REACTION OF NINE *VICIA* SPECIES TO *MELOIDOGYNE ARENARIA* RACE 2 AND *HETERODERA GLYCINES* RACE 4

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ABSTRACT

Mosjidis, J. A., R. Rodríguez-Kábana, C. F. Weaver, and P. S. King. 1994. Reaction of nine *Vicia* species to *Meloidogyne arenaria* race 2 and *Heterodera glycines* race 4. Nematropica 24:1–5.

Twenty three accessions of *Vicia* spp., including *V. articulata* Hornem., *V.benghalensis* L., *V. ervilia* (L.) Willd., *V. lutea* L., *V. narbonensis* L., *V. pannonica* Crantz., *V. peregrina* L., *V. sativa* L., and *V. villosa* Roth, were evaluated for resistance to *Meloidogyne arenaria* race 2 and *Heterodera glycines* race 4 in an 8-week greenhouse experiment. *Vicia ervilia* PI 203145, *V. lutea* PI 201994, and all accessions of *V. sativa* were immune to *M. arenaria* race 2 and *H. glycines* race 4. One accession of *V. villosa*, PI 206493, was infected and galled by *M. arenaria* but supported no nematode reproduction. This is the first time that this level of resistance to *M. arenaria* has been reported in a *Vicia* species.

Key words: Heterodera glycines, Meloidogyne arenaria, resistance, root-knot nematode, soybean cyst nematode, *Vicia articulata, Vicia benghalensis, Vicia ervilia, Vicia lutea, Vicia narbonensis, Vicia pannonica, Vicia peregrina, Vicia sativa, Vicia villosa.*

RESUMEN

Mosjidis, J. A., R. Rodríguez-Kábana, C. F. Weaver, y P. S. King. 1994. Reacción de nueve especies de *Vicia* frente a *Meloidogyne arenaria* y *Heterodera glycines*. Nematrópica 24:1–5.

Veintitres adquisiciones de germoplasma de *Vicia* spp., incluyendo, *V. articulata* Hornem., *V. benghalensis* L., *V. ervilia* (L.) Willd., *V. lutea* L., *V. narbonensis* L., *V. pannonica* Crantz., *V. peregrina* L., *V. sativa* L. y *V. villosa* Roth, se evaluaron en invernadero para determinar su resistencia a *Meloidogyne arenaria* y *Heterodera glycines*. *Vicia ervilia* PI 203145, *V. lutea* PI 201994 y todo el material genético de *V. sativa* fue inmune a la raza 2 de *M. arenaria* y a la raza 4 de *H. glycines*. *Vicia villosa* PI 206493, fue infectada y agallada por *M. arenaria* pero los nematodos no se reprodujeron. Esta es la primera vez que se encuentra este nivel de resistencia a *M. arenaria* en una especie de *Vicia*.

Palabras clave: Heterodera glycines, Meloidogyne arenaria, resistencia, nematodo agallador, nematodo del quiste de la soya, resistencia, *Vicia articulata, Vicia benghalensis, Vicia ervilia, Vicia lutea, Vicia narbonensis, Vicia pannonica, Vicia peregrina, Vicia sativa, Vicia villosa.*

INTRODUCTION

Renewed interest in cool-season annual forage legumes for use in conservation tillage systems (1,2) has led to a search in the U.S.A. for species which could also decrease the incidence of pests in the succeeding cash crop (5). Two of the more important pests in the southeastern region of the U.S.A. are the root-knot nematode *Meloidogyne arenaria* (Neal) Chitwood and the soybean cyst nematode (*Heterodera glycines* Ichinoe). Hairy vetch (*Vicia villosa* Roth) and common vetch (*Vicia sativa* L.) are widely accepted forage legumes that are resistant to *H. glycines* while some genotypes of common vetch are resistant to *M. arenaria* (5). The geographical regions in which common vetch can be grown are limited because of its susceptibility to freezing temperatures. Hairy vetch, however, is frost tolerant and is widely grown

throughout the U.S.A. (3). No cultivar of hairy vetch is commercially available. Other commercially unavailable *Vicia* species have also shown potential as cover or forage crops but have not been evaluated for nematode resistance (3). The objective of this study was to determine the reaction of accessions of nine *Vicia* species from 13 countries to *M. arenaria* race 2 and *H. glycines* race 4.

MATERIALS AND METHODS

An experiment that included 23 accessions of *V. articulata* Hornem., *V. benghalensis* L., *V. ervilia* (L.) Willd., *V. lutea* L., *V. narbonensis* L., *V. pannonica* Cranz., *V. peregrina* L., *V. sativa* L., and *V. villosa* Roth (Table 1) was established in the greenhouse. Soil for the experiment was a sandy loam (pH 6.2; organic matter content < 1.0%; cation exchange capacity < 10 meq/100 g soil) from a field planted to soybean [*Glycine max* (L.) Merr.] and infested with *M. arenaria* race 2 and *H. glycines* race 4. The soil was sieved (< 1 mm) and mixed 1:1 (v:v) with fine (< 0.1 mm) siliceous river sand. The mixture (referred to as soil) was apportioned in 1-kg amounts and placed in cylindrical 10-cm-diam,1-L capacity plastic pots. The pots were placed on greenhouse benches and planted with five seeds per pot. 'Davis' soybean and 'Crookneck' squash were included as susceptible controls for *H. glycines* (soybean) and *M. arenaria* (soybean and squash).Initial population densities of nematodes were determined by extracting nematodes with the salad bowl incubation method (6) from eight 100-cm^3 soil samples. The average-numbers of juveniles present were 55 and 12 per 100 cm^3 soil for *M. arenaria* and *H. glycines*, respectively.

Plants were allowed to grow for 8 weeks when they were removed from the pots, and the roots were washed free of soil.

Table 1. Accessions of *Vicia* Species tested

Accession	Origin
V. articulata	
PI 206390	Cyprus
PI 220879	Belgium
PI 449362	Ecuador
V. benghalensis	
PI 298001	Australia
PI 298003	Australia
PI 449330	Chile
V. ervilia	
PI 203145	Jordan
PI 252053	Turkey
PI 426021	Afghanistan
V. lutea	
PI 201994	Turkey
PI 249880	Crete
PI 250797	Afghanistan
V. narbonensis	
PI 206927	Turkey
PI 294301	Israel
V. pannonica	
PI 220877	Belgium
PI 220888	Belgium
V. peregrina	
PI 234766	Spain
V. sativa	
PI 284563	Germany
Cahaba White	U.S.A.
Warrior	U.S.A.
V. villosa	
PI 201883	Iran
PI 206493	Turkey
PI 222217	Afghanistan

Root galls caused by *M. arenaria* were counted and the degree of galling was assessed using Zeck's scale (7), where 0 represents no galls and 10 represents maximal galling. The general appearance of roots was rated using a subjective scale from 1–5 where 1 represented the best root system and 5 represented the worst. The fresh weights of roots and of shoots

were recorded. Nematodes were then extracted separately from roots and from soil by the salad bowl incubation method (6).

The experiment consisted of eight replications (pots) per treatment arranged in a completely randomized design. All data were analyzed following standard procedures for analysis of variance (4). Fisher's least significant differences were calculated when F values were significant ($P \leq 0.05$). Unless otherwise stated all differences referred to in the text were significant at the 5% or lower level of probability.

RESULTS AND DISCUSSION

Responses to Meloidogyne arenaria: Large differences in reaction to *M. arenaria* were found among the entries (Table 2). All *V. sativa* accessions were resistant to *M. arenaria*. *Vicia articulata* PI 220879 and *V. lutea* PI 201994 also had high levels of resistance. Their roots had no galls and no second-stage juveniles (J2) were recovered from roots. *Vicia benghalensis* PI 298001, *V. ervilia* PI 203145, *V. lutea* PI 250797, *V. peregrina* PI 234766, and *V. villosa* PI 206493 had gall ratings between 2.0 and 7.1; however, no J2 were recovered from roots (Table 2), and no J2 were recovered from soil where they were grown with the exception of *V. peregrina* PI 234766, where only two J2/100 cm^3 were detected (Table 3). *Vicia articulata* PI 449362, *V. benghalensis* PI 298003 and PI 449330, *V. lutea* PI 249880, and *V. narbonensis* PI 294301 had gall ratings between 0.4 and 6.3, and the number of J2 per pot from roots was not statistically different from zero (Table 2). The number of J2 recovered from the soil from these accessions was also not significantly different from zero, with the exception of *V. lutea* PI 249880 (Table 3). *Vicia pannonica* accessions showed no resistance to *M. arenaria* (Table 2).

Responses to Heterodera glycines: Davis soybean was the only entry to develop cysts when infected with *H. glycines* (Table 2). All *Vicia* accessions had a significantly lower number of juveniles of soybean cyst nematode in roots than Davis soybean. No J2 were found in the roots of *V. ervilia* PI 203145 or in *V. lutea* PI 201994, PI 249880, and PI 250797. In the following accessions, J2 were recovered from roots but the numbers were very low and were not significantly different from zero: All accessions of *V. benghalensis, V. pannonica, V. peregrina,* and *V. sativa*; accessions PI 220879 and PI 449362 of *V. articulata*; *V. narbonensis* PI 294301; and the *V. ervilia* accessions PI 252053 and PI 426021. Significant numbers of J2 were recovered from roots of the soybean check, as well as *V. articulata* PI 206390, *V. benghalensis* PI 298001, *V. narbonensis* PI 206927, and all *V. villosa* accessions (Table 2). Although *H. glycines* J2 were found in the soil where each of the accessions were grown, the values were not significantly different from zero. The soybean control had 20–100 times more *H. glycines* J2 in the soil than all other entries (Table 3).

In summary, *V. ervilia* PI 203145, *V. lutea* PI 201994, and all accessions of *V. sativa* were immune to *M. arenaria* race 2 and *H. glycines* race 4. The *V. villosa* PI 206493, although infected and galled, did not support reproduction of *M. arenaria*. This is the first report of this level of resistance in *V. villosa* cultivars which are widely adapted and well known to farmers in the U.S.A. Preliminary field observations have shown that PI 206493 has good agronomic characteristics (Mosjidis and Zhang, personal communication). Further field testing will be conducted to confirm the potential of PI 206493 as a cover and forage crop. The other *Vicia* species that tested immune to *M. arenaria* and *H. glycines* also should be evaluated under field conditions.

Table 2. Parameters of resistance to *Meloidogyne arenaria* race 2 and *Heterodera glycines* race 4 measured for nine *Vicia* species, 'Crookneck' squash, and 'Davis' soybean (experimental controls) in an 8-week greenhouse pot experiment.

	Overall plant growth			*M. arenaria*			*H. glycines*	
Entry	Shoot weight (g)	Root weight (g)	Root condition (1–5)[x]	Gall rating (0–10)[y]	Galls per pot	Juveniles per pot[z]	Cysts per pot	Juveniles per pot
Crookneck Squash	2.19[z]	0.22	4.0	6.1	244	40	0	0
Davis Soybean	1.28	0.76	3.0	2.1	11	16	15	452
V. articulata								
PI 206390	0.29	0.22	4.7	6.3	128	69	0	98
PI 220879	0.32	0.13	2.0	0.0	0	1	0	3
PI 449362	0.22	0.15	4.3	4.5	120	2	0	20
V. benghalensis								
PI 298001	0.24	0.18	4.5	7.1	191	0	0	42
PI 298003	0.29	0.16	3.3	0.6	13	17	0	8
PI 449330	0.35	0.22	2.4	0.4	5	11	0	26
V. ervilia								
PI 203145	0.17	0.06	3.5	0.5	25	0	0	0
PI 252053	0.31	0.15	4.2	4.3	143	323	0	22
PI 426021	0.20	0.13	5.0	6.4	235	329	0	6
V. lutea								
PI 201994	0.17	0.07	3.0	0.0	0	0	0	0
PI 249880	0.16	0.03	3.7	2.2	149	0	0	0
PI 250797	0.27	0.10	3.5	2.0	40	0	0	0
V. narbonensis								
PI 206927	1.18	0.26	4.6	4.9	83	266	0	50
PI 294301	0.91	0.30	4.8	6.3	107	1	0	5
V. pannonica								
PI 220887	0.35	0.27	4.5	7.4	179	123	0	5
PI 220880	0.43	0.25	4.2	6.3	156	67	0	28
V. peregrina								
PI 234766	0.35	0.11	2.5	2.3	61	0	0	2
V. sativa								
PI 284563	0.25	0.08	2.2	0.0	0	10	0	3
Cahaba White	0.26	0.12	1.8	0.0	0	0	0	11
Warrior	0.36	0.23	1.8	0.2	3	0	0	4
V. villosa								
PI 201883	0.27	0.23	4.4	6.6	157	136	0	98
PI 206493	0.32	0.24	4.6	6.4	134	0	0	41
PI 222217	0.30	0.25	4.2	5.3	113	41	0	126
LSD (0.05)	0.11	0.06	0.6	1.4	52	65	0	38
LSD (0.01)	0.14	0.09	0.8	1.9	69	86	0	50

[x] Root condition scale: 1 = best, 5 = worst.
[y] Gall rating scale: 0 = no galls, 10 = maximum galling.
[z] Five plants per pot.

Table 3. Number of *Meloidogyne arenaria* race 2 and *Heterodera glycines* race 4 per 100 cm^3 of soil after 8 weeks in greenhouse pots planted to 23 accessions of nine *Vicia* species, 'Crookneck' squash and 'Davis' soybean (experimental controls).

Entry	*M. arenaria* juveniles	*H. glycines* juveniles	Entry	*M. arenaria* juveniles	*H. glycines* juveniles
'Crookneck' squash	14.8	64.2	*V. narbonensis*		
'Davis' soybean	0.0	1188.8	PI 206927	6.2	41.2
V. articulata			PI 294301	1.3	11.7
PI 206390	3.0	40.0	*V. pannonica*		
PI 220879	12.0	66.3	PI 220877	2.2	42.3
PI 449362	1.7	50.0	PI 220888	4.3	23.2
V. benghalensis			*V. peregrina*		
PI 298001	0.0	16.0	PI 234766	1.7	23.8
PI298003	1.0	10.5	*V. sativa*		
PI 449330	0.8	10.0	PI 284563	1.8	25.0
V. ervilia			Cahaba White	0.3	53.8
PI 203145	0.0	11.0	Warrior	2.8	54.0
PI 252053	19.8	26.0	*V. villosa*		
PI 426021	21.2	33.0	PI 201883	3.0	62.8
V. lutea			PI 206493	0.0	29.8
PI 201994	3.0	34.0	PI 222217	1.5	60.0
PI 249880	10.0	43.0	LSD ($P \leq 0.05$)	8.4	80.4
PI 250797	0.0	28.0	LSD ($P \leq 0.01$)	11.1	106.3

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