Table 1. Density of germinable seeds for the five most abundant weed species, and categories of total annual grass and broadleaf weeds, and total weeds, in soil samples collected on 25 May 2007. Data were square root transformed prior to analysis of variance; untransformed means are presented.

| Species | Germinable seeds | | Reduction | P > F |
| --- | --- | --- | --- | --- |
|  | Exclosure + | Exclosure - |  |  |
|  | (no. m2 to 10 cm depth) | | (%) |  |
| Hairy galinsoga | 13,325 | 13,918 | -4 | 0.883 |
| Smooth crabgrass | 12,431 | 11,778 | 5 | 0.922 |
| Common lambsquarters | 745 | 826 | -11 | 0.775 |
| Redroot pigweed | 530 | 470 | 11 | 0.993 |
| Common chickweed | 645 | 313 | 51 | 0.357 |
| Annual grass total | 12,457 | 11,814 | 5 | 0.918 |
| Annual broadleaf total | 16,044 | 16,426 | -2 | 0.926 |
| Total | 28,794 | 28,403 | 1 | 0.983 |

1. Contrary to expectations, predator exclosures had no effect on the subsequent year’s germinable seedbank, suggesting that weed seed losses were similar without regard to the activity of predators.

Table 2. Density of germinable seeds for the five most abundant weed species, and categories of unknown grass and broadleaf weeds, in soil samples collected on 20 May 2008. Data were square root transformed prior to analysis of variance; untransformed means are presented. To overcome some of the expected within field variability that may have precluded detection of treatment effects in the 2006-2007 experiment, the number of exclosures was increased from one to four per plot.

| Species | Germinable seeds | | Reduction | P > F |
| --- | --- | --- | --- | --- |
|  | Exclosure + | Exclosure - |  |  |
|  | (no. m2 to 10 cm depth) | | (%) |  |
| Common lambsquarters | 24,672 | 15,755 | 36 | 0.027 |
| Redroot pigweed | 26,002 | 13,046 | 50 | 0.040 |
| Large crabgrass | 4,615 | 2,174 | 53 | 0.013 |
| Smooth crabgrass | 3,300 | 2,019 | 39 | 0.140 |
| Oak-leaved goosefoot | 686 | 396 | 42 | 0.048 |
| Annual grass total | 10,300 | 6,250 | 39 | 0.015 |
| Annual broadleaf total | 52,119 | 29,826 | 43 | 0.006 |
| Total | 62,466 | 36,110 | 42 | 0.001 |

1. In contrast to the first year experiment, and consistent with the hypothesis motivating this project, predator exclosures had a large and consistent effect on the subsequent year’s germinable seedbank.
2. Seed losses due to predators ranged from a low of 36% for common lambsquarters, to a high of 53% for large crabgrass.
3. Overall, the seedbank densities were much greater in this 2007-2008 experiment than in the first year trial (2006-2007).

Table 3. Density of germinable seeds for the five most abundant weed species, and categories of unknown grass and broadleaf weeds, in soil samples collected on 4 May 2009.

| Species | Germinable seeds | | Reduction | P > F |
| --- | --- | --- | --- | --- |
|  | Exclosure + | Exclosure - |  |  |
|  | (no. m2 to 10 cm depth) | | (%) |  |
| Redroot pigweed | 33028 | 30745 | 7 | 0.603 |
| Common lambsquarters | 9715 | 10599 | - 9 | 0.678 |
| Barnyardgrass | 1312 | 1650 | - 26 | 0.410 |
| Low cudweed | 1000 | 457 | 54 | 0.121 |
| Wormseed mustard | 4951 | 5286 | - 7 | 0.645 |
| Annual grass total | 1567 | 2079 | - 33 | 0.307 |
| Annual broadleaf total | 50853 | 49346 | 3 | 0.737 |
| Total | 53176 | 51766 | 3 | 0.765 |

1. Contrary to expectations, predator exclosures had no effect on the subsequent year’s germinable seedbank, this despite a more intensive sampling protocol as used in the 2007-2008 experiment where large predation losses were documented.

Table 4. Density of germinable seeds for the five most abundant weed species, and categories of total annual grass and broadleaf weeds, and total weeds, in soil samples collected on 20and 21 April 2010. Data was log (base 10) + 1 transformed prior to analysis, unless otherwise noted. Untransformed means are presented.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Species** | **Germinable Seeds** | | **Reduction** | **P > F** |
|  | Exclosure + | Exclosure - |  |  |
|  | (no. m2 to 10 cm depth) | | (%) |  |
| Redroot pigweed\* | 1781 | 1541 | 13.5 | 0.552 |
| Common lambsquarters\* | 2396 | 2087 | 14.8 | 0.477 |
| Large crabgrass\* | 21174 | 22968 | -8.5 | 0.470 |
| Barnyardgrass\* | 5657 | 3947 | 30.2 | 0.490 |
| Wormseed mustard\*\* | 546 | 533 | 2.4 | 0.853 |
| Total annual grass\*\* | 26901 | 26979 | -0.29 | 0.760 |
| Total annual broadleaf | 5283 | 4692 | 11.2 | -- |
| Total weeds | 32622 | 32136 | 1.5 | 0.726 |

\* Data sets were log (base 10) + 1 transformed for analysis.

\*\*Data sets were transformed to the 4th square root for analysis.

-- Non-normal data set; various transformations were unable to correct for normality.

1. Contrary to our original hypothesis, but consistent with years 1 and 3 of this study, exclosures failed to protect seeds from predation, indicating similar post dispersal seed losses with and without predators.Table 5. Effects of weed management practices on the subsequent years’ germinable weed seedbank. “No weeds” represents a so-called “zero seed rain” control; Flail and No-till/cover treatments were flail mowed in the late fall to uniformly place weed seed on the soil surface, with the latter treatment subsequently sown to fall cover crop of winter rye using a no-till drill. At this time, the Till/cover treatment was rototilled to a depth of 15 cm in two directions and cereal rye was sown (150 lbs. per acre). Soil cores were taken to a depth of 10 cm the following May (2007 and a separate field site in 2008) and subjected to exhaustive germination in the glasshouse to estimate the germinable weed seedbank.

| Weed Management Treatment | Germinable seeds | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | annual grasses | | | annual broadleaf | | | total weeds | | |
|  | 2007 | 2008 | 2007 | | 2008 | 2007 | | 2008 |
|  | (no. m2 to 10 cm depth) | | | | | | | | |
| No weeds | 1151 | 603 b | 14014 | | 1462 b | 15232 b | | 2064 c |
| Till / cover crop | 13412 | 1884 b | 19837 | | 26921 a | 33665 a | | 28805 ab |
| Flail mowed | 13092 | 6250 a | 12453 | | 29826 a | 26027 a | | 36110 a |
| No-till / cover crop | 13146 | 1612 b | 10524 | | 19711 a | 23695 ab | | 21323 b |
|  |  |  |  | |  |  | |  |
|  | P > F | | | | | | | | |
| ANOVA | 0.157 | 0.003 | 0.38 | | < 0.001 | 0.03 | | < 0.001 |
| Contrasts |  |  |  | |  |  | |  |
| No weeds vs. others | 0.028 | 0.006 | 0.944 | | <0.001 | 0.012 | | < 0.001 |
| Till vs. No-till | 0.901 | 0.765 | 0.097 | | 0.313 | 0.081 | | 0.268 |
| Till vs. Flail | 0.848 | 0.006 | 0.261 | | 0.407 | 0.216 | | 0.143 |

1. Hand weeding and prevention of weed seed rain resulted in a very dramatic reduction in the subsequent germinable seedbank, the exception, inexplicably, being annual broadleaf weeds in 2007. Although it was not surprising that the germinable seedbank was lower following hand weeding, the magnitude of this effect was much greater than expected. Preventing weed seed rain in 2006 and 2007 resulted in a 45 and 93% reduction in the subsequent germinable seedbank, 2007 and 2008, respectively.
2. Contrary to our central hypothesis, No-till / cover crop and Till / cover crop treatments resulted in a similar subsequent germinable seedbanks, with the exception of annual grasses in 2008, which were lower following tillage. Exclosure treatments in 2008 indicated large losses due to predation. It is expected that tillage would have buried seed preventing significant predation losses. Thus, we can’t explain the similarity observed between these treatments.

Table 6. Density of germinable seeds for the five most abundant weed species, and categories of total annual grass and broadleaf weeds, and total weeds, in soil samples collected on 4-5 May 2009.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Species** | **Treatments** | | | | **P > F** |
|  | No Weeds | Till/Cover Crop | No Till/Cover Crop | Flail |  |
| Redroot pigweed | 1025 b | 29151 a | 32040 a | 30468 a | < 0.001 |
| Common lambsquarters | 1597 c | 9664 ab | 5431 bc | 10476 a | 0.009 |
| Low cudweed | 1417 | 388 | 244 | 439 | 0.229 |
| Barnyardgrass | 20 b | 2810 a | 860 b | 1685 ab | 0.048 |
| Wormseed mustard | 786 b | 1542 b | 2069 b | 5284 b | < 0.001 |
| Annual Grasses | 328 b | 3233 a | 1353 ab | 2110 ab | 0.075 |
| Annual Broadleaf Weeds | 5809 b | 44385 a | 41749 a | 48918 a | < 0.001 |
| Total | 6227 b | 47866 a | 43206 a | 51353 a | < 0.001 |

1. This dataset failed to support the hypothesis that maintaining weed seeds on the soil surface results in greater overwinter seed losses and a lower subsequent germinable seedbank.
2. The only consistent effect in the 2008-2009 experiment was the large reduction in the seedbank in the “No Weeds” treatment, demonstrating that preventing seed rain can have a very dramatic single year effect on the seedbank.

Table 7. Density of germinable seeds for the five most abundant weed species, and categories of total annual grass and broadleaf weeds, and total weeds, in soil samples collected on 20and 21 April 2010.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Species** | **Treatments** | | | | | **P > F** |
|  | No Weeds | Till/Cover Crop | No Till/Cover Crop | Plow | Flail |  |
| Redroot pigweed | 1234 | 1268 | 1349 | 1761 | 2012 | 0.972 |
| Common lambsquarters | 1886 | 1338 | 876 | 1099 | 1709 | 0.681 |
| Large crabgrass | 2752 c | 24937 ab | 11444 abc | 11444 bc | 31287 a | 0.001 |
| Barnyardgrass | 5693 | 3601 | 4608 | 1299 | 4047 | 0.295 |
| Wormseed mustard | 398 | 481 | 219 | 532 | 334 | 0.932 |
| Annual Grasses | 8474 b | 28163 ab | 22159 ab | 12862 ab | 35220 a | 0.020 |
| Annual Broadleaf Weeds | 3717 | 3699 | 3070 | 5451 | 4403 | 0.985 |
| Total | 12266 b | 33426 ab | 25433 ab | 19114 ab | 39620 a | 0.023 |

1. The rank order of means was consistent with the hypothesis that no-till would reduce the germinable seedbank compared to tilled cover cropping, however, the high degree of variability obscured significant treatment effects.
2. The only treatment whose magnitude of effect was great enough to separate it from the background variability was “No Weeds,” which had a single season effect of reducing the germinable seedbank by 70% compared to the flail treatment.