, sustainable weed-management strategies.

Weeds are one of the most significant pests in agroecosystems; they are responsible for considerable economic losses and contribute to food insecurity. However, synthetic herbicides can result in harmful associated environmental impacts and rising levels of resistance. Efforts to reduce the use of synthetic herbicides and replace them with more environmentally friendly, sustainable weed-management practices are central to much contemporary environmental and agricultural policy.

In this context, allelopathic weed control has emerged as a particularly promising alternative. Allelopathy refers to the chemical inhibition of one plant species by another. Introducing allelopathic crops into crop rotations could help to effectively and sustainably control weeds within an ecosystem, and reduce reliance upon herbicides.

Previous studies have identified *Cynara cardunculus* L. as a potentially allelopathic crop, suggesting that its three botanical varieties (globe artichoke, cultivated cardoon and wild cardoon) release chemicals with effects both phytotoxic (poisonous to plants) and antimicrobial (fatal to microorganisms). However, this had not been evaluated in field conditions.

To rectify this, an Italian research team conducted two field experiments to evaluate the results of three consecutive years of *C. cardunculus* cultivation on weed soil seed banks and eubacterial (single-celled bacteria) communities in Mediterranean conditions. The experiments comprised monocultures of globe artichoke, cultivated cardoon and wild cardoon and control systems of a) an olive grove (a typical perennial Mediterranean crop) and b) fava bean and wheat on classic rotation (an arrangement representative of the grain legume/cereal rotation most common in the Mediterranean basin).

In both field experiments, the presence of *C. cardunculus* caused a significant reduction (from 34% to 50%) in the amount of weed seeds found in the soil of both sites compared to control. In some cases, the number of weed species also decreased. While cultivated cardoon negatively affected the beneficial ubiquitous bacteria *Bacillus subtilis* (also known as the hay or grass bacillus and found in soil and the gastrointestinal tract of ruminants and humans), it positively affected two other beneficial soil bacteria: *Pseudomonas putida* and *Azospirillum brasilense*.

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Globe artichoke and cardoon could manage weeds in sustainable, eco-friendly way (continued)

The researchers also investigated the in vitro antibacterial activity of aqueous, methanolic, and ethanolic leaf extracts of cultivated cardoon against three bacteria involved in the soil nitrogen cycle (Rhizobium leguminosarum, Sinorhizobium meliloti and Bacillus licheniformis). The results revealed no negative effects on R. leguminosarum or S. meliloti, but the methanolic and ethanolic leaf extracts were shown to inhibit B. licheniformis. Taken together, these findings suggest that C. cardunculus plays a positive role in the microbial community of the rhizosphere (the soil surrounding root systems).

Overall, these results show for the first time that C. cardunculus has an allelopathic effect in monoculture in the field. The researchers suggest their findings offer a practical demonstration of the possibility of introducing the species into a crop-rotation system in Mediterranean, or other, agroecosystems as a sustainable approach to weed management. They also call for further investigation of C. cardunculus field allelopathic activity.