REACTION OF CAULIFLOWER CULTIVARS TO *MELOIDOGYNE JAVANICA* AND RACES OF *MELOIDOGYNE INCOGNITA*

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ABSTRACT

Khan, A. A., and M. W. Khan. 1991. Reaction of cauliflower cultivars to *Meloidogyne javanica* and races of *Meloidogyne incognita*. Nematropica 21:161–166.

Thirty-seven cultivars of cauliflower (*Brassica oleracea*) were evaluated for resistance to *Meloidogyne javanica* and to the four races of *M. incognita* in greenhouse pots. Most cultivars were susceptible to both species but some showed race-specific or species-specific resistance. Three cultivars were resistant to race 1, five were resistant to race 2, two were resistant to race 3, and three were resistant to race 4 of *M. incognita*. 'Pusa Snow Ball' and '74–6C' were tolerant to *M. incognita* race 4. Cauliflower cv. 74–6C was resistant and cv. Superial Maghi was immune to *M. javanica*. A single cultivar, Dania, was immune to *M. javanica* and to all races of *M. incognita*.

Key words: Brassica oleracea, cauliflower, immunity, *Meloidogyne incognita, M. javanica,* resistance, root-knot nematode.

RESUMEN

Khan, A. A. y M. W. Khan. 1991. Reacción de cultivares de coliflor a *Meloidogyne javanica* y razas de *M. incognita*. Nematrópica 21:161–166.

Se evaluaron la reacción de 37 cultivares de coliflor contra *Meloidogyne javanica* y las cuatro razas de *M. incognita*. La majoriá de cultivares fueron susceptibles a ambas especies. Sin embargo, algunos cultivares mostraron resistencia condicionada a la raza o la especie. Tres cultivares fueron resistentes a la raza 1, cinco fueron resistentes a la raza 2, dos fueron resistentes a la raza 3 y tres fueron resistentes a la raza 4 de *M. incognita*. 'Pusa Snow Ball' y '74–6C' resultaron tolerantes a la raza 4. El cultivar 74–6C fue resistente y el cultivar Superial Maghi inmune a *M. javanica*. Sólo un cultivar, Dania, resultó inmune a las dos especies de nematodos.

Palabras clave: Brassica oleracea, coliflor, inmunidad, *Meloidogyne incognita, M. javanica,* nematodo agallador, resistencia.

INTRODUCTION

Since nematicides are expensive and potentially hazardous to human health, alternative measures are being explored for management of root–knot nematodes. The most economical and effective method of nematode management is the cultivation of resistant cultivars. However, the extensive host range of the major species of root–knot nematodes, *Meloidogyne incognita* (Kofoid & White) Chitwood, *M. javanica* (Treub) Chitwood, *M. arenaria* (Neal) Chitwood, and *M. hapla* Chitwood, combined with their occurrence in mixed populations in agricultural soils and the existence of races in some species (7,10), limit the use of resistance.

Few vegetable cultivars have shown resistance to the major species of root–knot nematodes, and cultivars that are resistant may only have race-specific resistance (1). Therefore, in recent years re-evaluation of vegetable cultivars for nematode resistance has become necessary. Cauliflower (*Brassica oleracea* L. var.

botrytis) is grown in many areas of India. In this paper, we report the host suitability of cultivars of cauliflower grown in India to *M. javanica* and to the four host races of *M. incognita*, all of which infest Indian vegetable fields (3,5).

MATERIALS AND METHODS

Cultures of *M. javanica* and the four host races of *M. incognita* were started with single egg masses and maintained in a glasshouse on roots of susceptible tomato (*Lycopersicon esculentum*) cv. Pusa Ruby (9). Seedlings of 37 cauliflower cultivars were raised in pots filled with autoclaved soil. Twenty-day-old seedlings were transplanted to individual 20-cm-diam pots (one seedling per pot) and were inoculated, 5 days after transplanting, with 5 000 freshly hatched second-stage juveniles (J2) per pot for each test nematode. Pots were arranged in randomized complete blocks with three replicates for each cultivar. Plants of tomato cv. Pusa Ruby were inoculated simultaneously as a control for determining the time of termination. Plants were grown in a glasshouse at 22–30 C for 60 days. Then, plants of each cauliflower cultivar were removed from pots and washed under running tap water to remove soil particles from roots. A gall index (GI) was rated on a 0–5 scale (9). Roots were chopped, and then macerated in a Waring blender in 1% NaOCl to extract eggs. Eggs were stained by adding a few drops of acid fuchsin-acetic acid solution, and the eggs from each plant were counted. The reproduction factor (R = Pf/Pi) was calculated for each root system, where Pf was the final population of eggs recovered and Pi was the initial population of 5 000 J2 (2).

Based on GI and R, the host suitability of each cultivar (degree of resistance) was designated according to the scheme of Canto-Sáenz (8). According to this scheme, cultivars with $R > 1$ and $GI > 2$, which are designated as susceptible, are efficient hosts and significant damage may occur. Cultivars with $R \leq 1$ and $GI > 2$, designated as hypersusceptible, are poor hosts yet significant damage may occur. Cultivars with $R > 1$ and $GI \leq 2$ are termed tolerant and minimal damage is expected even though the host is efficient and allows nematode reproduction. Cultivars with $R \leq$ and $GI \leq 2$ are designated as resistant; they are poor hosts with minimal galling. Plants with no nematode reproduction ($R = 0$) and no root galling ($GI = 0$) were categorized as immune. The standard deviation was calculated about the mean GI and R value for each cultivar × nematode combination.

RESULTS AND DISCUSSION

Ten of the 37 cultivars of cauliflower responded similarly to *M. javanica* and the four races of *M. incognita*. Eight were susceptible, one was hypersusceptible, and one (Dania) was immune to all nematodes tested (Table 1). The remaining 27 cultivars exhibited differential reactions. Three were resistant, 12 were hypersusceptible, and 12 were susceptible to *M. incognita* race 1. Five cultivars were resistant, 10 were hypersusceptible, and 12 were susceptible to *M. incognita* race 2. Two cultivars were resistant, nine were hypersusceptible, and 16 were susceptible to *M. incognita* race 3. When challenged by *M. incognita* race 4, three cultivars were resistant, two were tolerant, seven

were hypersusceptible, and 15 were susceptible. One cultivar (Superial Maghi) was immune, one (74–6C) was resistant, nine were susceptible, and 16 were hypersusceptible to *M. javanica* (Table 1).

Species-specific resistance was found in Superial Maghi, which was immune to *M. javanica* and susceptible to all races of *M. incognita*. Several race-specific responses to *M. incognita* were observed. 'Pusa Late' and 74–6C were resistant only to race 1. 'Pusa Snow Ball' was resistant to races 1 and 2. 'Massuria Snow Ball', 'Balwan Snow Ball', 'Indian Snow Ball', and 'Katki' were resistant only to race 2. 'Sutton's Pusi' was resistant to race 3. 'American White King' ('Vilayati') and 'Early Market' were resistant to race 4, but susceptible to races 1, 2, and 3.

These results are based on evaluations of three replications in greenhouse pots. Sources of resistance or immunity to *M. javanica* and *M. incognita* detected in this study must be confirmed with more replications and under field conditions. At this point, however, results with cauliflower are encouraging. By comparison, we previously found a general lack of resistance to *Meloidogyne* spp. in Indian cultivars of okra (*Hisbiscus esculentus*) and cucumber (*Cucumis sativas*). The 13 cauliflower cultivars identified to have race-specific resistance to *M. incognita* could be grown in infested fields, provided the race composition of the fields is known (5) and the cultivar is resistant to the races present. The same strategy could be used with the cultivars 74–6C and Superial Maghi, which were resistant and immune, respectively, to *M. javanica*. Since Dania was immune to all races of both species, it could be grown in most fields infested with root–knot nematodes. The resistant and immune cultivars, in addition, could be used as germplasm sources to develop new cultivars that combine desirable agronomic characters with multiple resistance against the races and species of root–knot nematodes that occur in India.

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Table 1. Host suitability of 37 cultivars of cauliflower to *Meloidogyne javanica* and races 1–4 of *Meloidogyne incognita*.

	M. incognita												*M. javanica*		
	Race 1			Race 2			Race 3			Race 4					
Cultivar	GI[x]	RF[y]	DR[z]	GI	RF	DR	GI	RF	DR	GI	RF	DR	GI	RF	DR
235-S	3.0±0.0	0.96±0.20	H	4.3±0.6	3.69±0.23	S	2.6±0.6	0.86±0.04	H	2.6±0.6	2.56±0.60	S	4.3±0.6	3.66±1.00	S
74-6C	1.6±1.6	0.17±0.02	R	3.0±0.0	0.25±0.02	H	3.0±0.0	0.53±0.02	H	2.0±0.0	1.28±0.12	T	2.0±0.0	0.51±0.02	R
Pusa Snow Ball	2.0±0.0	0.48±0.08	R	1.6±1.0	0.00±0.00	R	3.3±0.6	1.21±0.02	S	2.0±0.0	1.86±0.04	T	3.0±0.0	0.39±0.01	H
Massuria Snow Ball	2.3±0.6	0.90±0.02	H	2.0±0.0	0.00±0.00	R	2.0±0.0	0.57±0.04	H	3.0±0.0	1.16±0.80	S	2.3±1.2	0.54±0.04	H
Balwan Snow Ball	3.0±0.0	0.65±0.04	H	2.0±0.0	0.20±0.01	R	3.0±1.0	1.46±0.60	S	3.0±1.0	0.00±0.00	H	2.6±0.8	0.36±0.04	H
Special Indian Snow Ball	3.0±0.0	1.18±0.06	S	2.6±0.6	0.34±0.02	H	3.0±1.0	1.66±0.80	S	4.0±0.0	2.12±0.10	S	3.6±0.6	0.90±0.06	H
Snow Ball No. 16	4.0±0.0	1.93±0.55	S	5.0±0.0	5.64±1.02	S	3.3±0.6	1.94±0.02	S	5.0±0.0	4.77±1.04	S	5.0±0.0	5.04±2.20	S
Super Snow Ball	3.3±0.6	1.00±0.20	H	3.3±0.6	1.26±0.06	S	5.0±0.0	4.69±1.20	S	4.3±0.6	3.93±1.02	S	3.3±0.6	1.06±0.06	S
Superial Maghi	5.0±0.0	5.46±0.19	S	5.0±0.0	6.00±1.04	S	4.0±0.0	3.06±0.72	S	4.0±0.0	2.95±0.30	S	0.0±0.0	0.00±0.00	I
Special Agahni Late	3.6±0.6	0.93±0.16	H	3.0±1.0	0.11±0.01	H	4.6±0.6	4.13±1.72	S	5.0±0.0	2.05±0.20	S	5.0±0.0	1.10±0.05	S
Special Parijat Pusa	4.3±0.6	1.40±0.60	S	4.0±0.0	1.57±0.15	S	5.0±0.0	5.33±0.40	S	5.0±0.0	4.00±1.72	S	4.6±0.6	0.97±0.06	H
Special Agahni Jaldbaz	5.0±0.0	4.74±1.77	S	5.0±0.0	3.20±0.50	S	4.3±0.6	3.12±0.50	S	4.6±0.6	3.13±0.16	S	3.6±0.6	1.12±0.06	S
Silver King	4.0±0.0	1.93±0.21	S	4.0±0.0	0.86±0.03	H	5.0±0.0	4.32±1.02	S	5.0±0.0	3.13±0.08	S	4.3±0.6	1.45±0.02	S
American White King (Vilayati)	3.0±0.0	0.82±0.04	H	3.0±0.0	0.42±0.02	H	3.0±0.0	0.66±0.04	H	2.0±0.0	0.13±0.01	R	2.3±0.6	0.46±0.01	H
Early of India	4.0±0.0	2.46±0.31	S	3.0±0.0	0.51±0.05	H	1.3±0.7	0.00±0.00	R	2.0±0.0	0.00±0.00	R	2.6±0.6	0.54±0.04	H
Kartiki Faizabadi Kalmi	4.3±0.6	2.44±0.12	S	3.6±0.6	0.90±0.02	H	4.0±0.0	1.88±0.06	S	5.0±0.0	4.16±0.80	S	3.3±0.6	0.98±0.12	H
Selected Special Maghi	4.6±0.6	5.74±0.60	S	3.3±0.6	1.00±0.02	H	4.0±0.0	0.53±0.02	H	4.0±0.0	0.86±0.02	H	4.3±0.6	0.44±0.02	H

Kuwari Special Kalmi Hajipur	5.0±0.0	3.32±0.76	S	5.0±0.0	2.20±0.92	S	4.0±0.0	1.57±0.10	S	3.6±0.6	0.00±0.00	H	3.3±0.6	0.83±0.08	H
Patna Early	5.0±0.0	3.80±0.20	S	5.0±0.0	2.80±0.20	S	5.0±0.0	4.70±0.24	S	5.0±0.0	3.60±0.80	S	5.0±0.0	3.45±0.72	S
114-S	4.0±0.0	2.25±0.82	S	4.3±0.6	1.80±0.16	S	5.0±0.0	7.73±2.30	S	5.0±0.0	7.00±1.60	S	4.3±0.6	1.52±0.25	S
236-S	5.0±0.0	0.30±0.08	H	3.3±0.6	0.90±0.50	H	4.0±0.0	0.14±0.02	H	5.0±0.0	4.26±1.20	S	3.6±0.6	0.72±0.09	H
Indian Snow Ball	4.0±0.0	0.28±0.02	H	0.6±1.0	0.00±0.00	R	3.0±0.0	0.00±0.00	H	4.0±0.0	0.50±0.04	H	3.3±0.6	0.80±0.08	H
Early Kuwari	5.0±0.0	6.17±0.94	S	4.6±0.6	2.30±0.32	S	4.3±0.6	2.46±0.35	S	4.6±0.6	5.28±2.02	S	4.6±0.6	2.26±1.72	S
Maghi	3.0±0.0	0.28±0.02	H	4.3±0.6	2.53±0.16	S	4.0±0.0	1.90±0.12	S	3.6±0.6	1.00±0.20	H	3.3±0.6	0.80±0.16	H
Agani	5.0±0.0	1.80±0.11	S	4.6±0.6	1.65±0.60	S	4.6±0.6	2.86±0.20	S	5.0±0.0	6.40±2.40	S	4.6±0.6	2.05±0.12	S
Katki	4.0±1.0	1.65±0.13	S	0.6±0.4	0.00±0.00	R	4.3±0.6	3.60±1.00	S	4.6±0.6	4.16±1.02	S	4.3±0.6	1.90±0.16	S
Snow Ball Elite	5.0±0.0	3.84±0.23	S	2.0±0.0	2.00±0.02	S	5.0±0.0	7.00±2.04	S	4.6±0.6	4.61±0.60	S	3.3±0.6	1.50±0.10	S
Dania	0.0±0.0	0.00±0.00	I	0.0±0.0	0.00±0.00	I	0.0±0.0	0.00±0.00	I	0.0±0.0	0.00±0.00	I	0.0±0.0	0.00±0.00	I
Pusa Late	2.0±0.0	0.33±0.01	R	3.6±0.6	0.85±0.08	H	3.3±0.6	0.60±0.06	H	4.0±0.0	1.00±0.08	H	2.6±0.6	0.31±0.02	H
Patna Mid Season	3.0±0.0	0.24±0.02	H	3.0±0.0	0.94±0.04	H	3.0±0.0	0.74±0.02	H	2.3±0.6	0.80±0.10	H	3.0±0.0	0.68±0.08	H
Late Snow Ball	3.0±0.0	0.84±0.08	H	3.0±0.0	1.05±0.18	S	4.0±0.0	1.64±0.10	S	2.6±0.6	1.20±0.12	S	3.3±0.6	1.85±0.20	S
Early Snow Ball	4.6±0.6	5.45±1.20	S	4.6±0.6	2.15±0.14	S	3.6±0.6	1.14±0.20	S	3.3±0.6	0.74±0.06	H	4.0±1.0	1.25±0.09	S
Early Market	3.0±0.0	0.20±0.02	H	4.3±0.6	2.76±0.16	S	4.0±0.0	2.53±0.08	S	2.0±0.0	0.48±0.02	R	3.6±0.6	0.91±0.04	H
351-4	4.6±0.6	3.00±0.12	S	4.0±0.0	1.79±0.10	S	4.0±0.0	0.80±0.06	H	5.0±0.0	4.61±0.25	S	4.0±1.0	1.94±0.18	S
Snow Ball	5.0±0.0	2.20±0.40	S	3.3±1.5	1.20±0.20	S	5.0±0.0	2.40±0.08	S	4.6±0.6	4.33±0.81	S	2.6±1.7	0.75±0.16	H
Sutton's Pusi	2.6±0.6	0.14±0.01	H	3.3±0.6	2.00±0.04	S	2.0±0.0	0.00±0.00	R	3.6±1.5	2.20±0.36	S	4.6±0.6	1.62±0.06	S
Sutton's Dania	4.6±0.6	2.60±0.19	S	4.3±0.6	2.58±0.20	S	4.0±0.0	2.17±0.22	S	4.3±0.6	2.93±0.08	S	3.3±1.5	1.25±0.08	S

Values are means of three replications ± standard deviation.

[x]GI = gall index.

[y]RF = reproduction factor.

[z]DR = degree of resistance where R = resistant (GI ≤ 2, R ≤ 1), T = tolerant (GI ≤ 2, R > 1), H = hypersusceptible (GI > 2, r ≤ 1), S = susceptible (GI > 2, R > 1), and I = Immune (GI = 0, R = 0).

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Received: *27.XII.1989*
Recibido:

Accepted for publication: *18.V.1991*
Aceptado para publicar: