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# Nematode Problems in Sweet Potato and Their Management

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## ABSTRACT

Sweet potato is infested by root-knot and reinform nematodes. Root-knot nematode infestation in sweet potato is studied in detail. A number of resistant varieties are released in sweet potato from USA, Japan and China. A number of germplasm accessions and cultivars/ varieties were found resistant to the nematodes in Peru. Studies carried out by the authors indicated that sweet potato germplasm is resistant to root-knot nematode in general and susceptibility is less. 'Sree Bhadra', a high yielding variety of sweet potato is found as a resistant trap crop of root-knot nematode. *Pratylenchus* and *Ditylenchus* are also known to cause serious damage in Japan and China, respectively. However, they are not serious in India and it is desirable to be quarantined in India.

**Keywords:** *Ditylenchus*, *Meloidogyne*, *Pratylenchus*, *Radopholus*, Sree Bhadra

**Abbreviations: ACRIP**, All India Co-Ordinated Research Improvement Project; **GAU**, Gujarat Agricultural University; **JNKVV**, Jawaharlal Nehru Krishi Vishwa Vidyalaya; **KAU**, Kerala Agricultural University; **RKN**, root-knot nematode; **TNAU**, Tamil Nadu Agricultural University

## CONTENTS



## INTRODUCTION

Nematodes on sweet potato and the damage they cause are reviewed by various authors (Jatala and Bridge 1990; Mohandas 1994; Sharma *et al*. 1997). Species of *Meloidogyne* and *Rotylenchulus reniformis* cause reduction in yield and also quality of tubers the world over (Clark and Moyer 1988). *Pratylenchus* spp. are reported to be very serious in Japan whereas *Ditylenchus destructor* and *D. dipsaci* are reported to be quite serious in China (Sharma *et al.* 1997).

## ROOT-KNOT NEMATODES

*Meloidogyne incognita* is the most important species attacking sweet potato. Suzuki *et al*. (2012) reported that sweet potato is a highly suitable host of the southern RKN, *Meloidogyne incognita*, which causes severe damage to the tuberous roots. Root-knot nematodes represent a significant problem in sweet potato, *Ipomoea batatas* (L.) Lam., causing a reduction in yield and quality of the storage roots (Cervantes-Flores 2000). Other species of *Meloidogyne* include *M. javanica*, *M. hapla* and *M. arenaria*. Infestation by *Meloidogyne* spp. causes reduction in yield and quality. Gapasin (1981) reported that *M. incognita reduced* tuber production from 10.2-47.7% in Philippines. Severe infestation also produced deep longitudinal cracking on the tuber (Bridge 1978) affecting the marketability. Often the galls produced by the nematodes are very small and hence escape the attention of casual observers. However, reduction in yield due to the nematode is very high. In North Carolina,

**Fig. 1 Sweet potato (local variety) roots infested with root-knot nematodes (*Meloidogyne incognita*).**

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yield of sweet potato in the nematode infested sandy soils is up to one third compared to nematicide treated plots; cracked roots in infested plots were about 18% compared to 3% in treated plots (Neilsen and Sasser 1959). Hall *et al.* (1988) claimed double the yield of marketable tubers and 40% reduction in cracks in *M. incognita* infested plots which were treated with nematicide before planting. Similarly pre plant fumigation of infested plots was a regular feature in California before planting sweet potato (Roberts and Schueurman 1984) which helped in increased yield and production of high quality tubers. Kistner *et al.* (1993) reported 11.4% decrease in marketable yield due to infestation by *M. incognita* and *M. javanica* in South Africa.

Resistance to *M. incognita* and *M. javanica* are reported in sweet potato from various countries and active breeding programmes are being conducted in USA, Japan and China (Sun and Chen 1994) which had released high-yielding, nematode-resistant varieties namely 'Satsumahikari', 'Excel', 'Yushu 3', Fusabeni Topa 3', 'Hi-Starch', 'Red glow' and 'J-red' which show resistance to nematodes (Kukimura *et al.* 1989). A number of germplasm accessions, cultivars/varieties are resistant to the root-knot nematode in Peru (Jatala 1989; Jatala and Bridge 1990) and also in India (Mohandas and Palaniswami 1990; Mohandas and Rajendran 1993; Ramakrishnan *et al.* 1997). Differences in susceptibility of certain promising accessions of sweet potato to *M. incognita* was reported by Ramakrishnan *et al.* (1999).

Two dominant genes which are independent of each other control resistance in sweet potato (Shiotani *et al.* 1990). These workers also reported that there were no significant differences in the larval penetration in resistant and susceptible cultivars. Five days after inoculation a hypersensitive reaction was detected in all the resistant clones with high percentages of necrotic lesions. However, Mohandas *et al.* (1998) reported significant difference in juvenile penetrations and multiplication among thirty three resistant sweet potato germplasm accessions. Maluf *et al.* (1996) reported that most of the genotypes showed resistance to *M. javanica* whereas only a few were resistant to *M. incognita* race 2. Genotypic correlations for resistance to various *Meloidogyne* isolates utilized were weak ranging from 0.11 to 0.57 suggesting independent control; Silveira and Maluf (1993) also reported resistance to races of *M. incognita* and *M. javanica* but no genotype had multiple resistance to all races. They also reported that genotypic correlation coefficients between resistance to different races and/or species were low indicating an independent control of resistance for the nematode races and species. Crozzoli *et al.* (1994) reported tolerance among three selections of sweet potato as these supported nematode infection and reproduction whereas in other selections root and top weights were suppressed. Gapasin *et al.* (1988) reported that more phenolics accumulated in root extracts of resistant cultivars following *Meloidogyne* infection.

Control of nematodes in sweet potato using chemicals in California was restricted to pre planting fumigation with Methyl bromide (Roberts and Schueurman 1984). Pre plant nematicidal treatment of *M. incognita* infested field doubled the yield of marketable sweet potato roots and also reduced proportion of cracked tubers by over 40% (Hall *et al.* 1988). Nemacur and Aldicarb were also found to be effective in controlling *Meloidogyne* species (Clark *et al.* 1980; Gapasin 1981). Application of DS 38697 significantly reduced *M. incognita* in *I. batatas* (Averre *et al.* 1985).

Very high degree of resistance to *M. incognita* and *M. javanica* is reported from the world over and high yielding released varieties are available in many countries including India, USA, China and Japan. Sree Bhadra, a high yielding released variety of sweet potato was identified as a resistant trap crop to root knot nematode. When this variety was planted in a root-knot nematode infested field the nematode population declined to below detectible level over a single cropping duration of 90-95 days. Subsequent susceptible plants viz coleus and African yam also escaped nematode damage when planted in such fields. Different centres of ACRIP on Nematodes viz. KAU, Vellayani; JNKVV, Jabalpur; TNAU, Coimbatore confirmed that root knot nematode population declined in heavily infested fields when Sree bhadra was planted. However GAU, Anand isolate of RKN was found to infest Sree Bhadra variety. Sweet potato varieties such as Khajangod, Sree Vardhini and Sree Nandhini were found to be resistant to root-knot nematode.

Though many released varieties and major germplasm accessions are either immune or resistant to the root knot nematode a few varieties are susceptible. In such susceptible varieties reduction in shoot and root weight were significant even at a low initial inoculum of 20 infective juveniles per pot. Samples collected from Kalyani, West Bengal harboured very high soil, root and tuber nematode population. Soil population recorded was above 1000 infective juveniles per 100 ml soil. Infested tubers were unfit for consumption and often tuber bulking was very poor (**Fig. 1**).

Germplasm accessions (280) maintained at the Central Tuber Crops Research Institute were screened against *Meloidogyne incognita*. Fifty six accessions were found to be immune as neither root, tuber galls nor nematode numbers were recorded from these accessions (**Table 1**). One hundred and 16 accessions recorded very low populations in root. Another 88 accessions recorded a few galls on root and supported only low population which are categorized as resistant (**Table 2**). Twenty accessions recorded 11-30 galls per root. These are the susceptible accessions (**Table 3**). Inoculation studies on rooted cuttings of Sree Bhadra recorded high degree of penetration by the nematode which is comparable to susceptible sweet potato accessions. However, development of the infested juveniles turned into fourth stage males and adult females could not be recorded

**Table 1** Immnune accessions of sweet potato germplasm.

| Germplasm accessions | Index | Mean nematode population/g root |
|---|---|---|
| S 1, 2, 16, 17, 18, 24, 29, 34, 35,36, 37, 38, 39, 48, 49, 50, 53, 54,55, 59, 62, 65, 66, 118, 154, 167, 170, 172, 223, 246, 274, 286, 318, 501, 505, 507, 533, 553, 568, 571, 582, 587, 588, 594, 600, 601, 606, 610, 611, 612, 622, 623, 624, 625, 628, 629 | 0 | 0 |

**Table 2** Resistant accessions of sweet potato germplasm.

| Germplasm accessions | Index | Mean nematode population/g root (range) |
|---|---|---|
| S 21, 43, 44, 56, 57, 58, 72, 75, 87, 149, 150, 162, 164, 238, 244, 283, 284, 456, 508, 535, 567, 592, 598, 605, 608, 617, 630, 634 | 0 | 160.56 (19-400) |
| S 12, 13, 14, 22, 23, 25, 27, 31, 32, 33, 41, 71, 78, 81, 83, 117, 152, 155, 175, 207, 214, 217, 241, 292, 315, 380, 500, 503, 510, 515, 523, 529, 537, 557, 560, 580, 584, 591, 595, 609, 615, 618, 632, 637 | 1 | 324.26 (50-800) |
| S 4, 6, 8, 9, 22, 26, 28, 46, 61, 68, 69, 70, 80, 88, 156, 204, 208, 215, 222, 227, 256, 288, 312, 313, 316, 406, 493, 506, 525, 526, 527, 559, 562, 565, 572, 581, 590, 593, 603, 607, 620, 635, 641, 642 | 2 | 595.29 (110-1620) |

**Table 3** Susceptible accessions of sweet potato germplasm.

| Germplasm accessions | Index | Mean nematode population/g root (range) |
|---|---|---|
| S 10, 47, 119, 163, 220, 224, 258, 270, 311, 402, 481, 482, 495, 504, 524, 566, 570, 574, 577, 621 | 3 | 2497.40 (1080-6600) |
| S 52, 263, 472, 483, 513, 561, 563, 604 | 4 | 2534.44 (1600-4680) |

indicating that the nematode was not capable of completing its life cycle in Sree Bhadra.

### *Rotylenchulus reniformis*

The nematodes were found in large numbers by Verma and Prasad (1969) but nothing is known on yield loss and control (Mohandas 1994). Gapasin and Valdez (1979) observed 60.6% yield reduction in pot culture experiments. Gapasin (1981) reported that *R. reniformis* reduced the yield from 13.4-60.6% in the Philippines. Walters and Barker (1994) studied the effect of two populations on sweet potato and found that both populations restricted storage root growth but enhanced shoot growth. Besides, infestation by the nematode may cause cracking of storage roots (Clark and Wright 1983).

### *Pratylenchus*

Rajendran *et al.* (1972) reported high population of *Pratylenchus* sp. and *Hoplolaimus* sp. in soil and roots from Coimbatore, Tamil Nadu. *P. coffeae* is very serious in Japan in volcanic acid soils (Suzuki 1989). Other species reported feeding on sweet potato were *P. flakkeniss*, *P. brachyurus*, *P. penetrans*, *P. vulnus* and *P. zeae.* Auguiz and Canto-Saenz (1991) observed resistance to *P. flakkeniss* among 20 sweet potato cultivars.

### *Ditylenchus*

In China *Ditylenchus* nematode is a serious problem. *Ditylenchus* spp. induce "brown ring" in storage root. The species involved are *D. destructor and D. dipsaci* in China. A number of resistant accessions and varieties were reported from China (Wu and Zhang 1990; Wang *et al*. 1995). Lin *et al*. (1993) observed that exudate secreted by the oesophageal glands of *D. destructor* when inoculated with tubers of susceptible sweet potato the tissue around the inoculated area became brown and the cells were destroyed. In resistant cultivars the walls turned brown and parenchyma cells became cork barriers.

### Other nematodes

The burrowing nematode *Radopholus similis* is also reported to be a serious pest of sweet potato (Koshy and Jasy 1991). Several other species of nematodes are found associated with sweet potato (Clark and Moyer 1988) but their importance to the crop is not evaluated.

## QUARANTINE

Species of *Ditylenchus* which are reported to be very serious in China and in Japan are not reported from sweet potato in India. Hauogui *et al*. (2011) reported that a survey conducted in three different regions of Niger indicated that the major plant parasitic nematodes associated with sweet potato are *Tylenchorhynchus indicus*, *Criconemella curvata*, *Tylenchus* sp., and *Hirschmanniella oryzae.* Steps have to be taken to prevent the entry of such nematodes through planting materials, when imported.

## CONCLUSION

Root-knot nematode is a serious problem in sweet potato causing reduction in yield and longitudinal splitting of tubers. Several cultivars resistant to the nematode have been released from the USA, Japan, China, Peru and India. Sweet potato germplasm was found to have more number of resistant accessions compared to susceptible ones in India. 'Sree Bhadra', a released variety by CTCRI has been found to be a resistant trap crop of the root-knot nematode. Sweet potato varieties such as Kanhangad, Sree Vardhini and Sree Nandhini were found to be resistant to the nematode. *Pratylenchus* sp. and *Ditylenchus* sp. were found serious in Japan and China respectively. These nematode problems are not reported in India, the spread of the nematode to India has to be quarantined.

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