Using 2019 fecundity rates, waterhemp populations in all crop identity is decreasing in all rotation, fastest in the 3-year rotation (Figures ??).

In the corn phase of the 2-year rotation, the mobility of seeds at the bottom stratum to seedling cohort 2 was the highest contributor to changes in the population growth (); to the seedling cohorts 1, 3 and 4 were immediate contributors to changes in the population growth. The same pattern was observed for the top-stratum seeds in the corn phase of the 2-year rotation, but their contribution to changes in were lower than those of the bottom-stratum seeds.

In the soybean phase of the 2-year rotation, emergence minimally contributed to changes in population growth.

*need a table, as graphs will be too many*

In 2019, as ’s were under 1 for all treatments, fecundity did not contribute substantially to changes.

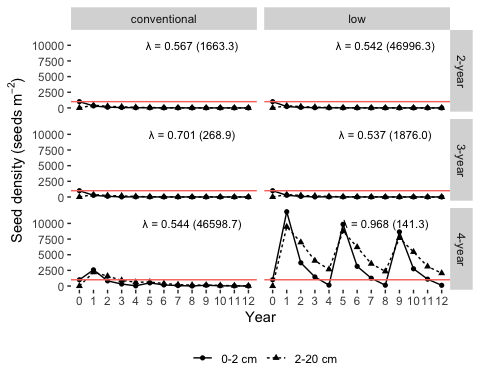


Figure 1: Scenario 1: Changes of a seed column with 1000 and 0 seeds per squared meter at the top (0-2 cm) and bottom (2-20 cm) strata after twelve years in three rotations crossed with two corn weed management programs. The red horizontal line shows the number of seeds at the top stratum at the begining of the model clock. The annualized population growth rates are followed by their variance in brackets. The crop sequence in the 2-year rotation was corn-soybean. The crop sequence in the 3-year rotation was corn-soybean-oat intercropped with red clover. The crop sequence in the 4-year rotation was corn-soybean-oat intercropped with alfalfa-alfalfa.

Under scenario 1:

summer seed survival was more important than seedling survival ( values were at ninth to fourteenth decimal places for seedlings)

Table 1: Elasticity of population growth rate to pre-planting tillage induced seed movement

| Rotation | Crop\_ID | Corn\_weed\_management | st1\_1 | st2\_1 | st1\_2 | st2\_2 |
| --- | --- | --- | --- | --- | --- | --- |
| 2yr | C2 | conv | 0.15 | 0.23 | 0.46 | 0.72 |
| 2yr | C2 | low | 0.15 | 0.24 | 0.48 | 0.76 |
| 2yr | S2 | conv | 0.14 | 0.24 | 0.41 | 0.70 |
| 2yr | S2 | low | 0.15 | 0.26 | 0.43 | 0.73 |
| 3yr | C3 | conv | 0.01 | 0.07 | 0.23 | 1.10 |
| 3yr | C3 | low | 0.01 | 0.07 | 0.23 | 1.10 |
| 3yr | S3 | conv | 0.10 | 0.26 | 0.33 | 0.88 |
| 3yr | S3 | low | 0.10 | 0.26 | 0.33 | 0.89 |
| 3yr | O3 | conv | 0.08 | 0.24 | 0.28 | 0.87 |
| 3yr | O3 | low | 0.08 | 0.24 | 0.29 | 0.88 |
| 4yr | C4 | conv | 0.02 | 0.04 | 0.36 | 0.66 |
| 4yr | C4 | low | 0.02 | 0.03 | 0.26 | 0.48 |
| 4yr | S4 | conv | 0.11 | 0.19 | 0.27 | 0.50 |
| 4yr | S4 | low | 0.08 | 0.14 | 0.20 | 0.36 |
| 4yr | O4 | conv | 2.97 | 3.01 | 5.41 | 5.49 |
| 4yr | O4 | low | 2.15 | 2.18 | 3.92 | 3.98 |
| 4yr | A4 | conv | 1.92 | 2.56 | 1.63 | 2.18 |
| 4yr | A4 | low | 1.39 | 1.86 | 1.19 | 1.58 |

Table 2: Elasticity of population growth rate to emergence rate

| Rotation | Crop\_ID | Corn\_weed\_management | seed\_top | plant\_cohort\_1 | plant\_cohort\_2 | plant\_cohort\_3 | plant\_cohort\_4 | plant\_cohort\_5 | plant\_cohort\_6 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2yr | C2 | conv | 0.13 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2yr | S2 | conv | 0.15 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2yr | S2 | low | 0.16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2yr | C2 | low | 0.14 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | C3 | conv | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | S3 | conv | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | O3 | conv | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | O3 | low | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | S3 | low | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | C3 | low | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | C4 | conv | 0.07 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | S4 | conv | 0.09 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | O4 | conv | 2.76 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | A4 | conv | 1.59 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | A4 | low | 1.18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | O4 | low | 2.00 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | S4 | low | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | C4 | low | 0.05 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 3: Elasticity of population growth rate to seed and seedling survival during crop season

| Rotation | Crop\_ID | Corn\_weed\_management | seed\_top | seed\_bottom | plant\_cohort\_1 | plant\_cohort\_2 | plant\_cohort\_3 | plant\_cohort\_4 | plant\_cohort\_5 | plant\_cohort\_6 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2yr | C2 | conv | 0.08 | 0.30 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2yr | C2 | low | 0.09 | 0.31 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2yr | S2 | conv | 0.07 | 0.28 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2yr | S2 | low | 0.08 | 0.29 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | C3 | conv | 0.04 | 0.42 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | C3 | low | 0.04 | 0.42 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | S3 | conv | 0.03 | 0.46 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | S3 | low | 0.03 | 0.47 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | O3 | conv | 0.01 | 0.45 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3yr | O3 | low | 0.01 | 0.46 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | C4 | conv | 0.04 | 0.25 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | C4 | low | 0.03 | 0.18 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | S4 | conv | 0.07 | 0.22 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | S4 | low | 0.05 | 0.16 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | O4 | conv | 0.63 | 1.44 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | O4 | low | 0.46 | 1.04 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | A4 | conv | 0.03 | 0.25 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4yr | A4 | low | 0.02 | 0.18 | 0 | 0 | 0 | 0 | 0 | 0 |

Table 4: Elasticity of population growth rate to cohort-based fecundity

| Rotation | Crop\_ID | Corn\_weed\_management | plant\_cohort\_1 | plant\_cohort\_2 | plant\_cohort\_3 | plant\_cohort\_4 | plant\_cohort\_5 | plant\_cohort\_6 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 2yr | C2 | conv | 43.13 | 10.71 | 2.86 | 0.92 | 0.48 | 0.62 |
| 2yr | C2 | low | 3.15 | 0.78 | 0.21 | 0.07 | 0.03 | 0.05 |
| 2yr | S2 | conv | 0.12 | 0.75 | 0.05 | 0.03 | 0.03 | 0.03 |
| 2yr | S2 | low | 0.69 | 4.18 | 0.27 | 0.20 | 0.16 | 0.15 |
| 3yr | C3 | conv | 0.56 | 1.00 | 0.65 | 0.42 | 0.05 | 0.02 |
| 3yr | C3 | low | 0.46 | 0.83 | 0.54 | 0.35 | 0.04 | 0.01 |
| 3yr | S3 | conv | 0.91 | 0.18 | 0.04 | 0.00 | 0.01 | 0.02 |
| 3yr | S3 | low | 0.83 | 0.16 | 0.04 | 0.00 | 0.01 | 0.01 |
| 3yr | O3 | conv | 0.05 | 0.25 | 0.02 | 0.03 | 0.01 | 0.01 |
| 3yr | O3 | low | 0.06 | 0.30 | 0.02 | 0.03 | 0.01 | 0.01 |
| 4yr | C4 | conv | 136.57 | 305.24 | 4.09 | 231.70 | 12.63 | 4.57 |
| 4yr | C4 | low | 144.55 | 323.07 | 4.33 | 245.23 | 13.36 | 4.83 |
| 4yr | S4 | conv | 0.42 | 1.07 | 0.75 | 0.46 | 0.21 | 0.08 |
| 4yr | S4 | low | 0.27 | 0.68 | 0.47 | 0.29 | 0.13 | 0.05 |
| 4yr | O4 | conv | 2.55 | 0.74 | 0.29 | 0.16 | 0.16 | 0.20 |
| 4yr | O4 | low | 2.88 | 0.83 | 0.33 | 0.18 | 0.18 | 0.22 |
| 4yr | A4 | conv | 7.09 | 36.78 | 2.14 | 1.67 | 1.39 | 1.35 |
| 4yr | A4 | low | 2.79 | 14.49 | 0.84 | 0.66 | 0.55 | 0.53 |

Table 5: Elasticity of population growth rate to post-harvest tillage induced seed movement

| Rotation | Crop\_ID | Corn\_weed\_management | ft1\_1 | ft2\_1 | ft1\_2 | ft2\_2 |
| --- | --- | --- | --- | --- | --- | --- |
| 2yr | C2 | conv | 0.09 | 0.18 | 0.26 | 0.52 |
| 2yr | C2 | low | 0.09 | 0.19 | 0.27 | 0.54 |
| 2yr | S2 | conv | 0.10 | 0.12 | 0.31 | 0.37 |
| 2yr | S2 | low | 0.11 | 0.13 | 0.33 | 0.39 |
| 3yr | C3 | conv | 0.05 | 0.18 | 0.16 | 0.55 |
| 3yr | C3 | low | 0.05 | 0.18 | 0.17 | 0.55 |
| 3yr | S3 | conv | 0.06 | 0.19 | 0.19 | 0.60 |
| 3yr | S3 | low | 0.06 | 0.19 | 0.19 | 0.60 |
| 3yr | O3 | conv | 0.01 | 0.17 | 0.05 | 0.80 |
| 3yr | O3 | low | 0.01 | 0.17 | 0.05 | 0.80 |
| 4yr | C4 | conv | 0.05 | 0.13 | 0.15 | 0.37 |
| 4yr | C4 | low | 0.04 | 0.09 | 0.11 | 0.27 |
| 4yr | S4 | conv | 0.10 | 0.12 | 0.23 | 0.29 |
| 4yr | S4 | low | 0.07 | 0.09 | 0.17 | 0.21 |
| 4yr | O4 | conv | 1.03 | 1.24 | 1.69 | 2.05 |
| 4yr | O4 | low | 0.74 | 0.90 | 1.23 | 1.49 |
| 4yr | A4 | conv | 0.01 | 0.11 | 0.03 | 0.54 |
| 4yr | A4 | low | 0.00 | 0.08 | 0.02 | 0.39 |

Table 6: Elasticity of population growth rate to overwinter seed survival

| Rotation | Crop\_ID | Corn\_weed\_management | seed\_top | seed\_bottom |
| --- | --- | --- | --- | --- |
| 2yr | C2 | conv | 0.08 | 0.31 |
| 2yr | C2 | low | 0.09 | 0.32 |
| 2yr | S2 | conv | 0.10 | 0.28 |
| 2yr | S2 | low | 0.10 | 0.30 |
| 3yr | C3 | conv | 0.05 | 0.51 |
| 3yr | C3 | low | 0.05 | 0.51 |
| 3yr | S3 | conv | 0.03 | 0.52 |
| 3yr | S3 | low | 0.03 | 0.52 |
| 3yr | O3 | conv | 0.00 | 0.67 |
| 3yr | O3 | low | 0.00 | 0.68 |
| 4yr | C4 | conv | 0.05 | 0.23 |
| 4yr | C4 | low | 0.03 | 0.17 |
| 4yr | S4 | conv | 3.32 | 0.20 |
| 4yr | S4 | low | 2.41 | 0.15 |
| 4yr | O4 | conv | 0.80 | 1.16 |
| 4yr | O4 | low | 0.58 | 0.84 |
| 4yr | A4 | conv | 0.01 | 0.28 |
| 4yr | A4 | low | 0.01 | 0.20 |