



Combined Stress: Omics data	
→ Phenomics	Morpho-Physiological combined stress data
→ Transcriptomics	

Literature	1088
Stress combinations	100
Organisms	325
Transcriptome	24
Traits	107

Photo credit: Ranjita Sinha  
NIPGR, field experiment

## 1. Searching phenomics data

- Home page provides the user with two major menus, namely Phenomics and Transcriptomics.
- To mine phenomics data, user's need to click the Phenomics button as shown in above screenshot.
- Once Phenomics tab is selected the user will be redirected to the Phenomics section which is shown below. The highlighted portion describes about the data hosted in this section in detail.



Home Phenome Transcriptome Meta-analysis

## Combined stress: Simultaneous and Sequential stress data

(Morphological, physiological and biochemical data)

STEP I : CATEGORY:

Choose a Category: **Simultaneous stress: Biotic-Biotic** ▼

STEP II: SUBCATEGORY:

Choose a Subcategory: **Nematode & Fungus** ▼

STEP III: PLANT SPECIES:

Choose a Plant: **Rice** ▼

[Reset](#) [Submit](#)

- This section of the SCIP database hosts comprehensive literature information for various stress combinations.
- The phenome depicts the net impact of individual and combined stress on a plant in comparison with non-stressed control, and also the interaction between the stresses at plant interface.
- The phenomic data represented here include a) growth and yield attributing traits directly showing the impact of combined stress on plants. E.g., yield, biomass, plant height etc, b) physiological and virulence-associated/immunity related/ pathogen defence-related traits indirectly showing the net impact of stress on plants. E.g., photosynthetic rate, stomatal conductance, bacterial number, cell death etc, and c) biochemical parameters showing the net impact of stress E.g., RUBISCO content, proline content etc.
- The net impact of stress was assessed by calculating the percentage reduction in the values of different growth and physiological parameters measured under combined and individual stresses over their non-stressed control plants
- Information can be accessed directly by choosing desired stress combination and crop of interest from the drop down menu on the left side.
- Order within stress combination is based on the dominant stress.
- Based on methodology followed for combined stress imposition, articles categorized into simultaneous stress (both the stresses imposed together) articles and sequential stress (stress imposed one after another in a sequential manner with overlap of one stress over other stress) articles.
- This section also includes the studies where more than two stresses were imposed simultaneously/sequentially during the experiment.
- Individual data page for each stress combination has two parts, first part depicts the...

[View more](#)

The phenomics data visualization links can aid users to decipher a holistic view and trends in a large number of stress combinations represented in the database as compared to individual stresses. Also provides information on the geographical distribution of stress combinations.

[View stress matrix](#)   [View net impact \(Based on stress combination\)](#)   [View net impact \(Based on plant\)](#)   [View geographical distribution](#)

©2017, National Institute Of Plant Genome Research  
**0031254**

- d) A three-level dropdown-based selection is required to mine the data from present section as explained below.
- e) Select desired combined stress category (first level) from the drop-down menu highlighted.



Home Phenome Transcriptome Meta-analysis

## Combined stress: Simultaneous and Sequential stress data (Morphological, physiological and biochemical data)

STEP I : CATEGORY:

Choose a Category:

- Select Category
- Simultaneous stress: Abiotic-Abiotic
- Simultaneous stress: Abiotic-Biotic
- Simultaneous stress: Biotic-Biotic**
- Sequential stress: Abiotic-Abiotic
- Sequential stress: Abiotic-Biotic
- Sequential stress: Biotic-Biotic

STEP II: SUBCATEGORY:

Choose a Subcategory:

STEP III: PLANT SPECIES:

Choose a Plant:

The phenomics data visualization links can aid users to decipher a holistic view and trends in a large number of stress combinations represented in the database as compared to individual stresses. Also provides information on the geographical distribution of stress combinations.

[View stress matrix](#) [View net impact \(Based on stress combination\)](#) [View net impact \(Based on plant\)](#) [View geographical distribution](#)

- This section of the SCIP database hosts comprehensive literature information for various stress combinations.
  - The phenome depicts the net impact of individual and combined stress on a plant in comparison with non-stressed control, and also the interaction between the stresses at plant interface.
  - The phenomic data represented here include a) growth and yield attributing traits directly showing the impact of combined stress on plants. E.g., yield, biomass, plant height etc, b) physiological and virulence-associated/immunity related/ pathogen defence-related traits indirectly showing the net impact of stress on plants. E.g., photosynthetic rate, stomatal conductance, bacterial number, cell death etc, and c) biochemical parameters showing the net impact of stress E.g., RUBISCO content, proline content etc.
  - The net impact of stress was assessed by calculating the percentage reduction in the values of different growth and physiological parameters measured under combined and individual stresses over their non-stressed control plants
  - Information can be accessed directly by choosing desired stress combination and crop of interest from the drop down menu on the left side.
  - Order within stress combination is based on the dominant stress.
  - Based on methodology followed for combined stress imposition, articles categorized into simultaneous stress (both the stresses imposed together) articles and sequential stress (stress imposed one after another in a sequential manner with overlap of one stress over other stress) articles.
  - This section also includes the studies where more than two stresses were imposed simultaneously/sequentially during the experiment.
  - Individual data page for each stress combination has two parts, first part depicts the...
- [View more](#)

f) All the corresponding stress combinations under the above chosen category will be presented, in the second level of dropdown.

g) Select a desired combined stress sub category from the drop-down menu highlighted.

Home Phenome Transcriptome Meta-analysis

## Combined stress: Simultaneous and Sequential stress data (Morphological, physiological and biochemical data)

STEP I : CATEGORY:

Choose a Category:

STEP II: SUBCATEGORY:

Choose a Subcategory:

STEP III: PLANT SPECIES:

Choose a Plant:

The phenomics data visualization links can aid users to decipher a holistic view and trends in a large number of stress combinations represented in the database as compared to individual stresses. Also provides information on the geographical distribution of stress combinations.

[View stress matrix](#) [View net impact \(Based on stress combination\)](#) [View net impact \(Based on plant\)](#) [View geographical distribution](#)

- This section of the SCIP database hosts comprehensive literature information for various stress combinations.
- The phenome depicts the net impact of individual and combined stress on a plant in comparison with non-stressed control, and also the interaction between the stresses at plant interface.
- The phenomic data represented here include a) growth and yield attributing traits directly showing the impact of combined stress on plants. E.g., yield, biomass, plant height etc, b) physiological and virulence-associated/immunity related/ pathogen defence-related traits indirectly showing the net impact of stress on plants. E.g., photosynthetic rate, stomatal conductance, bacterial number, cell death etc, and c) biochemical parameters showing the net impact of stress E.g., RUBISCO content, proline content etc.
- The net impact of stress was assessed by calculating the percentage reduction in the values of different growth and physiological parameters measured under combined and individual stresses over their non-stressed control plants
- Information can be accessed directly by choosing desired stress combination and crop of interest from the drop down menu on the left side.
- Order within stress combination is based on the dominant stress.
- Based on methodology followed for combined stress imposition, articles categorized into simultaneous stress (both the stresses imposed together) articles and sequential stress (stress imposed one after another in a sequential manner with overlap of one stress over other stress) articles.
- This section also includes the studies where more than two stresses were imposed simultaneously/sequentially during the experiment.
- Individual data page for each stress combination has two parts, first part depicts the...

[View more](#)



h) All the corresponding plant species under the above chosen subcategory will be presented, in the third level of dropdown. Select a desired plant species from the dropdown menu, as shown in highlighted section below.

[Home](#)      [Phenome](#)      [Transcriptome](#)      [Meta-analysis](#)

**Combined stress: Simultaneous and Sequential stress data**  
(Morphological, physiological and biochemical data)

**STEP I : CATEGORY:**  
Please select Plant

**Choose a Category:**

**STEP II: SUBCATEGORY:**  
Please select Plant

**Choose a Subcategory:**

**STEP III: PLANT:**  
Please select Plant

**Choose a Plant:**

- This section of the SCIP database hosts comprehensive literature information for various stress combinations.
- The phenome depicts the net impact of individual and combined stress on a plant in comparison with non-stressed control, and also the interaction between the stresses at plant interface.
- The phenomic data represented here include a) growth and yield attributing traits directly showing the impact of combined stress on plants. E.g., yield, biomass, plant height etc, b) physiological and virulence-associated/immunity related/ pathogen defence-related traits indirectly showing the net impact of stress on plants. E.g., photosynthetic rate, stomatal conductance, bacterial number, cell death etc, and c) biochemical parameters showing the net impact of stress E.g., RUBISCO content, proline content etc.
- The net impact of stress was assessed by calculating the percentage reduction in the values of different growth and physiological parameters measured under combined and individual stresses over their non-stressed control plants
- Information can be accessed directly by choosing desired stress combination and crop of interest from the drop down menu on the left side.
- Order within stress combination is based on the dominant stress.
- Based on methodology followed for combined stress imposition, articles categorized into simultaneous stress (both the stresses imposed together) articles and sequential stress (stress imposed one after another in a sequential manner with overlap of one stress over other stress) articles.
- This section also includes the studies where more than two stresses were imposed simultaneously/sequentially during the experiment.
- Individual data page for each stress combination has two parts, first part depicts the...

[View more](#)

The phenomics data visualization links can aid users to decipher a holistic view and trends in a large number of stress combinations represented in the database as compared to individual stresses. Also provides information on the geographical distribution of stress combinations.

[View stress matrix](#)    [View net impact \(Based on stress combination\)](#)    [View net impact \(Based on plant\)](#)    [View geographical distribution](#)

i) On clicking the submit button, the webpage containing the phenomics data pertaining to the user-based selection is presented.



## Combined stress: Simultaneous and Sequential stress data (Morphological, physiological and biochemical data)

STEP I : CATEGORY:

Choose a Category:

STEP II: SUBCATEGORY:

Choose a Subcategory:

STEP III: PLANT SPECIES:

Choose a Plant:

- This section of the SCIP database hosts comprehensive literature information for various stress combinations.
- The phenome depicts the net impact of individual and combined stress on a plant in comparison with non-stressed control, and also the interaction between the stresses at plant interface.
- The phenomic data represented here include a) growth and yield attributing traits directly showing the impact of combined stress on plants. E.g., yield, biomass, plant height etc, b) physiological and virulence-associated/immunity related/ pathogen defence-related traits indirectly showing the net impact of stress on plants. E.g., photosynthetic rate, stomatal conductance, bacterial number, cell death etc, and c) biochemical parameters showing the net impact of stress E.g., RUBISCO content, proline content etc.
- The net impact of stress was assessed by calculating the percentage reduction in the values of different growth and physiological parameters measured under combined and individual stresses over their non-stressed control plants
- Information can be accessed directly by choosing desired stress combination and crop of interest from the drop down menu on the left side.
- Order within stress combination is based on the dominant stress.
- Based on methodology followed for combined stress imposition, articles categorized into simultaneous stress (both the stresses imposed together) articles and sequential stress (stress imposed one after another in a sequential manner with overlap of one stress over other stress) articles.
- This section also includes the studies where more than two stresses were imposed simultaneously/sequentially during the experiment.
- Individual data page for each stress combination has two parts, first part depicts the...  
[View more](#)

The phenomics data visualization links can aid users to decipher a holistic view and trends in a large number of stress combinations represented in the database as compared to individual stresses. Also provides information on the geographical distribution of stress combinations.

[View stress matrix](#)   [View net impact \(Based on stress combination\)](#)   [View net impact \(Based on plant\)](#)   [View geographical distribution](#)

## 2. Understanding phenomics data

The user will be redirected to the webpage containing the phenomics details of the species selected for particular stress combination. The image shown below is the phenomics data from **Nematode and Fungus** stress combination for rice (*Oryza sativa*).

- a) Any phenomics data starts with a brief introduction as shown in highlighted section of the below screenshot. On clicking view more button, a representative image (wherever possible) is also presented.



# Stress Combination and their Interaction in Plants (SCIP) Database

Website link- <http://www.nipgr.ac.in/scipdb.php>



## Combined Nematode and Fungus Stress

Plants encounter various types of soil-borne pathogens. Nematode and fungus are the two most important type of pathogens which can affect the growth and yield of the plants. Several plant species are known to form a disease complex induced by this pathogen combination. This combination has been well studied in more than 25+ plant species with over 100+ articles. Disease complex caused by this pathogen combination has been reported in several economically important species like potato, tomato, wheat, cotton, sugarbeet, rice, chickpea and lentils, to mention a few. The results from this combination studies mostly indicated the negative effect on growth and yield however, a few studies show no net additive impact i.e. upon simultaneous or sequential inoculation of both pathogens the effect on growth/yield was less than or equal to single stress. This pathogen combination is well studied and a lot of literature is available. However, we still need to understand the molecular basis of disease progression caused by nematode and fungus and also upon how these two individual pathogens are affecting each other in terms of their physiology.

For more clarity on terminologies, like combined stress, sequential stress, and multiple individual stress, please refer to "Pandey et al., 2017".

View more

### Effect on rice (*Oryza sativa* cv. Saturn)

#### Study-1,

##### 1. The net impact of individual and combined stress on plant growth

Crop: rice (*Oryza sativa* cv. Saturn)  
Stress 1: *Aphelenchoides besseyi*  
Stress 2: *Magnaporthe salvinii*  
Stage of plant: 15 day old seedling

The table shows the impact of nematode and fungus alone and in combination on weight of rice plants

Treatments	Plant response to stress (reduction over control %)
	Type A parameters*
	Plant weight
<i>Aphelenchoides besseyi</i> (350 nematodes/plant)	12.4 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant)	14.0 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant) + <i>Aphelenchoides besseyi</i> (350 nematodes/plant) Simultaneous stress	8.3 ↓

b) The highlighted grey box, provides the summary about the plant species, stresses imposed in the current study, and also about the stage of the plant.

### Effect on rice (*Oryza sativa* cv. Saturn)

#### Study-1,

##### 1. The net impact of individual and combined stress on plant growth

Crop: rice (*Oryza sativa* cv. Saturn)  
Stress 1: *Aphelenchoides besseyi*  
Stress 2: *Magnaporthe salvinii*  
Stage of plant: 15 day old seedling

The table shows the impact of nematode and fungus alone and in combination on weight of rice plants

Treatments	Plant response to stress (reduction over control %)
	Type A parameters*
	Plant weight
<i>Aphelenchoides besseyi</i> (350 nematodes/plant)	12.4 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant)	14.0 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant) + <i>Aphelenchoides besseyi</i> (350 nematodes/plant) Simultaneous stress	8.3 ↓

c) After this, a tabular depiction of the treatment given in current study, is presented to the user. The values here indicate percentage reduction over control, under two individual stresses and also combined stress and reflects the net impact of individual and combined stress on plant growth.

### Effect on rice (*Oryza sativa* cv. Saturn)

#### Study-1,

##### 1. The net impact of individual and combined stress on plant growth

Crop: rice (*Oryza sativa* cv. Saturn)  
Stress 1: *Aphelenchoides besseyi*  
Stress 2: *Magnaporthe salvinii*  
Stage of plant: 15 day old seedling


The table shows the impact of nematode and fungus alone and in combination on weight of rice plants

Treatments	Plant response to stress (reduction over control %)
	Type A parameters*
	Plant weight
<i>Aphelenchoides besseyi</i> (350 nematodes/plant)	12.4 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant)	14.0 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant) + <i>Aphelenchoides besseyi</i> (350 nematodes/plant) Simultaneous stress	8.3 ↓



- d) The percent change values are shown here along with arrows in red and green color, for an easy interpretation of results. A red-colored downward arrow indicates the parameter is affected under stress, and the higher the positive value greater the damage to the parameter under stress. Green-colored upward arrow indicated parameters are not affected under stress conditions as compared to control.
- e) **Type A parameter**, highlighted in above screenshot implies, those that includes growth (plant height, biomass, leaf area, leaf number, root length, shoot weight, root weight, etc.) and yield (seed weight, seed number, test weight, etc.), attributing parameters that directly reflect the impact of stress.
- f) **Type B parameters** includes physiological (photosynthesis, stomatal conductance, transpiration, chlorophyll content, etc.) and pathogenesis (disease index, pathogen load, disease score, etc.) related parameters which indirectly reflect the impact of stress.
- g) **Type C parameters** includes biochemical parameters such as proline content, MDA content, nutrient composition, ROS content, etc., which also explains the impact of stress but to a lesser extent compared to the other two classes of parameters.

In cases where interaction between two stresses occur at plant interface, a second table is also presented depicting the same.

2. The interaction between nematode and fungal pathogen under combined stress at plant interface 

The table shows the effect of the fungal pathogen on nematode population per plant and the effect of the nematode on fungus induced disease index under combined stress treatment

Treatments	Response to combined stress**	
	Type B parameters*	M. salvinii (disease index)A. bessey (no./plant)
Aphelenchoides bessey (350 nematodes/plant)	0	1540
Magnaporthe salvinii (0.5g/plant)	1-2	N/A
Magnaporthe salvinii (0.5g/plant) + Aphelenchoides bessey (350 nematodes/plant) Simultaneous stress	2	1365

For raw data – Click here (.xlsx file)  
For genotype study– Click here (.pdf file)  
Reference- McGawley EC, Rush MC, Hollis JP (1984) Occurrence of *Aphelenchoides besseyi* in Louisiana Rice Seed and Its Interaction with *Sclerotium oryzae* in Selected Cultivars. *Journal of Nematology* 16(1) : 65-68

- h) The corresponding raw data, genotype/cultivar/variety/species study data (if present) and the link to the journal is available beneath the corresponding table which is highlighted below.



# Stress Combination and their Interaction in Plants (SCIP) Database

Website link- <http://www.nipgr.ac.in/scipdb.php>

## Effect on rice (*Oryza sativa* cv. Saturn)

### Study-1,

#### 1. The net impact of individual and combined stress on plant growth

Crop: rice (*Oryza sativa* cv. Saturn)  
 Stress 1: *Aphelenchoides besseyi*  
 Stress 2: *Magnaporthe salvinii*  
 Stage of plant: 15 day old seedling

The table shows the impact of nematode and fungus alone and in combination on weight of rice plants

Treatments	Plant response to stress (reduction over control %)
	Type A parameters*
	Plant weight
<i>Aphelenchoides besseyi</i> (350 nematodes/plant)	12.4 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant)	14.0 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant) + <i>Aphelenchoides besseyi</i> (350 nematodes/plant) Simultaneous stress	8.3 ↓

For raw data – Click here (.xlsx file)  
 For genotype study– Click here (.pdf file)  
 Reference- McGawley EC, Rush MC, Hollis JP (1984) Occurrence of *Aphelenchoides besseyi* in Louisiana Rice Seed and Its Interaction with *Sclerotium oryzae* in Selected Cultivars. Journal of Nematology 16(1) : 65-68

i) The view more section which is highlighted below, depicts the formula with which the values for the column “Plant response to the stress” is calculated for each treatment.

### Study-1,

#### 1. The net impact of individual and combined stress on plant growth

Crop: rice (*Oryza sativa* cv. Saturn)  
 Stress 1: *Aphelenchoides besseyi*  
 Stress 2: *Magnaporthe salvinii*  
 Stage of plant: 15 day old seedling

The table shows the impact of nematode and fungus alone and in combination on weight of rice plants

Treatments	Plant response to stress (reduction over control %)
	Type A parameters*
	Plant weight
<i>Aphelenchoides besseyi</i> (350 nematodes/plant)	12.4 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant)	14.0 ↓
<i>Magnaporthe salvinii</i> (0.5g/plant) + <i>Aphelenchoides besseyi</i> (350 nematodes/plant) Simultaneous stress	8.3 ↓

For raw data – Click here (.xlsx file)  
 For genotype study– Click here (.pdf file)  
 Reference- McGawley EC, Rush MC, Hollis JP (1984) Occurrence of *Aphelenchoides besseyi* in Louisiana Rice Seed and Its Interaction with *Sclerotium oryzae* in Selected Cultivars. Journal of Nematology 16(1) : 65-68

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

View more

$$\text{Reduction over control}(\%) = \frac{(\text{Value}_{\text{Control}} - \text{Value}_{\text{Stress}})}{\text{Value}_{\text{Control}}} \times 100$$

1) ↓ indicates plant parameters affected by stress that lead to high susceptibility (higher the value more the damage).

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

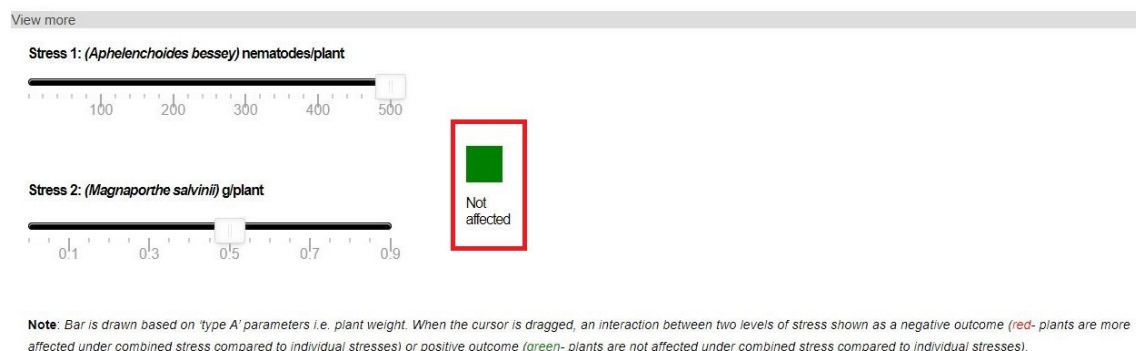
j) The next view more tab depicts an interactive scroll bar which on scroll depicts, an interaction between two levels of stress shown as a negative outcome (red- plants are more affected under combined stress compared to individual stresses) or positive outcome (green- plants are not affected under combined stress compared to individual stresses).

Bar is drawn based on ‘type A’ parameters (in the depiction below for eg. plant weight).



h) In the depiction shown below, the first stress is *Aphelenchoides bessey* (a nematode) and the second stress is *Magnaporthe salvinii* (a fungus).

i) The user can scroll over the scales for both the individual stresses and check whether a particular combination of concentrations of both the stresses is detrimental to the plant or not compared to the individual stresses. If it is not detrimental a small square box having green color with a text “**Not affected**” will be shown as highlighted below. If a particular stress combinations concentrations are deleterious to the host plant, then a red box will be show with a text “**Affected**”, which means more detrimental compared to each of the individual stresses.



j) The phenomics data ends with a brief inference for each study, which summarises the major finding of the article.

**The inference from the study:** McGawley et.al. 1984 studied interaction of *Aphelenchoides besseyi* and *Sclerotium oryzae* in rice cultivar Saturn. Pathogens were inoculated singly and simultaneously. Rice plants were then analysed for their plant weight, which was not affected additively upon simultaneous inoculation. Disease index was also similar to fungus only single inoculation. Although, the nematode population was reduced under combined stress conditions. **Thus, this pathogen combination does not show a synergistic effect of two pathogens upon rice cultivar Saturn.**