## Effect on pea genotypes (*Pisum sativum* L.)

### A. The net impact of individual and combined stress on the plant

Stress 1: *Rhizoctonia solani, Fusarium solani* f.sp.pisi
Stress 2: *Pythium ultimum, Aphanomyces euteiches*
Stage of plant: Seedlings 7 days after planting

The table shows the impact of individual and combined stress on the dry weight of pea genotypes

| Genotypes | Treatment | Response under combined stress (Type A parameters*) | |
|---|---|---|---|
| | | Reduction over control (%) Dry weight | Dead plant** (%) |
| Little marvel (Susceptible to all pathogen) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 45.31 ↓ | 80 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 39.06 ↓ | 43 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 29.68 ↓ | 35 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 53.12 ↓ | 82 |
| | *R. solani* | 29.68 ↓ | 43 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 20.31 ↓ | 67 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 43.75 ↓ | 37 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 15.62 ↓ | 17 |
| PI 257593 (Moderately resistant to *F. solani* f. sp.*pisi*) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 61.76 ↓ | 90 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 21.56 ↓ | 20 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 17.64 ↓ | 21 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 66.17 ↓ | 84 |
| | *R. solani* | 18.62 ↓ | 17 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 24.50 ↓ | 69 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 16.67 ↓ | 10 |

| | | | |
|---|---|---|---|
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 13.72 ↓ | 7 |
| Dark Skin Perfection (Moderately resistant to *R. solani*) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 52.99 ↓ | 73 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 30.76 ↓ | 28 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 17.94 ↓ | 28 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 59.82 ↓ | 77 |
| | *R. solani* | 5.12 ↓ | 31 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 26.49 ↓ | 26 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 25.64 ↓ | 2 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 1.70 ↓ | 0 |
| Minnesota 494-A11 (Moderately resistant to *A. euteiches*) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 54.92 ↓ | 90 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 33.80 ↓ | 20 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 33.09 ↓ | 21 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 54.92 ↓ | 84 |
| | *R. solani* | 34.50 ↓ | 17 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 22.53 ↓ | 69 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 18.30 ↓ | 10 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 2.81 ↓ | 7 |

**Note:** *Values presented in the table were calculated using the formula described below.*

$$\textit{Reduction over control (\%)} = \frac{(Value_{Control} - Value_{Stress})}{Value_{Control}} x100$$

'↓'- *indicates plant parameter is more affected by stress that leads to high susceptibility (higher the value more the damage).*
'**' - *Values are presented as it is from the source article*

'*'- *For more information on parameters classification, please refer to 'methodology' tab*

**B. The interaction between the fungus and oomycete pathogens under the combined stress treatment at the plant interface**

The table shows the interaction between the fungi *R. solani, F.solani,* and oomycetes *P. ultimum* and *A. euteiches* causing disease on pea plants

| Genotypes | Treatment | Response under combined stress (Type B parameters*) | |
|---|---|---|---|
| | | Disease rating | |
| | | Stem rot | Root rot |
| Little marvel (Susceptible to all pathogen) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 5 | 4.9 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 4.3 | 3.7 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 4.4 | 3 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 5 | 4.9 |
| | *R. solani* | 4.2 | 1.4 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 4.9 | 3.7 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 1.8 | 3.9 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 1.2 | 2.5 |
| PI 257593 (Moderately resistant to *F. solani* f. sp.*pisi*) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 4.6 | 4.9 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 4 | 1.7 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 4 | 1.7 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 5 | 4.8 |
| | *R. solani* | 3.8 | 1.2 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 4.1 | 2.6 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 1.4 | 2.1 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 1.1 | 1.6 |
| Dark Skin Perfection (Moderately resistant to *R. solani*) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 5 | 4.9 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 3.6 | 2.2 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 3.2 | 1.9 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 5 | 4.9 |
| | *R. solani* | 3.3 | 1.2 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 5 | 2.8 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 2.1 | 2.4 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 1.6 | 1.9 |

| | | | |
|---|---|---|---|
| Minnesota 494-A11 (Moderately resistant to *A. euteiches*) | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) (Sequential stress) | 4.9 | 4.8 |
| | *R. solani* + *P. ultimum* (agar disks of 4 mm in diameter) (Sequential stress) | 4.2 | 2.3 |
| | *R. solani* + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 4.1 | 1.9 |
| | *R. solani* + *F. solani* ($1\times10^6$ conidia/mL) + *P. ultimum* (agar disks of 4mm in diameter) + *A. euteiches* ($1.5\times10^5$ conidia/mL) (Sequential stress) | 5 | 4.9 |
| | *R. solani* | 4.3 | 1.2 |
| | *F. solani* ($1\times10^6$ conidia/mL) | 3.8 | 2.4 |
| | *P. ultimum* (agar disks of 4 mm in diameter) | 1.5 | 2.1 |
| | *A. euteiches* ($1.5\times10^5$ conidia/mL) | 1.2 | 1.8 |

*(Root rot rating: on a 1-5 index; 1 = no symptoms and 5 = severe symptoms (dead plant))*

For raw data – Click here (.xlsx file)

Reference– Shehata MA, Pfleger FL, Davis DW (1983) Response of susceptible and moderately resistant genotypes to interaction between *Rhizoctonia solani* and three other stem and root rot pathogens. Plant Dis. **67:**1146-1148

**Note:** *Values are presented as it is from the source article without subjecting to the calculation.*

'*'- *For more information on parameters classification, please refer to 'methodology' tab*

**The inference from the study:** Shehata *et al*., 1983 studied the interaction between the the fungi *R. solani, F. solani,* and oomycetes *P. ultimum* and *A. euteiches* on susceptible pea genotype Little marvel and moderately resistant PI 257593, Dark Skin Perfection and Minnesota 494-A11. The combination of fungus and oomycete pathogens caused a more reduction in dry weight of the plants in comparison with the single treatment of either pathogen. However, the moderately resistant genotype showed a less reduction in dry weight upon combined treatment of *R. Solani* and *A. euteiches* in comparison with the reduction caused by *R. solani*. Also, the moderately resistant cultivar showed a less reduction in dry weight upon combined inoculation with *R. solani* + *P. ultimum* and *R. solani* + *A. euteiches* in comparison withthe single inoculation of *R.solani*. **The overall observation concludes genotype dependant interaction among the fungal and oomycete pathogens.**