**APPENDIX 2-5. Glyphosate Species Sensitivity Distribution Analysis for Aquatic Plants**

SSDs were fit to toxicity data for vascular and nonvascular aquatic plants exposed to technical grade glyphosate. Aquatic vascular plant growth data were insufficient to derive a separate SSD, therefore the results from the all aquatic plants were used for the SSD.Table 1provides a summary of the results.

Table . Summary statistics for SSDs fit to glyphosate test results.

|  |  |
| --- | --- |
| **Statistic** | **All****Aquatic Plants** |
| Best Distribution (by AICc) | Gumbel |
| Goodness of fit P-value | 0.1269 |
| CV of the HC05 | 0.15 |
| HC05 | 5.0 |
| HC10 | 5.5 |
| HC50 | 8.4 |
| HC90 | 16.4 |
| HC95 | 21.1 |

1. Data

Data used in this analysis are detailed in Table 6 (at the end of the document) and were from registrant submitted studies as well as an ECOTOX query (**APPENDIX 2-2**). Table 2provides the distribution of the test results for glyphosate including the number of species represented. Insufficient data were available to derive separate SSDs for vascular aquatic plants because only one vascular species was tested. Therefore, one set of distributions was derived: all aquatic plants (combines vascular and nonvascular aquatic plants).

Table . Distribution of test results available for glyphosate.

|  |  |  |
| --- | --- | --- |
| **Data Subset** | **Test results** | **Species** |
| All Aquatic Plants | 20 | 9 |
| Nonvascular Aquatic Plants | 16 | 8 |
| Vascular Aquatic Plants | 4 | 1 |

Figure 1 shows the distribution of test results among species, indicating that a few species have been repeatedly tested (one species has been tested four times), but the majority of species have been tested fewer than three times, with 14 species having only one test result.

 

Figure . Distribution of the number of test results per species in glyphosate aquatic plant data.

Six potential distributions for the glyphosate were considered, including log-normal, log-logistic, log-triangular, log-gumbel, Weibull, and Burr. To fit each of the first four distributions, the toxicity values were first common log (log10) transformed. Finally, effect thresholds and five quantiles from the fitted SSDs (HC05, HC10, HC50, HC90, HC95) were calculated and reported.

1. Comparison of distributions using AICc

Akaike’s Information Criterion corrected for sample size (AICc) was used to compare the five distributions for the aquatic plant dataset. For these comparisons all SSDs were fit using maximum likelihood. The AICc suggested that the gumbel distribution provided the best fit (Table 3).

Table . Comparison of distributions for all aquatic plant toxicity data for glyphosate.

| **distribution** | **AICc** | **∆AICc** | **Weight** | **HC05** |
| --- | --- | --- | --- | --- |
| gumbeltriangularnormallogisticweibullburr | 180.3159180.6375181.3515182.2892182.7830185.1183 | 00.32161.03561.97332.46714.8023 | 0.31230.26590.18610.11640.09100.0283 | 5.034.894.373.923.205.03 |

1. Goodness of fit

The plot of the cumulative distribution functions for the best-fit distributions (as determined by AICc) suggest little evidence of lack-of-fit (Figure 2).Similarly, bootstrap goodness-of-fit tests did not show evidence for lack-of-fit (P-values > 0.05, Table 4).The coefficient of variation for the HC05 was below 1 for all distributions.



Figure . Log-logistic SSD for glyphosate toxicity values for all aquatic plants pooled. Black points indicate single toxicity values. Red points indicate average of multiple toxicity values for a single species. Blue line indicates full range of toxicity values for a given taxon.

Table . Range of HC05 values for glyphosate SSDs for all aquatic plants (mg a.e./L).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Distribution** | **Method** | **HC05** | **SE** | **CV** | **Lower CI** | **Upper CI** | **P** |
| Normal | ML | 4.3793 | 1.0854 | 0.2479 | 2.9952 | 7.2796 | 0.0939 |
| Normal | MO | 4.1874 | 1.1029 | 0.2634 | 2.5712 | 6.8974 | 0.0959 |
| Normal | GR | 3.685 | 1.0759 | 0.292 | 1.749 | 5.8525 | 0.1738 |
| Logistic | ML | 3.9247 | 1.1695 | 0.298 | 2.2881 | 6.9581 | 0.0529 |
| Logistic | MO | 4.2305 | 1.2099 | 0.286 | 2.3443 | 7.1347 | 0.0829 |
| Logistic | GR | 3.4931 | 1.1187 | 0.3203 | 1.1508 | 5.5822 | 0.1808 |
| Triangular | ML | 4.8992 | 1.0012 | 0.2044 | 4.0332 | 7.8928 | 0.0669 |
| Triangular | MO | 4.1279 | 1.08 | 0.2616 | 2.6745 | 6.9761 | 0.1249 |
| Triangular | GR | 3.8168 | 1.0407 | 0.2727 | 2.1181 | 6.0195 | 0.1708 |
| **Gumbel** | **ML** | **5.0335** | **0.7621004** | **0.1514** | **4.041** | **6.9918** | **0.1269** |
| Gumbel | MO | 4.922 | 0.8563381 | 0.174 | 3.6261 | 7.0347 | 0.2248 |
| Gumbel | GR | 4.3761 | 1.0282 | 0.235 | 2.3459 | 6.3566 | 0.3906 |
| Burr | ML | 5.0325 | 0.6461294 | 0.1284 | 4.0964 | 6.6196 | 0.1329 |

ML=maximum likelihood, MO= moment estimators, and GR=graphical methods

LCp and UCp=projections of the confidence limits of the HC05 (LCx and UCx) onto the cumulative distribution function of the fitted distribution.

1. Calculation of other quantiles

Table 5 provides estimates of the HC05 as well as other quantiles of the fitted SSDs.

Table . Estimated quantiles of the fitted SSDs for glyphosate EC50s for all aquatic plants (mg a.e./L).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Distribution** | **Method** | **HC05** | **HC10** | **HC50** | **HC90** | **HC95** |
| Normal | ML | 4.3793 | 5.1554 | 9.1668 | 16.299 | 19.188 |
| Normal | MO | 4.1874 | 4.9785 | 9.1668 | 16.878 | 20.067 |
| Normal | GR | 3.685 | 4.5066 | 9.1668 | 18.646 | 22.803 |
| Logistic | ML | 3.9247 | 4.8241 | 8.8494 | 16.233 | 19.953 |
| Logistic | MO | 4.2305 | 5.1477 | 9.1668 | 16.324 | 19.863 |
| Logistic | GR | 3.4931 | 4.4621 | 9.1668 | 18.832 | 24.056 |
| Triangular | ML | 4.8992 | 5.5481 | 9.3777 | 15.851 | 17.95 |
| Triangular | MO | 4.1279 | 4.8096 | 9.1668 | 17.471 | 20.356 |
| Triangular | GR | 3.8168 | 4.5143 | 9.1668 | 18.614 | 22.016 |
| **Gumbel** | **ML** | **5.0335** | **5.5226** | **8.4314** | **16.377** | **21.107** |
| Gumbel | MO | 4.922 | 5.4274 | 8.4768 | 17.064 | 22.294 |
| Gumbel | GR | 4.3761 | 4.9468 | 8.6537 | 20.812 | 29.104 |
| Burr | ML | 5.0325 | 5.5221 | 8.4319 | 16.376 | 21.104 |

Table 6 provides all the available EC50 values for aquatic plants. If a species was not represented with a 96 hour study, and other values were available from shorter/longer duration studies (up to 10 days) then the data were included. If there were multiple other durations, the value from the study closer to a 96h duration was selected and if there were multiple values for the same duration, all values were included.

Table . Available effective lethal concentration (EC50) data for aquatic plants exposed to technical grade glyphosate.

|  |  |  |
| --- | --- | --- |
| Genus | species | EC50 |
| Scenedesmus | quadricauda | 7.2 |
| Scenedesmus | acutus | 10.2 |
| Pseudokirchneriella | subcapitata | 13.5 |
| Skeletonema | costatum | 2.27 |
| Pseudokirchneriella | subcapitata | 24.7 |
| Lemna | gibba | 18.3 |
| Microcystis | aeruginosa | 6.3 |
| Selenastrum | capricornutum | 13.8 |
| Navicula | pelliculosa | 38.6 |
| Skeletonema | costatum | 0.77 |
| Anabaena  | flos-aquae | 16.5 |
| Lemna | gibba | 21.5 |
| Selenastrum | capricornutum | 14.0 |
| Anabaena  | flos-aquae | 19.82 |
| Skeletonema | costatum | 12.0 |
| Lemna | gibba | 0.70 |
| Skeletonema | costatum | 33.4 |
| Anabaena  | flos-aquae | 0.92 |
| Navicula | pelliculosa | 7.8 |
| Lemna | gibba | 11.9 |