# CHARACTERISATION OF HERBICIDE BEHAVIOUR IN SOME INNOVATIVE GROWING MEDIA

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## ABSTRACT

An abundance of waste products from the forestry industry (sawdust and paper pulp) lead to the concept of using them as growing media for high value crops on a field scale. However, management of subsequent weed growth posed a problem as the impact of these novel media on the performance and fate of herbicides was unknown. Three aspects of sawdust and paper pulp waste were examined and compared to two cropping soils, viz. their effect on herbicide behaviour with regard to crop selectivity, weed control efficacy and the environmental fate of selected chemicals.

Cropping species such as lettuce and onions were more susceptible to alachlor and chlorpropham in sawdust than in paper pulp. The two cropping soils evaluated (Horotiu sandy loam and Mangateretere silt loam) tended to be intermediate although the former was often close to the sawdust and the latter to the paper pulp in terms of herbicide phytotoxicity to the crop plants. For the less water soluble herbicide pendimethalin, the differences in crop selectivity in the different media were not significant.

The effect of the media on the efficacy of weed control was evaluated through plant species with a much lower tolerance to the herbicides evaluated in contrast to the above species. For these plants the efficacy of the herbicides was generally lower in both the sawdust and paper pulp than in the two soils. The effect was more pronounced with the more soluble alachlor, where efficacy was reduced by factors of 5 – 10, compared to pendimethalin where efficacy reduction was by factors of 0 – 3.

The two high organic media had contrasting effects on the various environmental behaviour indices evaluated. Herbicide adsorption as quantified by distribution coefficient ($K_d$) was higher in the two novel media compared to both the Horotiu and Mangateretere soils. However, when the $K_d$ was normalised to organic carbon ($K_{oc}$), there was less variation amongst the media indicating that organic matter is an important factor in controlling sorption in these media. However, despite the high level of adsorption in the sawdust, herbicides were most prone to leaching in this medium. Conversely the paper pulp tended to be more retentive while the two soils were intermediate. The degradation as quantified by half-lives ($t_{½}$) of the herbicides was generally slower in the two novel media, probably reflecting the higher sorption in these two media but also due to the lower level of microbial activity in the sawdust and paper pulp.

The study shows that herbicide behaviour in these carbon based media differs significantly from that expected from soil organic matter, mainly due to the non-humified nature of the organic matter in the media and its poor biological activity.

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| | |
|---|---|
| a.i. | Active ingredient |
| ANOVA | Analysis Of Variance |
| CAS | A division of the American Chemical Society |
| DO | Dissolved Oxygen |
| DOC | Dissolved Organic Carbon (see also OC) |
| DOM | Dissolved Organic Matter |
| $DT_{50}$ | Time required for dissipation of the first 50% of the original pesticide concentration |
| EC | Emulsifiable Concentrate |
| $ED_{10}$ ($ED_{50}$; $ED_{90}$) | Effective Dose to reduce plant production to 10% (50%; 90%) of untreated |
| GC | Gas Chromatography |
| HPLC | High Performance Liquid Chromatography |
| IUPAC | International Union of Pure and Applied Chemistry |
| $K_d$ | Distribution (partition) coefficient (the ratio of pesticide adsorbed to that in solution) |
| $K_{oc}$ | Soil organic carbon affinity coefficient (i.e. $K_d$ normalised to OC content) |
| $LD_{50}$ ($LD_{90}$) | Lethal Dose required to kill 50% (90%) of the population |
| LOD | Limit Of Detection |
| $LSD_{0.05}$ | Least Significant Difference with 95% confidence interval |
| MWHC | Maximum Water Holding Capacity |
| NOEL | No Observable Effect Level |
| NTU | Nephelometric Turbidity Unit |
| OC | Organic Carbon (often calculated from OM by dividing by 1.73) |
| ODTMA | Octadecyltrimethylammonium chloride (a surfactant) |
| OM | Organic Matter |
| PTFE | Polytetrafluoroethylene or Teflon® |
| pKa | Acid dissociation constant |
| rpm | Revolutions per minute |
| SD | Standard Deviation |
| SED | Standard Error of Difference |
| SEM | Standard Error of the Mean |
| SOM | Soluble Organic Matter |
| SPE | Solid Phase Extraction |
| $t_{½}$ | First-order kinetic half-life |
| TDS | Total Dissolved Solids |
| WSSOM | Water Soluble Soil Organic Matter |