



CHARACTERIZATION OF HOST SPECIFIC RACES OF *Rotylenchulus reniformis* INFECTING *Beta vulgaris* IN PILIBHIT

NEHA KHAN¹

Section of Plant Pathology and Nematology, Department of Botany, Aligarh Muslim University, Aligarh, U.P., India

ABSTRACT

In a preliminary survey associated with vegetables in Pilibhit district of Western Uttar Pradesh, frequent infection of *Rotylenchulus reniformis* was detected on beetroot. Prevalence of intraspecific variability amongst the populations of *R. reniformis* is an important aspect to facilitate the studies on the distribution patterns, pathogenic behavior and reproduction of nematode. With this aim in mind the categorization of races of *R. reniformis* was performed in *Beta vulgaris*. A survey was conducted and 70 isolates of *R. reniformis* were collected from 14 different beetroot growing localities of Pilibhit. The pure culture isolates of reniform nematode were maintained on castor plants in a net house at Botany Department, Aligarh Muslim University, India. Morphological variations and reproduction patterns were examined and the races of *R. reniformis* were recognized on the basis of their response to differential host plants. The studies showed the occurrence of two host specific races (race 4 and race 2) of reniform nematode in Beetroot. The frequency of occurrence of race 4 (95.7%) was higher than race 2. The information gathered from this study may provide a baseline for further research in developing suitable strategies for managing the races of reniform nematode in beetroot.

KEYWORDS: *Rotylenchulus reniformis*, *Beta vulgaris*, Host Races, Pilibhit, Host Resistance

The reniform nematode (*Rotylenchulus reniformis*), first reported on cowpea roots in Hawaii (Linford and Oliveira 1940) is considered an important emerging problem of tropical and subtropical zones (Robinson *et al.*, 1997). Besides other soil microbes infecting beetroot, nematodes have also been reported as pests of *B. vulgaris* (Koike *et al.*, 2006) and causes around 10.9% annual losses worldwide (Sasser, 1989). There are fewer reports on the occurrence of plant parasitic nematodes in *B. vulgaris* (Anamika and Simon, 2010; Akyazi and Felek, 2020; Khan and Khan, 2018; Kumar *et al.*, 2003; Mashela, 2017; Sikora, 1972; Sitaramaiah, 1984; Steyn *et al.*, 2014). The information concerning the occurrence and distribution of physiological races of *R. reniformis* in *B. vulgaris* is not available. This is the first report of occurrence of races of *R. reniformis* associated with beetroot from India.

The control methods for the management of this nematode involves the use of nematicides and crop rotation practices (Davis *et al.*, 2003; Koenning *et al.*, 2004). The prevailing environmental factors make host resistance as the most preferred and economic method adopted for nematode management. Successful nematode management involves accurate information on their species distribution, intraspecific variations and pathogenicity towards their host. However, variations amongst the nematode populations makes it difficult to identify their species on the basis of morphology.

Additionally, the information is scarce on the occurrence and distribution of races in reniform nematode. Birchfield and Brister (1962) first postulated the existence of races in *R. reniformis* associated with sugarcane from Dominican Republic, Puerto Rico and Venezuela. Nakasono (1983) described three morphologically dissimilar populations that matched with 3 biological isolates of reniform nematode on the basis of male frequency in Japan. The existence of races in *R. reniformis* was first reported by Dasgupta and Seshadri (1971), from India based on their reproduction patterns on cotton, castor, or cowpea. They studied 10 populations of which 9 reproduced on cowpea, castor and cotton were labeled as race-'A' and the 10th population collected from Andhra Pradesh, reproduced only on cowpea was labeled as race-B, but this has not been widely accepted. Vadhera *et al.* (1999) recognized a population of *R. reniformis* from Madhya Pradesh which failed to reproduce on castor and labeled it as another race. Rao and Ganguly (1996) categorized four distinct races of *R. reniformis* which showed variations in their reproduction towards five host differential plants (cotton, castor, cowpea, bajra, and mustard). Six populations of *R. reniformis* were observed which showed remarkable variations in their reproduction and pathogenicity towards cotton and soybean (McGawley *et al.*, 2010).

The development of effective control methods depends on the biological significance of the particular

¹Corresponding author

race of *R. reniformis* and the correlation of such deviation with genetic diversity of the nematode. The pattern of distribution of races of reniform nematode in the beetroot growing areas of Pilibhit reflects its production in these areas. The objective of this study was to examine and characterize the biological races of reniform nematode in beetroot growing localities of Pilibhit district (Western Uttar Pradesh).

MATERIALS AND METHODS

A survey was conducted in beetroot growing areas of Pilibhit and 70 isolates of *R. reniformis* were collected from 14 different localities (Banoa, Barkhera, Bilsanda, Bisalpur, Deoria, Jaitpur, Jamania, Kadher Chaura, Khandelpur, Parewa, Puranpur, Saraur, Shivnagar and Tukunian). The initial inoculum was collected from the infected beetroot plants. The pure culture isolates of reniform nematode used in this study were maintained on castor plants in a net house at Botany Department, Aligarh Muslim University. Morphological variations and reproduction patterns were examined for

these isolates of reniform nematode. The races of *R. reniformis* were recognized on the basis of their response to differential host plants viz., castor var. CH-1, cotton var. H-777, cowpea var. Pusa Komal, bajra, var. Pusa 23 and mustard var. Pusa Bold. The seeds of differential hosts were sown in 6 inch earthen pots containing sterilized soil. The seedlings were thinned to maintain one seedling per pot. The one week old seedlings were inoculated with 2000 immature females (IF) of reniform nematode. Each treatment was replicated three times.

The plants were depotted after 60 days of inoculation, roots were washed and stained with acid fuchsin for counting the females and egg masses. The host plants that showed an average number of females and egg masses up to 10 were labeled as resistant (-), whereas, the plants with an average number of females and egg masses more than 10 were labeled as susceptible (+). The data was compared with the Table 1 for the categorization of races as per the scheme proposed by Rao and Ganguly (1996).

Table 1: Response of races of *Rotylenchulus reniformis* to the differential hosts

Physiological Races of <i>R. reniformis</i>	Differential Host Plants				
	Castor cv. CH-1	Cotton cv. H-777	Cowpea cv. Pusa Komal	Bajra cv. Pusa 23	Mustard cv. Pusa Bold
Race-2	+	+	+	+	-
Race-4	+	+	+	+	+

(+) indicates a susceptible host; (-) indicates a resistant host.

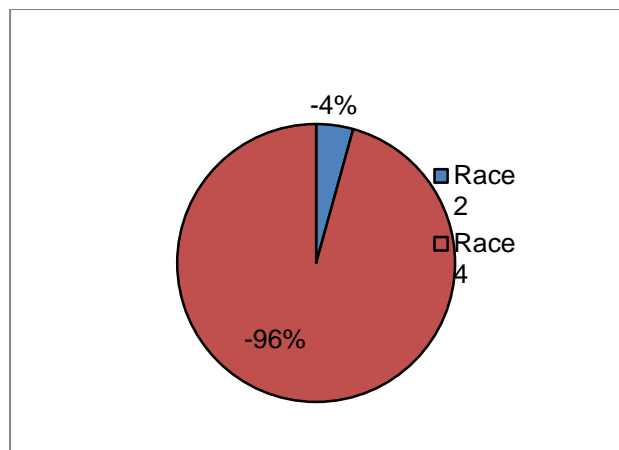


Figure 1: Frequency of occurrence of races of *Rotylenchulus reniformis*

RESULTS AND DISCUSSION

Differences were observed in the reproduction of isolates on host differential plants. Out of 70 isolates of *R. reniformis*, 67 isolates (collected from Banoa, Barkhera, Bilsanda, Bisalpur, Deoria, Jaitpur, Jamania, Kadher Chaura, Khandelpur, Parewa, Puranpur, Saraur, Shivnagar and Tukunian) reproduced on all the five host

differential plants viz., Cotton var. H-777, Castor var. CH-2, Cowpea var. Pusa Komal, Bajra var. Pusa-23 and Mustard var. Pusa Bold but, the remaining 3 isolates (collected from Tukunian) differed in their pathogenic behavior towards mustard var. Pusa Bold and did not reproduced on it, but reproduced on Cotton var. H-777, Castor var. CH-2, Cowpea var. Pusa Komal and Bajra var. Pusa-23. Consequently, the 67 isolates were designated as Race 4, while 3 isolates were recognized as Race 2 as per the scheme proposed by Rao and Ganguly (1996). The eggmasses of these isolates contained embryonated eggs, second stage larvae and a few males. The soil populations were composed of males, immature females and larvae. The ratio of males to young females was higher in poor host but lesser in a good host. Amongst the races of *R. reniformis*, the race 4 showed the higher frequency of occurrence which was recorded as 95.7% and race 4 showed a lower frequency of occurrence which was recorded as 4.3% (Figure 1).

The information related to the occurrence and distribution of races of reniform nematode is meager. So far there is no substantiation related to the races of *R.*

reniformis associated with beetroot. However, there are records of persistence of different races in reniform nematode from different crops growing all over the world (Adam *et al.*, 2018; Agudelo *et al.*, 2005; Bairwa and Patel, 2014; Dasgupta and Seshadri, 1971; Khan, 1986; McGawley *et al.*, 2010; Nakasona, 1983; Rao and Ganguly, 1996; Singh and Azam, 2012; Vadhera *et al.*, 1999).

Khan *et al.* (1986) observed the population of *R. reniformis* (race A) which was pathogenic to cowpea, cotton and castor in Aligarh. Similar investigations were reported from Egypt by Adam *et al.* (2018). Vadhera *et al.* (1999) observed a different population of reniform nematode which failed to reproduce on castor from Jabalpur. Rao and Ganguly (1996) have proposed the

existence of four discrete races of *R. reniformis*, of which AP-2 and GJ-1 isolates reproduced on cowpea, cotton, castor, bajra but not on mustard and DL-1 isolate reproduced on all the host differentials. These findings support our result in which race 4 reproduced on all the host differential plants whereas race 2 differed in its pathogenic behavior towards mustard and did not reproduce on it. Singh and Azam (2012) reported three races of *R. reniformis*, (race 4, race 3 and race 2) in castor from Aligarh and race 1 was absent which is in agreement with our results but race 2 was more dominant as compared to race 4 which is contrary to our findings. Moreover, they reported the existence of race 3 in castor which was absent in beetroot. Bairwa and Patel (2014) observed the existence of race 1 of *R. reniformis* in tobacco from Gujarat which is contrary to our results.

Table 2: Identification of races of reniform nematode, *Rotylenchulus reniformis* infecting *Beta vulgaris* in Pilibhit district of Western Uttar Pradesh

Locality/ Isolates	Host differential plants/ Number of females and egg masses per root system					Races of <i>Rotylenchulus reniformis</i>
	Cotton var. CH-1	Castor var. H-777	Cowpea var. Pusa Komal	Bajra var. Pusa 23	Mustard var. Pusa Bold	
	Female/ Egg mass	Female/ Egg mass	Female/ Egg mass	Female/ Egg mass	Female/ Egg mass	
Tukunian-1	77/28 (+)	88/40 (+)	102/58 (+)	37/22 (+)	0/0 (-)	<i>R. reniformis</i> Race 2
Tukunian-2	82/32 (+)	94/44 (+)	108/60 (+)	20/13 (+)	0/0 (-)	<i>R. reniformis</i> Race 2
Tukunian-3	74/29 (+)	79/38 (+)	99/51 (+)	28/15 (+)	0/0 (-)	<i>R. reniformis</i> Race 2
Tukunian-4	78/33 (+)	85/41 (+)	104/55 (+)	39/12 (+)	34/21 (+)	<i>R. reniformis</i> Race 4
Tukunian-5	86/36 (+)	90/43 (+)	107/57 (+)	36/14 (+)	37/26 (+)	<i>R. reniformis</i> Race 4
Parewa-1	81/33 (+)	135/57 (+)	84/43 (+)	36/17 (+)	41/29 (+)	<i>R. reniformis</i> Race 4
Parewa-2	85/32 (+)	110/50 (+)	88/44 (+)	24/21 (+)	44/28 (+)	<i>R. reniformis</i> Race 4
Parewa-3	83/29 (+)	122/55 (+)	90/46 (+)	32/16 (+)	47/32 (+)	<i>R. reniformis</i> Race 4
Parewa-4	88/37 (+)	128/54 (+)	80/48 (+)	30/19 (+)	38/24 (+)	<i>R. reniformis</i> Race 4
Parewa-5	79/33 (+)	119/49 (+)	85/51 (+)	36/20 (+)	40/27 (+)	<i>R. reniformis</i> Race 4
Saraur-1	75/30 (+)	90/51 (+)	99/48 (+)	29/21 (+)	36/23 (+)	<i>R. reniformis</i> Race 4
Saraur-2	78/28 (+)	85/43 (+)	103/58 (+)	34/25 (+)	41/30 (+)	<i>R. reniformis</i> Race 4
Saraur-3	83/35 (+)	88/46 (+)	105/55 (+)	37/14 (+)	44/34 (+)	<i>R. reniformis</i> Race 4
Saraur-4	76/30 (+)	79/40 (+)	100/50 (+)	24/18 (+)	48/26 (+)	<i>R. reniformis</i> Race 4
Saraur-5	73/29 (+)	84/42 (+)	95/52 (+)	39/23 (+)	51/30 (+)	<i>R. reniformis</i> Race 4
Jaitpur-1	77/28 (+)	88/41 (+)	86/47 (+)	29/12 (+)	42/24 (+)	<i>R. reniformis</i> Race 4
Jaitpur-2	81/35 (+)	85/43 (+)	82/40 (+)	33/14 (+)	44/20 (+)	<i>R. reniformis</i> Race 4
Jaitpur-3	84/38 (+)	80/39 (+)	87/43 (+)	34/19 (+)	46/27 (+)	<i>R. reniformis</i> Race 4
Jaitpur-4	88/36 (+)	86/46 (+)	81/40 (+)	37/13 (+)	34/21 (+)	<i>R. reniformis</i> Race 4
Jaitpur-5	79/30 (+)	82/38 (+)	88/45 (+)	26/17 (+)	39/23 (+)	<i>R. reniformis</i> Race 4
Kadher Chaura-1	85/32 (+)	112/49 (+)	106/64 (+)	36/24 (+)	34/22 (+)	<i>R. reniformis</i> Race 4
Kadher Chaura-2	89/36 (+)	119/39 (+)	102/58 (+)	31/26 (+)	37/26 (+)	<i>R. reniformis</i> Race 4
Kadher Chaura-3	93/31 (+)	109/41 (+)	108/60 (+)	32/22 (+)	40/28 (+)	<i>R. reniformis</i> Race 4
Kadher Chaura-4	78/33 (+)	115/47 (+)	98/56 (+)	34/17 (+)	36/20 (+)	<i>R. reniformis</i> Race 4
Kadher Chaura-5	76/29 (+)	121/40 (+)	104/62 (+)	21/11 (+)	41/21 (+)	<i>R. reniformis</i> Race 4

Puranpur-1	94/40 (+)	135/52 (+)	84/45 (+)	29/19 (+)	43/20 (+)	<i>R. reniformis</i> Race 4
Puranpur-2	91/37 (+)	130/54 (+)	87/47 (+)	27/14 (+)	38/23 (+)	<i>R. reniformis</i> Race 4
Puranpur-3	98/35 (+)	133/50 (+)	82/42 (+)	32/18 (+)	36/21 (+)	<i>R. reniformis</i> Race 4
Puranpur-4	90/38 (+)	128/51 (+)	89/49 (+)	30/26 (+)	47/20 (+)	<i>R. reniformis</i> Race 4
Puranpur-5	93/36 (+)	134/55 (+)	85/41(+)	34/28 (+)	44/24 (+)	<i>R. reniformis</i> Race 4
Jamania-1	73/32 (+)	98/36 (+)	97/58 (+)	36/22 (+)	37/26 (+)	<i>R. reniformis</i> Race 4
Jamania-2	77/35 (+)	94/39 (+)	91/54 (+)	26/15 (+)	44/22 (+)	<i>R. reniformis</i> Race 4
Jamania-3	81/30 (+)	105/44 (+)	89/48 (+)	31/25 (+)	46/24 (+)	<i>R. reniformis</i> Race 4
Jamania-4	75/28 (+)	93/40 (+)	96/60 (+)	30/18 (+)	50/29 (+)	<i>R. reniformis</i> Race 4
Jamania-5	76/30 (+)	102/41 (+)	100/64 (+)	34/21 (+)	53/32 (+)	<i>R. reniformis</i> Race 4
Shivnagar-1	81/35 (+)	81/35 (+)	113/63 (+)	35/26 (+)	46/27 (+)	<i>R. reniformis</i> Race 4
Shivnagar-2	82/30 (+)	84/40 (+)	107/61 (+)	29/17 (+)	49/25 (+)	<i>R. reniformis</i> Race 4
Shivnagar-3	87/28 (+)	79/38 (+)	109/65 (+)	33/22 (+)	52/32 (+)	<i>R. reniformis</i> Race 4
Shivnagar-4	84/37 (+)	83/37 (+)	103/55 (+)	37/24 (+)	54/30 (+)	<i>R. reniformis</i> Race 4
Shivnagar-5	79/30 (+)	84/35 (+)	110/59 (+)	34/20 (+)	50/29 (+)	<i>R. reniformis</i> Race 4
Barkhera-1	92/40 (+)	99/39 (+)	85/44 (+)	31/19 (+)	41/22 (+)	<i>R. reniformis</i> Race 4
Barkhera-2	82/35 (+)	112/48 (+)	98/51 (+)	36/25 (+)	52/26 (+)	<i>R. reniformis</i> Race 4
Barkhera-3	90/37 (+)	130/54 (+)	91/48 (+)	35/20 (+)	48/23 (+)	<i>R. reniformis</i> Race 4
Barkhera-4	88/36 (+)	126/51 (+)	87/42 (+)	24/14 (+)	45/20 (+)	<i>R. reniformis</i> Race 4
Barkhera-5	91/37 (+)	132/56 (+)	93/42 (+)	24/17 (+)	40/23 (+)	<i>R. reniformis</i> Race 4
Deoria-1	77/29 (+)	89/38 (+)	94/48 (+)	34/18 (+)	49/20 (+)	<i>R. reniformis</i> Race 4
Deoria-2	79/28 (+)	79/39 (+)	98/46 (+)	39/20 (+)	53/30 (+)	<i>R. reniformis</i> Race 4
Deoria-3	74/31 (+)	82/41 (+)	83/40 (+)	31/23 (+)	56/27 (+)	<i>R. reniformis</i> Race 4
Deoria-4	75/29 (+)	86/44 (+)	86/43 (+)	28/15 (+)	45/21 (+)	<i>R. reniformis</i> Race 4
Deoria-5	76/28 (+)	83/40 (+)	91/47 (+)	34/19 (+)	57/29 (+)	<i>R. reniformis</i> Race 4
Bisalpur-1	85/32 (+)	96/47 (+)	102/51 (+)	37/21 (+)	41/24 (+)	<i>R. reniformis</i> Race 4
Bisalpur-2	89/34 (+)	91/43 (+)	108/54 (+)	30/23 (+)	46/20 (+)	<i>R. reniformis</i> Race 4
Bisalpur-3	91/37 (+)	88/40 (+)	114/62 (+)	36/19 (+)	42/22 (+)	<i>R. reniformis</i> Race 4
Bisalpur-4	88/36 (+)	84/39 (+)	105/58 (+)	32/23 (+)	48/26 (+)	<i>R. reniformis</i> Race 4
Bisalpur-5	93/36 (+)	93/45 (+)	111/65 (+)	34/26 (+)	43/23 (+)	<i>R. reniformis</i> Race 4
Bilsanda-1	78/32 (+)	132/51 (+)	97/50 (+)	31/18 (+)	35/20 (+)	<i>R. reniformis</i> Race 4
Bilsanda-2	91/37 (+)	135/54 (+)	103/58 (+)	37/26 (+)	39/23 (+)	<i>R. reniformis</i> Race 4
Bilsanda-3	73/28 (+)	128/55 (+)	85/43 (+)	37/23 (+)	41/25 (+)	<i>R. reniformis</i> Race 4
Bilsanda-4	85/31 (+)	131/57 (+)	108/53 (+)	36/23 (+)	37/20 (+)	<i>R. reniformis</i> Race 4
Bilsanda-5	89/35 (+)	133/50 (+)	89/47 (+)	22/19 (+)	33/20 (+)	<i>R. reniformis</i> Race 4
Khandelpur-1	78/31 (+)	81/38 (+)	89/43 (+)	29/12 (+)	35/18 (+)	<i>R. reniformis</i> Race 4
Khandelpur-2	73/28 (+)	88/44 (+)	86/46 (+)	32/23 (+)	40/19 (+)	<i>R. reniformis</i> Race 4
Khandelpur-3	79/32 (+)	84/41 (+)	82/40 (+)	36/26 (+)	43/23 (+)	<i>R. reniformis</i> Race 4
Khandelpur-4	75/30 (+)	79/41 (+)	92/47 (+)	40/27 (+)	38/20 (+)	<i>R. reniformis</i> Race 4
Khandelpur-5	73/31 (+)	86/47 (+)	84/45 (+)	33/21 (+)	37/24 (+)	<i>R. reniformis</i> Race 4
Banoa-1	78/34 (+)	126/39 (+)	93/52 (+)	31/23 (+)	45/26 (+)	<i>R. reniformis</i> Race 4
Banoa-2	82/37 (+)	130/44 (+)	87/45 (+)	28/19 (+)	48/29 (+)	<i>R. reniformis</i> Race 4
Banoa-3	86/39 (+)	134/48 (+)	88/47 (+)	23/14 (+)	52/34 (+)	<i>R. reniformis</i> Race 4
Banoa-4	90/40 (+)	128/40 (+)	90/48 (+)	26/21 (+)	56/32 (+)	<i>R. reniformis</i> Race 4
Banoa-5	94/35 (+)	132/48 (+)	96/51 (+)	29/18 (+)	54/30 (+)	<i>R. reniformis</i> Race 4

CONCLUSION

It was clear from this investigation conducted in Botany department of Aligarh Muslim University, Aligarh that race 1 and 3 of *R. reniformis* were altogether absent in beetroot growing in Pilibhit district. The

absence of race 1 and 3 may be attributed to the host resistance offered by beetroot, climatic conditions of the surveyed localities, soil profile, temperature and other ecological factors. The information gathered from the present study may provide the baseline for further

research to study the host parasite interactions and is helpful in plant breeding programs for developing beetroot cultivars resistant to races of *R. reniformis*. This study can assist in developing appropriate strategies for the management of races of reniform nematode in beetroot.

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