



## Effect on alfalfa cultivars (*Medicago sativa* cv. Apollo, Agate, Saranac)

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

Crop: Alfalfa (*Medicago sativa* cv. Apollo, Agate, Saranac)  
 Stress 1: *Meloidogyne hapla*  
 Stress 2: *Phytophthora megasperma* f.sp. *medicaginis*  
 Stage of plant: 28 day old seedling

The table shows the impact of nematode and oomycete alone and in combination on plant height, top weight, and root weight of alfalfa plants.

	Treatment	Plant response to stress (reduction over control %)		
		Type A parameters*		
		Plant height	Top weight	Root weight
Apollo	<i>Phytophthora megasperma</i> (50 ml/pot)	4.1 ↓	14.7 ↓	14.9 ↓
	<i>Meloidogyne hapla</i> (20000 eggs/pot)	5.5 ↓	10.7 ↓	-8.0 ↑
	<i>Meloidogyne incognita</i> (20000 eggs/pot)	8.2 ↓	27.2 ↓	29.4 ↓
	<i>Meloidogyne hapla</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	19.2 ↓	65.1 ↓	43.9 ↓
	<i>Meloidogyne incognita</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	-1.4 ↑	33.1 ↓	14.9 ↓
Agate	<i>Phytophthora megasperma</i> (50 ml/pot)	15.4 ↓	28.1 ↓	29.1 ↓
	<i>Meloidogyne hapla</i> (20000 eggs/pot)	23.1 ↓	15.8 ↓	-2.5 ↑

	<i>Meloidogyne incognita</i> (20000 eggs/pot)	16.7 ↓	15 ↓	25.3 ↓
	<i>Meloidogyne hapla</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	24.4 ↓	42.7 ↓	1.8 ↓
	<i>Meloidogyne incognita</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	14.1 ↓	15 ↓	20.4 ↓
Saranac	<i>Phytophthora megasperma</i> (50 ml/pot)	11.3 ↓	54 ↓	44.7 ↓
	<i>Meloidogyne hapla</i> (20000 eggs/pot)	11.3 ↓	13.5 ↓	3.4 ↓
	<i>Meloidogyne incognita</i> (20000 eggs/pot)	2.5 ↓	13.5 ↓	4.4 ↓
	<i>Meloidogyne hapla</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	18.8 ↓	60.9 ↓	50.8 ↓
	<i>Meloidogyne incognita</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	12.5 ↓	49.8 ↓	40.7 ↓

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

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

- 1) '↓'- indicates plant parameters affected by stress that lead to high susceptibility (higher the value more the damage).
- 2) '↑' - indicates plant parameters less/not affected by stress leading to improved resistance (higher the value lesser the damage).

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

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

The table shows the effect of the oomycete pathogen on nematode larvae, eggs and root-knot galling and effect of nematode on oomycete induced tap root necrosis and foliage chlorosis under combined stress treatment

	Treatment	Response to combined stress**				
		Type B parameters*				
		Taproot necrosis	Foliage Chlorosis	Root-knot galling	No. of Nematode larvae	No. of Nematode eggs
Apollo	<i>Phytophthora megasperma</i> (50 ml/pot)	3	3.5	0	0	0
	<i>Meloidogyne hapla</i> (20000 eggs/pot)	2	3.3	41.7	62	2860
	<i>Meloidogyne incognita</i> (20000 eggs/pot)	2	3.7	13.3	173	490
	<i>Meloidogyne hapla</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	4.2	1.8	28.3	17	199
	<i>Meloidogyne incognita</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	3.7	2.5	11.7	192	27
Agate	<i>Phytophthora megasperma</i> (50 ml/pot)	2.3	3.7	3.3	0	0
	<i>Meloidogyne hapla</i> (20000 eggs/pot)	1.7	3.8	43.3	57	19996
	<i>Meloidogyne incognita</i> (20000 eggs/pot)	1.2	4.2	11.7	63	1191
	<i>Meloidogyne hapla</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	4	3	35	40	1107

	<i>Meloidogyne incognita</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	3.2	3.7	15	137	2009
Saranac	<i>Phytophthora megasperma</i> (50 ml/pot)	4.2	2.3	1.7	0	0
	<i>Meloidogyne hapla</i> (20000 eggs/pot)	2	3.3	40	67	1302
	<i>Meloidogyne incognita</i> (20000 eggs/pot)	1.2	4.2	11.7	122	2186
	<i>Meloidogyne hapla</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	4.5	2	28.3	92	330
	<i>Meloidogyne incognita</i> (20000 eggs/pot) + <i>Phytophthora megasperma</i> (50ml/pot) 42 days later (Sequential stress)	3.7	2.8	13.3	158	44

For raw data – Click here (.xlsx file)

Reference - Welty RE, Barker KR, Lindsey DL (1980) Effects of *Meloidogyne hapla* and *M.incognita* on *Phytophthora* root rot of alfalfa. Plant Disease 64:1097-1099

**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:** Welty RE (1980) studied the interaction of nematodes *Meloidogyne hapla*, *Meloidogyne incognita* with *Phytophthora megasperma* in three alfalfa cultivars Apollo, Agate, Saranac. Pathogens were inoculated singly and sequentially. Plants were then analyzed for their plant height, top weight, and root weight. All growth parameters showed an additive reduction under combined stress conditions. However, combined stress with *Meloidogyne incognita* resulted in lesser reduction values. Cultivar Apollo and Agate were more susceptible to this pathogen combination and showed higher reduction values. Taproot necrosis was high in combined stress with *Meloidogyne hapla*, whereas foliage necrosis was high with *Meloidogyne incognita*. Nematode population larvae, eggs, and root galling were reduced under combined stress treatment. **Thus, this pathogen combination acts synergistically to reduce plant growth and forms a complex disease phenotype in all alfalfa cultivars.**