Geophysical Research Abstracts
Vol. 13, EGU2011-4984, 2011
EGU General Assembly 2011

Terrestrial Phototrophs can make an Important Contribution to the Degradation of Crop Protection Products

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In order to assess the potential impact of crop protection products (CPPs) on the environment it is essential to have a robust understanding of their rate and route of degradation. The current regulatory testing guidelines provide useful initial data but do not take account of all potential degradation processes and as a result often do not always provide a fully integrated overview of degradation in soil. The prescribed laboratory test system requires that soils are sieved to 2mm and incubated in the dark under a regime of constant temperature and moisture content. Sieving the soil disrupts the habitat of soil microbes and damages fungal hyphae. Incubation in the dark eliminates the presence of phototrophic organisms and precludes plant growth. Similarly field studies are often conducted shortly after cultivation on bare soils which, while reasonably realistic for CPPs used pre- or early post-emergence is deficient when considering the fate of CPPs that are applied to an established crop canopy or no till systems. Cultivation may impair the function of fungi and phototrophs and the absence of plants means that rhizosphere microbes are absent. As a result the contribution of these various organisms to both the degradation and sorption (directly and indirectly) of CPPs is not adequately assessed.

Following cultivation a range of phototrophic organisms such as algae, cyanobacteria and mosses re-colonise the soil surface. Recent publications (Knapen et al., 2007, Jeffery et al., 2010) have investigated the prevalence of these communities within arable landscapes and the influence that they have on physical processes such as soil erosion but little is known about the role they have in the sorption and degradation of CPPs.

To begin to address this, the rate of degradation of seven 14C labelled CPPs have been studied in soil exposed to a 16 hour light: 8 hour dark cycle under fluorescent light (to minimise the potential contribution from photolysis). Soils were incubated at a moisture content of PF2 and a temperature of 20°C in a typical flow through incubation system with the air flow passing through NaOH traps to retain any evolved 14CO2. Such systems enable all of the applied 14C-CPP to be accounted for. The light/dark cycle facilitated the growth of a phototrophic community on the surface of the soil.

In all but one case the rate of degradation was noticeably enhanced in the soil exposed to light.

The enhanced degradation observed may be the result of direct metabolism of the CPP by the phototrophs or an indirect product of the stimulation of other microbes by the phototrophs. To elucidate the processes further the degradation of some of the CPPs were studied in pure cultures of algae and cyanobacteria.

The pure cultures of algae and cyanobacteria were able to degrade the CPPs for which enhanced degradation was observed under the light/dark cycle.

These data indicate that phototrophic communities that colonise the surface of soils may directly degrade many CPPs with which they come into contact.

References

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