# Supplementary Information 3: Expanding on parameter search of typical model

The following tables show the effective life (the year in which insect mortality is decreased below 50%, four days after application) under different model formulations starting from the typical model parameterization (described in the paper): Table SI 3.1 uses the typical model; Table SI 3.2 uses the typical model but with sexual reproduction; Table SI 3.3 uses the typical model but with sexual reproduction and a haplodiploid ploidy.

Table SI 3.1. The effective life when each parameter or factor is changed from the typical model parameterisation. The shortest effective life is shaded red, while the longest (the optimal strategy) is shaded green.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Default value | New value |  | Effective life | | | | |
|  |  |  | SA | LM | | LR | | RM |
| Typical model | - | - | 11 | 9 | | 11 | | 17 |
| Parameters | | | | | | | | |
| Birth rate - | 1 | 0.5 | 22 | 19 | | 26 | | 43 |
| Birth rate + | 1 | 2.0 | 7 | 6 | | 7 | | 9 |
| Carrying capacity - | 100 | 50 | 10 | 8 | | 11 | | 15 |
| Carrying capacity + | 100 | 200 | 12 | 10 | | 13 | | 20 |
| Larval mortality rate - | 0.01 | 0.005 | 11 | 8 | | 11 | | 17 |
| Larval mortality rate + | 0.01 | 0.02 | 11 | 9 | | 13 | | 18 |
| Adult mortality rate - | 0.01 | 0.005 | 11 | 9 | | 11 | | 17 |
| Adult mortality rate + | 0.01 | 0.02 | 11 | 9 | | 13 | | 18 |
| Larval lifespan - | 7 | 3.5 | 8 | 7 | | 9 | | 11 |
| Larval lifespan + | 7 | 14 | 18 | 14 | | 21 | | 33 |
| Adult lifespan - | 10 | 5 | 16 | 13 | | 19 | | 34 |
| Adult lifespan + | 10 | 20 | 9 | 8 | | 9 | | 13 |
| Resistance ratio - | 32 | 16 | 12 | 10 | | 13 | | 18 |
| Resistance ratio + | 32 | 64 | 11 | 8 | | 11 | | 17 |
| Dominance - | 0.5 | 0.25 | 16 | 38 | | 15 | | 18 |
| Dominance + | 0.5 | 0.75 | 11 | 9 | | 13 | | 20 |
| Insecticide half-life - | 3.5 | 1.75 | 11 | 9 | | 13 | | 18 |
| Insecticide half-life + | 3.5 | 5.25 | 11 | 8 | | 11 | | 17 |
| Efficacy - | 0.9 | 0.81 | 14 | 9 | | 15 | | 27 |
| Efficacy + | 0.9 | 0.99 | 29 | 17 | | 45 | | 10 |
| External population size - | 1 | 0.5 | 11 | 8 | | 11 | | 16 |
| External population size + | 1 | 2.0 | 11 | 9 | | 13 | | 18 |
| Movement rate - | 0.1 | 0.05 | 11 | 9 | | 13 | | 17 |
| Movement rate + | 0.1 | 0.2 | 11 | 9 | | 12 | | 17 |
| Immigration rate - | 0.01 | 0.005 | 10 | 8 | | 11 | | 16 |
| Immigration rate + | 0.01 | 0.02 | 12 | 10 | | 13 | | 18 |
| Initial resistance frequency - | 1x10-5 | 5x10-6 | 11 | 9 | | 13 | | 18 |
| Initial resistance frequency + | 1x10-5 | 5x10-5 | 10 | 8 | | 11 | | 16 |
| Proportion of crop untreated - | 0.01 | 0.005 | 11 | 9 | | 11 | | 17 |
| Proportion of crop untreated + | 0.01 | 0.02 | 11 | 9 | | 13 | | 17 |
| Fitness cost - | 0.05 | 0.025 | 10 | 8 | | 11 | | 14 |
| Fitness cost + | 0.05 | 0.075 | 13 | 12 | | 19 | | 30 |
| Factors | | | | | | | | |
| Haplodiploid genetics | - | - | 12 | 26 | 17 | | 19 | |
| Sexual reproduction | - | - | 11 | 20 | 13 | | 21 | |
| No external untreated population | - | - | 10 | 6 | 9 | | 15 | |
| No within-field refuge | - | - | 11 | 8 | 11 | | 18 | |
| No fitness cost | - | - | 9 | 7 | 9 | | 12 | |
| Only larvae affected | - | - | 37 | 33 | 67 | | >100 | |

Table SI 3.2. Effective life when each parameter or factor is changed in the default model parameterisation, except with sexual reproduction included. The shortest effective life is shaded red, while the longest (the optimal strategy) is shaded green.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Default value | New value |  | Effective life | | | | |
|  |  |  | SA | LM | | LR | | RM |
| Typical model with sexual reproduction | - | - | 11 | 20 | | 13 | | 21 |
| Parameters | | | | | | | | |
| Birth rate - | 1 | 0.5 | 23 | 86 | | 37 | | 60 |
| Birth rate + | 1 | 2.0 | 7 | 13 | | 7 | | 10 |
| Carrying capacity - | 100 | 50 | 10 | 18 | | 11 | | 18 |
| Carrying capacity + | 100 | 200 | 13 | 22 | | 15 | | 25 |
| Larval mortality rate - | 0.01 | 0.005 | 11 | 19 | | 13 | | 20 |
| Larval mortality rate + | 0.01 | 0.02 | 12 | 21 | | 15 | | 23 |
| Adult mortality rate - | 0.01 | 0.005 | 11 | 19 | | 13 | | 20 |
| Adult mortality rate + | 0.01 | 0.02 | 12 | 20 | | 15 | | 22 |
| Larval lifespan - | 7 | 3.5 | 8 | 16 | | 9 | | 14 |
| Larval lifespan + | 7 | 14 | 18 | 37 | | 25 | | 42 |
| Adult lifespan - | 10 | 5 | 18 | >100 | | >100 | | 62 |
| Adult lifespan + | 10 | 20 | 9 | 18 | | 11 | | 15 |
| Resistance ratio - | 32 | 16 | 12 | 23 | | 15 | | 22 |
| Resistance ratio + | 32 | 64 | 11 | 18 | | 13 | | 20 |
| Dominance - | 0.5 | 0.25 | 15 | 30 | | 17 | | 23 |
| Dominance + | 0.5 | 0.75 | 12 | 21 | | 13 | | 25 |
| Insecticide half-life - | 3.5 | 1.75 | 12 | 20 | | 13 | | 22 |
| Insecticide half-life + | 3.5 | 5.25 | 11 | 19 | | 13 | | 20 |
| Efficacy - | 0.9 | 0.81 | 14 | 15 | | 17 | | 30 |
| Efficacy + | 0.9 | 0.99 | 11 | 56 | | 13 | | 43 |
| External population size - | 1 | 0.5 | 11 | 17 | | 11 | | 19 |
| External population size + | 1 | 2.0 | 12 | 24 | | 15 | | 24 |
| Movement rate - | 0.1 | 0.05 | 11 | 20 | | 13 | | 21 |
| Movement rate + | 0.1 | 0.2 | 11 | 19 | | 13 | | 21 |
| Immigration rate - | 0.01 | 0.005 | 11 | 15 | | 13 | | 19 |
| Immigration rate + | 0.01 | 0.02 | 12 | 26 | | 13 | | 22 |
| Initial resistance frequency - | 1x10-5 | 5x10-6 | 12 | 21 | | 13 | | 22 |
| Initial resistance frequency + | 1x10-5 | 5x10-5 | 11 | 18 | | 13 | | 20 |
| Proportion protected - | 0.01 | 0.005 | 11 | 18 | | 13 | | 21 |
| Proportion protected + | 0.01 | 0.02 | 11 | 22 | | 13 | | 21 |
| Fitness cost - | 0.05 | 0.025 | 10 | 16 | | 11 | | 16 |
| Fitness cost + | 0.05 | 0.075 | 14 | >100 | | >100 | | >100 |
| Factors | | | | | | | | |
| Haplodiploid genetics | - | - | 12 | 26 | 17 | | 29 | |
| Asexual reproduction | - | - | 11 | 9 | 11 | | 17 | |
| No external untreated population | - | - | 10 | 8 | 11 | | 16 | |
| No protected population | - | - | 11 | 17 | 13 | | 21 | |
| No fitness cost | - | - | 9 | 13 | 9 | | 13 | |
| Unaffected larvae | - | - | 20 | 52 | 27 | | 54 | |

Table SI 3.3. Effective life when each parameter or factor is changed in the default model parameterisation, except with a haplodiploid pest with sexual reproduction included. The shortest effective life is shaded red, while the longest (the optimal strategy) is shaded green.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | Default value | New value |  | Effective life | | | | |
|  |  |  | SA | LM | | LR | | RM |
| Typical model, but haplodiploid and sexual | - | - | 12 | 26 | | 17 | | 29 |
| Parameters | | | | | | | | |
| Birth rate - | 1 | 0.5 | 27 | >100 | | >100 | | >100 |
| Birth rate + | 1 | 2.0 | 7 | 16 | | 9 | | 12 |
| Carrying capacity - | 100 | 50 | 11 | 24 | | 15 | | 24 |
| Carrying capacity + | 100 | 200 | 14 | 30 | | 21 | | 38 |
| Larval mortality rate - | 0.01 | 0.005 | 12 | 25 | | 15 | | 27 |
| Larval mortality rate + | 0.01 | 0.02 | 13 | 28 | | 19 | | 32 |
| Adult mortality rate - | 0.01 | 0.005 | 12 | 25 | | 15 | | 27 |
| Adult mortality rate + | 0.01 | 0.02 | 13 | 27 | | 17 | | 32 |
| Larval lifespan - | 7 | 3.5 | 9 | 20 | | 11 | | 18 |
| Larval lifespan + | 7 | 14 | 21 | 57 | | 41 | | 72 |
| Adult lifespan - | 10 | 5 | 20 | >100 | | >100 | | >100 |
| Adult lifespan + | 10 | 20 | 9 | 24 | | 13 | | 19 |
| Resistance ratio - | 32 | 16 | 13 | 30 | | 17 | | 30 |
| Resistance ratio + | 32 | 64 | 12 | 24 | | 15 | | 28 |
| Dominance - | 0.5 | 0.25 | 14 | 35 | | 19 | | 30 |
| Dominance + | 0.5 | 0.75 | 12 | 27 | | 17 | | 33 |
| Insecticide half-life - | 3.5 | 1.75 | 13 | 27 | | 17 | | 30 |
| Insecticide half-life + | 3.5 | 5.25 | 12 | 25 | | 15 | | 27 |
| Efficacy - | 0.9 | 0.81 | 16 | 19 | | 21 | | 47 |
| Efficacy + | 0.9 | 0.99 | 9 | 89 | | 13 | | 72 |
| External population size - | 1 | 0.5 | 12 | 21 | | 15 | | 24 |
| External population size + | 1 | 2.0 | 13 | 35 | | 21 | | 35 |
| Movement rate - | 0.1 | 0.05 | 12 | 27 | | 17 | | 29 |
| Movement rate + | 0.1 | 0.2 | 12 | 25 | | 17 | | 29 |
| Immigration rate - | 0.01 | 0.005 | 11 | 17 | | 15 | | 25 |
| Immigration rate + | 0.01 | 0.02 | 14 | 38 | | 17 | | 31 |
| Initial resistance frequency - | 1x10-5 | 5x10-6 | 13 | 28 | | 17 | | 30 |
| Initial resistance frequency + | 1x10-5 | 5x10-5 | 11 | 24 | | 15 | | 27 |
| Proportion protected - | 0.01 | 0.005 | 12 | 24 | | 17 | | 29 |
| Proportion protected + | 0.01 | 0.02 | 12 | 30 | | 17 | | 28 |
| Fitness cost - | 0.05 | 0.025 | 11 | 19 | | 13 | | 19 |
| Fitness cost + | 0.05 | 0.075 | 16 | >100 | | >100 | | >100 |
| Factors | | | | | | | | |
| Asexual and diploid | - | - | 11 | 9 | 11 | | 17 | |
| Sexual and diploid | - | - | 11 | 20 | 13 | | 21 | |
| No external untreated population | - | - | 10 | 8 | 11 | | 18 | |
| No protected population | - | - | 12 | 23 | 17 | | 29 | |
| No fitness cost | - | - | 9 | 15 | 9 | | 15 | |
| Unaffected larvae | - | - | 18 | 79 | 25 | | 90 | |