Sensitivity of wild plant and crop species to plant protection products
Literature review and analysis for SETAC AG Plants

Heino Christl[1] on behalf of the SETAC workshop on "Non-target terrestrial plants"
[1]tier3 solutions GmbH, 51382 Leverkusen, Germany, (e-mail: info@tier3.de)

Meet us on Tuesday, 5th May, 18:00; Exhibition hall, poster corner ID: TUPC360

INTRODUCTION

In the SETAC workshop on "Non-target terrestrial plants" a literature review was proposed aiming to compare the intrinsic sensitivity of terrestrial plant species (crop species and wild species), searching for evidence (or lack of evidence) that wild plant species could be more sensitive to plant protection products (PPPs) than crop species, the latter generally being used for ecotoxicological testing.

MATERIAL & METHODS

Published literature and unpublished data generated for the registration of PPPs were searched for this review, and endpoints from crop species and wild species were collated in a data base. Each endpoint comprises of three main elements: the study type (e.g. SE, VV, or corresponding field tests with incorporation or with spray application), the measured variable (e.g. seedling emergence, shoot height, biomass wet- or dry weight, etc.) and effect level (e.g. ER_{25}, ER_{50}, ER_{75}, etc.). Further known variables were the mode of action, active substance/formulation tested, the test species, higher taxon (e.g. family, monocot/dicot), its 'anthropinistic affiliation' (i.e. wild plant or crop species), and the test system (i.e. lab/field), parameters subsequently used as boolean predictors. For the quotient approach the database then was searched for subsets of data where matching datasets both of crop or wild plant species were available, active substance by active substance (a.s.).

Fig. 2. Lab tests with NTTPs (court. IBACON)

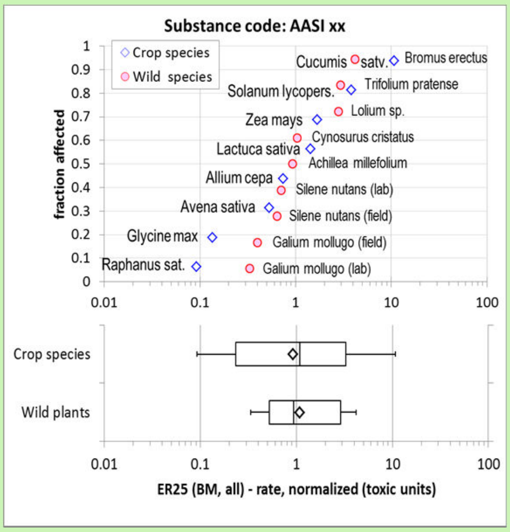

Fig. 1 Sample data set, individual endpoints and resulting groups of wild and crop species. The rhombi represent the geometric means, these or the group's minima (lower whiskers) were used in the quotient approach.

Fig. 3. field tests with NTTPs (courtesy of tier3)

The selected data was split into crop species and wild plant species and, for each subgroup, the lowest endpoint (minimum – most sensitive species per group) and the average endpoint (geometric mean, average sensitivity of the subgroup) were calculated: the former as it is the regulatory most relevant endpoint, the latter as it is less affected by different and extreme values, so better reflects the overall sensitivity of the whole group. Quotients were calculated (always dividing crop by wild endpoint) for each such data set and presented and evaluated together. Quotients >1 indicated cases where wild species were more sensitive than crop species, quotients < 1 the opposite.

In addition to the quotients approach by substance, the largest subset of data (vegetative-vigour-like data, biomass & equivalent) was submitted to multiple regression analysis (ANOVA in the widest sense, based on log-transformed endpoints), resulting in canonical coefficients for the selected combinations of predictors. Furthermore MDDs were calculated for all predictors, including the focal one for this assessment, the difference between crops and wild plant species.

Finally the analysis was repeated with manipulated data sets (one group downscaled by factors between 1.3 and 2.0), which is another way to demonstrate how large the signal would have needed to be, to result in a detectable difference between the two groups based on the current size of the database and its scatter.

RESULTS & DISCUSSION

A total of 2048 species/a.s. test combinations were included in the data base, comprising 49 herbicides. For 42 of these both crop and wild species numeric endpoints were available (allowing calculation of quotients). Individual comparison of crop and wild species endpoints (by active substance) resulted in datasets like these:

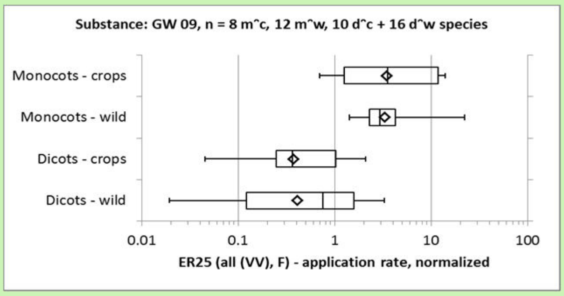

Fig. 4. Sample data set, comparing monocots and dicots ' endpoints based on one substance

The example above allows to illustrate how the final evaluation may either be based on the minima (i.e. the most sensitive species of each group) or on the geometric means, which are a measure of the average sensitivity. Based on the most sensitive species (left whisker bars), the most sensitive was a wild dicot species. However, based on the geometric mean of dicots (rhombi), the crops appeared to be more sensitive than the wild species. These differences in sensitivity were expressed by means of a quotient, dividing the crop endpoint by the wild species endpoint. Quotients below "1" indicate cases where crop species were more sensitive than wild species (i.e. crop endpoints lower than wild species' endpoints), quotients above "1" indicate that wild species were more sensitive than crop species. The quotients themselves are displayed in Figure 5.

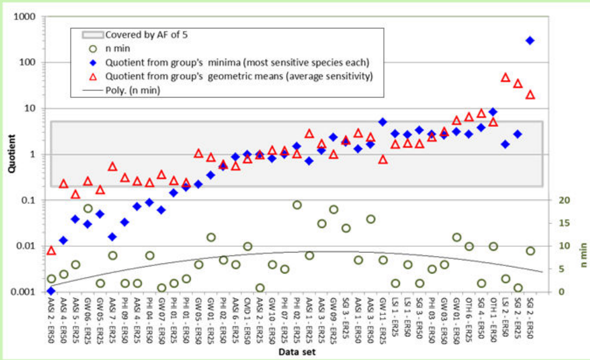

Fig. 5. All data sets for which quotients could be calculated. Triangles representing quotients from group means, rhombi from group minima. Green circles depict lower "n" (no. of species)

Three conclusions can be deduced from this graphical representation: There are as many quotients above one as below one. Quotients based on minima do scatter more than those based on the central tendencies. Extreme quotients are usually based on fewer data points (circles & lower curve).

The multiple regression analysis overall confirmed the findings above. Based on ER_{25} wild species were on average slightly less sensitive than crop species (by a factor of 1.6). In contrast, based on ER_{50} wild species were on average slightly more sensitive than crops (by a factor of 1.57). Based on pooled endpoints sensitivity of both groups was basically identical.

Indicator of power: The MDD for the predictor crop/wild plant was a factor of ca 1.4. However downscaling wild species endpoints by a factor of 1.4 did not result in significance (just). Downscaling by a factor of 1.5 (or more) however did. Thus, the fitted factorial model applied would have been sufficiently powerful to detect an intrinsic difference in sensitivity between wild and crop species if there had been one of any relevance; even from data as heterogeneous and variable as found here. If endpoints of one group had been different by a factor of 1.5 or more from the other, deviations would have been detected to be statistically significant.

CONCLUSION

Based on vegetative vigour biomass data (ER_{25} and ER_{50} endpoints) and for the taxonomic groups for which data were available (mainly herbs, grasses and forbs) no consistent difference in intrinsic sensitivity between crop species and wild plant species could be detected. Testing crop species as model organisms and surrogates in standard toxicity tests thus appears to be a conservative approach, and there seems to be little reason for including further wild species in standard ecotoxicity testing. Finally, testing crop species as surrogates allows word-wide standardised testing which delivers reliable and comparable results with limited variance, good and timely germination and predictable growth.

BARCELONA SETAC Europe 2015

References:

1 EFSA 2014. Scientific Opinion addressing the state of the science on risk assessment of plant protection products for non-target terrestrial plants. EFSA Journal 2014;12(7):3800, 163 pp. doi:10.2903/j.efsa.2014.3800 .

Acknowledgements:

This review was sponsored by members of the CLI NTP group and ECPA. We thank the participants to the SETAC workshop on "Non-target terrestrial plants" and the members of the CLI NTP group for their comments.

For more information about us, scan it!