Effect on cowpea cultivars (*Vigna unguiculata cv. S-488, Co-4, IC-503, IC244, EC-4213A, RC-8*)

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

Crop: Cowpea (*Vigna unguiculata* cv. S-488, Co-4, IC-503, IC244, EC-4213A, RC-8)
Stress 1: *Meloidogyne incognita, Rotylenchulus reniformis*
Stress 2: *Rhizoctonia solani*
Stage of plant: 1 week Seedling

The table shows the impact of nematode and fungus alone and in combination on shoot and root dry weight and number of nodules/root system of cowpea cultivars.

	Treatment	Plant response to stress (reduction over control %) Type A parameters*	
		Shoot + root dry weight	No. of nodules/ root system
S-488	*Rotylenchulus reniformis (1000 nematode/plant)*	4.8 ↓	5.6 ↓
	Rhizoctonia solani (1g/plant)	41.9 ↓	41.7 ↓
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	50.0 ↓	47.2 ↓
CO-4	*Rotylenchulus reniformis (1000 nematode/plant)*	26.5 ↓	22.7 ↓
	Meloidogyne incognita (1000 nematode/plant)	21.4 ↓	19.3 ↓
	Rhizoctonia solani (1g/plant)	0.0	4.5 ↓
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	29.6 ↓	28.4 ↓
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	44.9 ↓	48.9 ↓
IC-503	*Meloidogyne incognita (1000 nematode/plant)*	4.4 ↓	1.3 ↓
	Rhizoctonia solani (1g/plant)	43.3 ↓	31.2 ↓

	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	46.7 ↓	37.7 ↓
IC-244	*Rotylenchulus reniformis (1000 nematode/plant)*	35.2 ↓	28.6 ↓
	Meloidogyne incognita (1000 nematode/plant)	31.0 ↓	19.0 ↓
	Rhizoctonia solani (1g/plant)	8.5 ↓	4.8 ↓
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	49.3 ↓	50.0 ↓
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	54.9 ↓	52.4 ↓
EC-4213A	*Rotylenchulus reniformis (1000 nematode/plant)*	8.6 ↓	1.9 ↓
	Meloidogyne incognita (1000 nematode/plant)	34.3 ↓	32.1 ↓
	Rhizoctonia solani (1g/plant)	7.1 ↓	5.7 ↓
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	21.4 ↓	17.9 ↓
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	50.0 ↓	58.5 ↓
RC-8	*Rotylenchulus reniformis (1000 nematode/plant)*	8.4 ↓	4.3 ↓
	Meloidogyne incognita (1000 nematode/plant)	28.9 ↓	26.1 ↓
	Rhizoctonia solani (1g/plant)	8.4 ↓	7.2 ↓
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	28.9 ↓	31.9 ↓
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	49.4 ↓	55.1 ↓

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 population, reproduction factor and root-knot index under combined stress treatment

		Response to combined stress Type B parameters***				
		R. reniformis		***M. incognita***		**Root-knot index**
	Treatment	**Juvenile/kg soil**	**Reproduction factor R=Pf/Pi**	**Juvenile/kg soil**	**Reproduction factor R=Pf/Pi**	
S-488	*Rotylenchulus reniformis (1000 nematode/plant)*	533	0.6	N/A	N/A	N/A
	Rhizoctonia solani (1g/plant)	N/A	N/A	N/A	N/A	N/A
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	833	0.9	N/A	N/A	N/A
CO-4	*Rotylenchulus reniformis (1000 nematode/plant)*	11400	11.6	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant)	N/A	N/A	8200	8.4	1.8
	Rhizoctonia solani (1g/plant)	N/A	N/A	N/A	N/A	N/A
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant)	10067	10.3	N/A	N/A	N/A

	(Simultaneous stress)					
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant)	N/A	N/A	9533	9.7	2
IC-503	*Meloidogyne incognita (1000 nematode/plant)*	N/A	N/A	2000	2.1	0.5
	Rhizoctonia solani (1g/plant)	N/A	N/A	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	N/A	N/A	833	0.9	0.4
IC-244	*Rotylenchulus reniformis (1000 nematode/plant)*	13633	13.8	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant)	N/A	N/A	12733	13	3.4
	Rhizoctonia solani (1g/plant)	N/A	N/A	N/A	N/A	N/A
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	10933	11.2	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	N/A	N/A	11867	12.1	3
EC-4213A	*Rotylenchulus reniformis (1000 nematode/plant)*	1800	1.9	N/A	N/A	N/A
	Meloidogyne incognita (1000	N/A	N/A	16500	16.8	4

	nematode/plant)					
	Rhizoctonia solani (1g/plant)	N/A	N/A	N/A	N/A	N/A
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	2600	2.7	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	N/A	N/A	12000	12.3	3.2
RC-8	*Rotylenchulus reniformis (1000 nematode/plant)*	3533	3.7	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant)	N/A	N/A	14933	15.2	3.6
	Rhizoctonia solani (1g/plant)	N/A	N/A	N/A	N/A	N/A
	Rotylenchulus reniformis (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	5033	5.2	N/A	N/A	N/A
	Meloidogyne incognita (1000 nematode/plant) + Rhizoctonia solani (1g/plant) (Simultaneous stress)	N/A	N/A	11200	11.4	3.5

Root-knot index (0 = no galling; 1 = 1-25 galls/plant; 2 =26-50; 3 = 51-75; 4 = 76-100; 5 = more than 100)

For raw data – Click here (.xlsx file)

Reference - Khan TA, Husain SI (1989) Relative resistance of six cowpea cultivars as affected by the concomitance of two nematodes and a fungus. Nematol. medit. 17: 39-41

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.*

Inference From the study: Khan TA 1989 studied interaction of *Rotylenchulus reniformis, Meloidogyne incognita,* and *Rhizoctonia solani* in six cowpea cultivars S-488, Co-4, IC-503, IC244, EC-4213A, RC-8. Pathogens were inoculated singly and simultaneously. Plants were then analyzed for their shoot and root weight and the number of nodules/root system. Simultaneous inoculation resulted in a synergistic reduction of shoot and root weight and also the number of nodules. Nematode population and reproduction factor were increased under simultaneous inoculation for nematode *Rotylenchulus reniformis* for cultivar S-488, EC-4213A, and RC-8. Still, for *Meloidogyne incognita* the nematode population was decreased under combined stress for all the cultivars. Root-knot index reduced under combined stress treatment compared to single *Meloidogyne incognita* inoculation. **Thus, all cowpea cultivars showed synergistically reduced growth parameters, under simultaneous combined stress treatment for both nematode species, but did not show an additive root-knot severity.**