

The relevance of races in *Ditylenchus dipsaci* (Kühn) Filipjev, the stem nematode

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Summary – A review of reports regarding the (non-) host status of seventeen plant species towards eight host-races of *Ditylenchus dipsaci*, the stem nematode, is presented. Much variation in host range was observed for the different host-races. The value of host ranges, host range tests and the designation of races is discussed. It is proposed to describe stem nematode populations with information about the place of origin and host plant, with the exception of tetraploid stem nematode populations. Future research on molecular and/or biochemical characterization could lead to a new strategy of designating intraspecific variation.

Résumé – Pertinence des races chez *Ditylenchus dipsaci* (Kühn) Filipjev, le nématode des tiges et des bulbes – Cet article passe en revue les signalisations concernant le statut de dix-sept plantes en tant qu'hôte ou non-hôte du nématode des tiges et des bulbes, *Ditylenchus dipsaci*. Une grande variabilité est notée dans la gamme d'hôtes des différentes races d'hôtes. La valeur de la gamme d'hôtes et les tests permettant de la définir, ainsi que la désignation des races sont discutés. Il est proposé de décrire les populations de *D. dipsaci* en précisant leur origine géographique et la plante hôte attaquée, à l'exception toutefois des races tétraploïdes. Dans le futur, une caractérisation moléculaire et (ou) biochimique pourrait conduire à une nouvelle approche pour la définition de ces variations intraspécifiques.

Key-words : *Ditylenchus dipsaci*, host range, race, review, stem nematode.

A cosmopolitan distribution, including extreme climatological areas (Viglierchio, 1971), and ability to parasitize some 500 plant species (Sturhan & Brzeski, 1991) have shown an almost unlimited adaptability of stem nematodes, *Ditylenchus dipsaci*, to various hosts and conditions. However, as early as 1888 Ritzema Bos noticed different host preferences for stem nematode populations of different origins. Ever since, discussion has continued regarding the extensive intraspecific variation in host range of *D. dipsaci*. Seinhorst (1957) believed that these host preferences were constant and distinguished eleven biological races with nine plant species. Over the years, however, considerable variation in host range of these biological – or host-races was noticed, while the number of recorded races increased to over 30 (Ladygina, 1982; Sturhan & Brzeski, 1991). The identification of races remained based on host range observations. Although the usefulness of designating races has regularly been questioned (Hesling, 1966 b; Sturhan, 1969, 1971; Viglierchio, 1971; Whitehead *et al.*, 1987; Dropkin, 1988; Sturhan & Brzeski, 1991), there has been no clear rejection of the race-concept for *D. dipsaci*.

This review surveys a selected number of reports with information regarding the (non-) host status of different crops for eight selected host-races. The reliability of host ranges and the usefulness of designating races is evaluated.

Results

In Table 1 seventeen plant species, i. e. lucerne, red clover, white clover, tulip, hyacinth, narcissus, onion, oat, rye, sugar beet, potato, corn, pea, *Phaseolus* bean, carrot, strawberry and teasel, are listed, that have been reported as either good, poor or non-host for eight host-races of *D. dipsaci*, i.e. lucerne-, red clover-, oat-, rye-, beet-, narcissus-, tulip-, and onion-race. Each letter stands for a different reference to the literature. Owing to a large variation in descriptions of (non-) hosts by the various authors' observations are subdivided into three groups : “ + ” stands for a good host, on which nematodes multiply moderately to well; “ ± ” stands for a poor host, on which nematodes multiply badly and “ – ” stands for a non-host, where nematodes may enter, but do not multiply at all. Most reports are of original observations, but some literature references are reviews. This might have caused double notations in some cases.

Much variation is shown for the observed host ranges of eight host-races. Observations on many plant species/host-race combinations are conflicting. Other reports, which were not added to Table 1, could supply more variation, like multiplication of the onion-race in tulip (Hesling, 1965) and of the red clover-race on rye (Kotthoff, 1950). For other races similar conflicting results have been observed (e.g. Whitehead *et al.*, 1987).

Table 1. Reported (non-) hosts of eight "host-races" of *Ditylenchus dipsaci*. (+ : good host, nematodes multiply well; ± : poor, host, nematodes multiply badly; - : non-host, nematodes don't multiply).

host plant	lucerne-race	red clover-race	oat-race	rye-race	host plant	lucerne-race	red clover-race	oat-race	rye-race
lucerne	+ **	•	•	M	lucerne	+ •	•	•	•
	± •	AKP	N	C		± ATV	•	A	•
	- •	BCE	ABDE	•		- BTV	AER	BE	ABHJLP
r. clover	+ •	**	•	•	r. clover	+ •	•	•	•
	± AEGK	•	AN	•		± V	AE	ADS	P
	- BCDP	•	BDE	ACM		- ABTV	DEFR	BEF	ABCHJLP
wh. clover	+ BK	K	•	•	wh. clover	+ T	•	•	B
	± •	K	EN	M		± •	•	•	•
	- BCDEGP	BCDEP	BD	C		- BT	ER	BE	BCHJLP
tulip	+ AE	•	AEN	•	tulip	+ •	E	**	•
	± •	•	•	•		± •	ARE	•	•
	- G	ACE	•	AC		- T	CF	•	ACHL
hyacinth	+ •	•	AN	•	hyacinth	+ •	•	ACDF	Q
	± •	•	E	•		± •	A	E	•
	- AEG	ACE	•	AC		- T	CEF	•	ACHL
narcissus	+ •	•	•	•	narcissus	+ •	**	ACDEF	Q
	± •	E	•	•		± •	•	•	A
	- AEG	AC	AE	AC		- T	•	•	CHL
onion	+ E	E	DEO	C	onion	+ TV	CDEFRP	CES	**
	± •	•	•	•		± T	•	DF	•
	- G	CP	•	•		- •	•	•	•
oat	+ A	•	**	ACM	oat	+ ATUV	P	A	BCP
	± •	E	•	•		± TV	AE	E	L
	- CEG	ACP	•	•		- TV	CFR	F	ABHJLP
rye	+ •	•	D	**	rye	+ TUV	•	•	Q
	± G	•	•	•		± •	•	•	•
	- C	CP	•	•		- TV	•	•	HJLP
sugar beet	+ B	B	DO	CM	sugar beet	+ **	•	B	BCP
	± •	•	•	•		± •	•	D	•
	- B	BCP	B	•		- •	•	B	BJLP
potato	+ •	•	•	•	potato	+ ATV	•	•	J
	± •	A	AD	C		± V	•	•	CL
	- AG	C	•	AM		- T	A	•	AHP
corn	+ •	•	O	C	corn	+ V	R	D	C
	± •	•	•	M		± •	•	S	•
	- G	C	O	•		- T	•	•	HJLP
pea	+ AG	C	ADO	A	pea	+ ATV	RP	DS	ACHJLP
	± G	•	•	M		± T	R	S	•
	- •	A	•	C		- •	•	•	•
Phas. bean	+ G	C	DO	C	Phas. bean	+ TV	R	S	CJL
	± •	•	•	•		± T	R	D	•
	- •	•	•	•		- T	•	•	•
carrot	+ •	C	DO	•	carrot	+ U	•	•	CJ
	± •	•	•	•		± V	•	DS	L
	- G	P	•	C		- TV	R	•	CHP
strawberry	+ •	A	D	•	strawberry	+ •	AP	AF	A
	± •	C	•	•		± •	D	D	•
	- •	•	•	C		- A	•	•	CJ
teasel	+ •	•	D	•	teasel	+ •	•	S	Q
	± •	•	A	A		± •	•	•	•
	- AG	C	•	C		- •	A	•	ACHLP

References : A = Metlitzky (1972); B = Whitehead *et al.* (1987); C = Seinhorst (unpubl.); D = Jones & Jones (1964); E = Webster (1967); F = Southey (1957); G = Barker & Sasser (1959); H = Sayre & Mountain (1962); J = Fritzsche (1967); K = Binglefors (1967); L = Edwards & Taylor (1963); M = Kradel (1957); N = Stanton *et al.* (1984); O = Hooper (1984); P = Kir'yanova & Krall (1971); Q = Thorne (1961); R = Hesling (1966 a); S = Hesling (1972); T = Sturhan (1965); U = Löcher (1963); V = Goffart (1964).

** : principle race host.

It is further noteworthy that barley (not listed), if observed, was a non-host for stem nematodes. Infestation of wheat has been reported as a rare event (Löcher, 1963; Hesling, 1966 *b*; Kir'yanova & Krall, 1971). On the other hand *Vicia faba* and *Phaseolus vulgaris* beans were often good hosts for *D. dipsaci* populations.

Discussion

There are several arguments to question the value and reliability of the described host ranges and its variation; this survey contains a collection of results from different researchers, experimental conditions and time. Several possible explanations for errors have been suggested, like using mixtures of stem nematode populations (e.g. Thorne, 1961; Ladygina, 1982), the existence of several biological races from a (original) host (e.g. Sturhan, 1965; Kir'yanova & Krall, 1971), seasonal variation in aggressiveness of nematode populations (Fritzsche, 1967), differences in viability of the used inoculates (Barker & Sasser, 1959; Ladygina, 1982), false negative results due to failure of (artificial) inoculation (e.g. Thorne, 1961; Whitehead *et al.*, 1987), use of resistant cultivars of a plant species (e.g. Jones & Jones, 1964; Sturhan, 1969; Whitehead *et al.*, 1987; Sturhan & Brzeski, 1991) and variation in the physiological state of the plants (Ladygina, 1982).

In addition it is commonly recognized that variation in host ranges and pathogenicity of local populations of a race can be genetically determined (Sturhan & Brzeski, 1991). Numerous crossing experiments with individual nematodes confirmed not only the unity of the species, but also proved pathogenicity to be genetically determined (e.g. Sturhan 1964; Webster, 1967; Eriksson, 1974; Ladygina, 1978). Although incompatibility factors and abnormal hybrids were sometimes observed, interbreeding is possibly an important reason for the variation in host plant/biological race interaction (Sturhan, 1969), as is shown in Table 1. Interbreeding can easily occur under natural conditions in plants being penetrated by specimens of several races, even though the nematodes of one of these races are unable to multiply (Sturhan, 1964; Hesling, 1966 *b*; Ladygina, 1982).

The variation in host range, presented in Table 1, implies that populations from crops like onion, beet and oat can hardly be distinguished from each other and that a differentiation and designation of these host-races seem to have lost their value. In the case of the more specialized races, like the lucerne- and red clover-race, not only has considerable variation in host range been shown, but also some multiplication on each other's hosts has been observed and even good multiplication on white clover (Table 1). Therefore a workable host differential test for distinguishing host-races seems unlikely to be attained (e.g. Whitehead *et al.*, 1987; Stur-

han & Brzeski, 1991), and moreover, nominating biological of host-races, based on host range alone, seems neither possible nor justifiable.

Some authors have considered the species *Ditylenchus dipsaci* as wild type polyphagous with race deviations under selective conditions (Hesling, 1966 *b*; Viglierchio, 1971; Green, 1981). In line with this hypothesis, it is proposed to describe stem nematode populations according to the host plant from which it was recovered and additionally the place of origin. For example: *D. dipsaci*, derived from lucerne, Wageningen (The Netherlands). Additional information from host range tests can lead to further specification, but it should be recognised that the variability and genetic behaviour of pathogenicity, as well as the resistance factors of the plant species, will make classification a delicate job.

An exception on the use of race-designation can be made for populations which are cytogenetically different, like the tetraploid giant bean-race. Successful crosses with other cytogenetically different diploid populations confirmed no complete genetical isolation of this group (Sturhan, 1969). Differentiation in terms of a sibling species has been postulated (Sturhan, 1971), but also for *Meloidogyne hapla* diploid and tetraploid variants have been designated as race A and B respectively (Triantaphyllou, 1985).

Although several limitations of host range tests have been discussed, they will retain their usefulness in characterizing naturally occurring stem nematode populations for rotation management. However, results will be reliable only for limited time and restricted areas (e.g. Hesling, 1966 *b*; Whitehead *et al.*, 1987). For scientific purposes, like resistance studies, the use of genetically more uniform nematode populations will be a prerequisite.

Present molecular techniques might give rise to a new method for designating virulence groups within *D. dipsaci*. Economical impact by means of development of new strategies in rotation management or (= R) restriction measures seems evident. Palmer *et al.* (1992) used monoclonal antibodies to determine intraspecific variation of stem nematode populations, whereas Wendt *et al.* (1993) were able to differentiate populations on ribosomal DNA using Southern blot analysis with the ribosomal cistron as a probe. However, the consistency of these molecular characters for diagnostic use still needs to be investigated. For *Globodera* spp. promising results have been obtained by use of molecular techniques, in order to classify (virulence) polymorphisms as a more reliable and stable alternative for the pathotype scheme (Bakker *et al.*, 1993). Therefore a successful strategy in search for molecular and/or biochemical characterization of stem nematode populations will be based on markers for pathogenicity characters, and most likely not on the present race-concept of *Ditylenchus dipsaci*.

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