



Effect on winter wheat cultivars (*Triticum aestivum* L. cv. Sardari, Bakkras-Roshan)

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

Crop: Winter Wheat (*Triticum aestivum* L. cv. Sardari, Bakkras-Roshan)
 Stress 1: *Heterodera filipjevi*
 Stress 2: *Fusarium culmorum*
 Stage of plant: At sowing

The table shows the impact of nematode and fungus alone and in combination on growth and yield of wheat plants.

	Treatment	Plant response to stress (reduction over control %) Type A parameters*			
		Plant height	Shoot dry weight	Root dry weight	Grain yield
Sardari	<i>Heterodera filipjevi</i> (4000 eggs/ plant)	9.0↓	21.7↓	40.9↓	25.5↓
	<i>Fusarium culmorum</i> (1.4g /100g soil)	10.0↓	24.0↓	45.5↓	35.5↓
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Fusarium culmorum</i> (1.4 g /100g soil) Simultaneous stress	17.6↓	30.0↓	52.3↓	49.4↓
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Fusarium culmorum</i> (1.4 g /100g soil) 1 month later (Sequential stress)	12.2↓	29.0↓	38.6↓	38.2↓
	<i>Fusarium culmorum</i> (1.4g/ 100g soil) + <i>Heterodera filipjevi</i> (4000 eggs/ plant) 1 month later (Sequential stress)	6.7↓	15.7↓	22.7↓	11.2↓
Bakkras-Roshan	<i>Heterodera filipjevi</i> (4000 eggs/ plant)	15.4↓	8.9↓	22.7↓	12.7↓
	<i>Bipolaris sorokiniana</i> (1.4g /100g soil)	12.6↓	11.6↓	22.7↓	10.3↓
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Bipolaris sorokiniana</i> (1.4 g /100g soil) Simultaneous stress	18.0↓	8.6↓	25.0↓	19.1↓

	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Bipolaris sorokiniana</i> (1.4 g /100g soil) 1 month later (Sequential stress)	15.1 ↓	15.8 ↓	40.9 ↓	19.1 ↓
	<i>Fusarium culmorum</i> (1.4g/ 100g soil) + <i>Bipolaris sorokiniana</i> (4000 eggs/ plant) 1 month later (Sequential stress)	8.5 ↓	13.2 ↓	13.6 ↓	8.1 ↓

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

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

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.

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 reproduction factor and effect of nematode on fungus induced disease severity under combined stress treatment

	Treatment	Response to combined stress** Type B parameters*	
		Disease severity	Reproduction factor (Rf)
Sardari	<i>Heterodera filipjevi</i> (4000 eggs/ plant)	0.4	4
	<i>Fusarium culmorum</i> (1.4g /100g soil)	2.7	N/A
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Fusarium culmorum</i> (1.4 g /100g soil) Simultaneous stress	2.7	3.3
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Fusarium culmorum</i> (1.4 g /100g soil) 1 month later (Sequential stress)	2.9	3.1
	<i>Fusarium culmorum</i> (1.4g/ 100g soil) + <i>Heterodera filipjevi</i> (4000 eggs/ plant) 1 month later (Sequential stress)	2.8	2.6

Bakkras-Roshan	<i>Heterodera filipjevi</i> (4000 eggs/ plant)	0.2	3.6
	<i>Bipolaris sorokiniana</i> (1.4g /100g soil)	2	N/A
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Bipolaris sorokiniana</i> (1.4 g /100g soil) Simultaneous stress	1.5	2.4
	<i>Heterodera filipjevi</i> (4000 eggs/ plant) + <i>Bipolaris sorokiniana</i> (1.4 g /100g soil) 1 month later (Sequential stress)	1.8	2.9
	<i>Fusarium culmorum</i> (1.4g/ 100g soil) + <i>Bipolaris sorokiniana</i> (4000 eggs/ plant) 1 month later (Sequential stress)	1.8	2.3

For raw data – Click here (.xlsx file)

Reference - Hajihassani A, Maafi ZT, Hosseinijad A (2013) Interactions between *Heterodera filipjevi* and *Fusarium culmorum*, and between *H. filipjevi* and *Bipolaris sorokiniana* in winter wheat. *Journal of Plant Diseases and Protection* 120 (2): 77–84

Note:

‘***’ - Values are presented as it is from the source article without subjecting to the calculation.

‘*’ - For more information on parameter classification, please refer to the ‘methodology’ tab.

Inference From the study: Hajihassani A et. al. 2013 studied interaction of *Heterodera filipjevi* and *Fusarium culmorum* in two wheat cultivar Sardari and Bakkras-Roshan. Pathogens were inoculated singly, sequentially, and simultaneously. Plants were then analyzed for their plant height, shoot dry weight, root dry weight, and grain yield. An additive reduction in all growth parameters was observed under combined stress treatment. However, this reduction was more in cultivar sardari compared to Bakkras-Roshan. Nematode reproduction factor decreased under combined stress, whereas disease index increased under combined stress. Disease severity was also high in cultivar sardari. **Thus, this pathogen combination work synergistically to reduce plant growth and forms a severe disease complex in wheat cultivar sardari. Cultivar Bakkras-Roshan is tolerant of this pathogen combination.**