Journal of Entomology and Zoology Studies
Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 45-48

Received: 01-05-2020
Accepted: 03-06-2020

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Resistance of sugarcane clones against root knot nematode, *Meloidogyne incognita* and lesion nematode, *Pratylenchus zeae*

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Abstract
Root knot nematode, *Meloidogyne incognita* and lesion nematode, *Pratylenchus zeae* are major nematode species attacking sugarcane crop and causes considerable yield loss. Identification of resistant varieties or clones are important tools for resistant breeding programme. A pot culture experiments were conducted under glasshouse conditions to evaluate their resistance reaction against root knot and lesion in 27 sugarcane clones. Resistance and susceptibility reaction evaluated based on lesion index in lesion nematode and gall index in root knot nematode for each clone. The results indicated that 20 clones were found to be tolerant and six clones were found to be susceptible. The clone C 260628 was found to be moderately resistant to *Pratylenchus zeae*. Regarding the root knot nematode, *Meloidogyne incognita* resistant reaction observed that 19 clones were found to be moderately resistant and six clones were susceptible. The two clones C 260628 and CoC 24 were found to be resistant against the root knot nematode. The clone C 260628 was moderately resistant and CoC 24 was tolerant against the lesion nematode.

Keywords: Lesion nematode, *Meloidogyne incognita, Pratylenchus zeae,* root knot nematode, sugarcane clones

Introduction
India is the largest producer of cane in the world and its share in the world sugar production is around 20 per cent. Currently, it is cultivated in an area of 5.0 million ha with an average productivity 66.9 t/ha with the total production of 339 million tonnes of sugarcane and 25.0 million tonnes of sugar. In Tamil Nadu, it is cultivated in an area of 3.83 lakh ha with the total production of 351 lakh tonnes of sugarcane and 21.46 lakh tonnes of sugar. The productivity is 92.0 t/ha. Though the potential yield of sugarcane is 485 t/ha, the productivity in India is low as only 65-70 t/ha [1]. Sugarcane is cultivated under varied conditions ranging from the tropics to the sub-tropics. At present 48 genera and 275 species of nematodes have been associated with sugarcane from 36 countries. Species of five genera viz., *Pratylenchus spp, Hoplolaimus spp, Helicotylenchus spp, Tylenchorhynchus spp* and *Meloidogyne spp* were listed as the major plant parasitic nematode. All these nematode have a wide distribution and are common in sugarcane being cultivated in India [2].

Nematode diversity in sugarcane is greater than other crops, with more than 310 species of 48 genera of endo and ectoparasitic nematodes. Certain genera particularly *Pratylenchus* (20 species) *Helicotylenchus* (3 species) and *Tylenchorhynchus* (36 species) show wide spread in sugarcane. Several others are common locally eg. *Meloidogyne* (7 spp), *Xiphinema* (52 spp), *Hoplolaimus* (11 spp.). Sugarcane is normally grown as a continuous monoculture crop with usually no more than a few months break between removing the old ratoon crop and replanting the field. Thus conditions tend to favour the development of relatively large populations of nematodes. Among these *Pratylenchus zeae, Meloidogyne incognita* and *Meloidogyne javanica* were reported as highly pathogenic nematodes [3]. Attention has so far focused on species of *Pratylenchus* and *Meloidogyne* as they are wide spread on sugarcane and generally considered the most damaging plant parasitic nematodes. However, these and other nematodes associated with sugarcane rarely occur alone in the soil but are present in communities comprising a number of species. Surveys from several parts of Tamil Nadu showed that the number of genera present in a single soil sample ranges from one to 12 genera/species an average of between 3.2 and 7.9 [1].

Root lesion and root knot nematodes are obligate parasites of plants and their reproductive capacity is limited by the availability of roots. If clones with similar root biomass have different number of nematodes, then the difference is most likely due to resistance. However, if a clone has smaller root system, the lower number of nematodes could be due to the limitations in the root biomass available as a food source. In introgression populations, it is even harder to have uniform root biomass because of the significant variation of the root and shoot biomass among test clones. Plant parasitic nematodes are one of the important biotic constraints in sugarcane production in subtropical and tropical regions of the world. It is estimated that nematodes cause an average annual yield loss of 15.3% in sugarcane [4]. Among the 20 life sustaining crops of the world, highest monetary loss due to nematodes is reported in sugarcane. In India nematodes are reported to cause about 10-40% yield loss in sugarcane. More than 200 species of nematodes have been reported to be infecting sugarcane. In India five genera viz., *Pratylenchus, Meloidogyne, Hoplolaimus, Tylenchorhynchus* and *Helicotylenchus* are found widely prevalent in sugarcane ecosystem. In Tamil Nadu they have shown the association of *Helicotylenchus, Pratylenchus, Hoplolaimus, Tylenchorhynchus* and *Meloidogyne spp* in sugarcane crop [5]. Of these, Lesion nematode *Pratylenchus spp* is the most predominant and economically important genus.

Long duration of one year followed by 2-3 ratoons with little disturbance of soil facilitate the build up of high nematode population in just 2-3 crop cycles which results in yield decline in subsequent crops. Further, monocropping of sugarcane to meet the cane demands of increasing number of sugar factories makes phytonematodes a constraint to sustainable sugarcane production in many parts of India. Considering the above facts involve an attempt was made to screening the available varieties / clones against the root knot and lesion nematode in sugarcane.

Materials and Methods

Screening and assessment of resistance to root knot nematode, *M. incognita*

To assess the level of resistance against root knot nematode in glasshouse experiment was taken-up in Sugarcane Research Station, Cuddalore. A completely randomized block design was used with three replicatios each for inoculated and uninoculated treatments were maintained for each clone. Single budded setts of 27 sugarcane clones were planted in 5 kg capacity of pots mixed with soil and maintained in glasshouse. One month after planting inoculate with freshly hatched second stage *M. incognita* juveniles @ 5000J_2/pot. Remove the top of soil and pour nematode suspension and cover with soil. Remove the plants 90 days after inoculation and gall index the plants on 1-5 scale.

Screening and assessment of resistance to lesion nematode, *P. zeae*

Single budded setts of 27 sugarcane clones were planted in 5 kg capacity of pots containing sterilized soil and maintained in glasshouse. One month after planting inoculate with *P. zeae* @ 5000 juveniles / pot. Three replications each for inoculated and uninoculated control were maintained. Three months after inoculation observations on nematode multiplication in soil and root population were recorded. Each plants were carefully uprooted and cut the root system and were washed free of soil. Roots were processed by root maceration technique. Soil samples were processed by Cobb's wet-seiving and sedimentation technique. The nematodes were extracted by Modified Baermann method and the soil population of plant parasitic nematodes were assessed. The lesion index of the root was estimated by measuring the length of roots with lesioned tissue and is expressed in percentage.

Results and Discussion

Screening of sugarcane varieties / clones against root knot nematode, *Meloidogyne incognita*

A total of 27 germplasm / clones were screened against root knot nematode, *M. incognita*. Among them 19 clones were found to be moderately resistant (C 33004, C 33005, C 33008, C 33018, C 33025, C 33028, C 33035, C 33042, C 33049, C 33050, C 33051, C 33056, C 33060, C 33062, C 33074, C 33075, C 33105, C 33114, and C 33122) and six clones were susceptible (C 33024, C 33032, C 33046, C 33064, C 33082, and C 33108). The two clones (C 260628 and CoC24) were found to be resistant. The results were furnished in the table 1. Visual ratings for root knot nematode (RKN) were highly correlated with reproductive factor (RF) value and nematode eggs per g of roots. This is in agreement with our previous work where visual ratings were correlated with extracted nematodes and eggs from the test clones [6]. Visual rating has been used to screen other crops against root knot nematodes such as peanuts and *Psidium* species [7, 8]. However, Matsuo *et al.* (2012) [9] opposed the exclusive use of root galling to assess resistance, as it can cause errors in selecting for nematode resistance. They indicated that some genotypes do not produce galls in response to RKN infection even though nematode reproduction in those genotypes may be high. However, we favour the use of visual rating as an assessment method when screening clones for resistance to RKN because of the short time (less than a minute) to assess a nematode-infested root.

This study found that basic *S. spontaneum*, and *E. arundinaceus*; and some backcross progenies derived from these wild canes, and commercial hybrids are resistant to moderately resistant to RKN. This is in agreement with earlier studies [3, 6, 10]. One *S. spontaneum* clone (Glagah-1286) was resistant to both types of nematodes. In general, the wild relative of sugarcane, *S. spontaneum*, is relatively easy to cross with sugarcane hybrids, and in fact, modern sugarcane varieties are the product of successful crosses between *S. officinarum* and *S. spontaneum* [11]. These crosses provided modern sugarcane with resistance to a range of diseases and abiotic stresses, as well as greater ratoon capacity [12]. Testing of more *S. spontaneum* clones for nematode resistance and targeted crossing with commercial hybrid should be continued to produce nematode-resistant sugarcane varieties for the Australian sugar industry.

Screening of sugarcane varieties / clones against lesion nematode, *Pratylenchus zeae*

A total of 27 germplasm / clones were screened against lesion nematode, *P. zeae.* Among them 20 clones were found to be tolerant, (C 33004, C 33005, C 33008, C 33018, C 33025, C 33028, C 33035, C 33042, C 33049, C 33050, C 33051, C 33056, C 33060, C 33062, C 33074, C 33075, C 33105, C 33114, C 33122 and CoC 24) and six clones were found to be susceptible (C 33024, C 33032, C 33046, C 33064, C 33082, and C 33108). The clone C 260628 were found to be moderately resistant. The results were furnished in the table 2.

Studies on resistance to *P. zeae* sugarcane clones Co 88020, Co 89009 and Co 89034 were found to be resistant to *P. zeae* [2]. Novaretti *et al*., 1988 [13] reported that sugarcane clone, NA 56-79 was tolerant to *P. zeae*. In Brazil, sugarcane clone cv.sp 70-1143 was found to be resistant to both *P. zeae* and *Meloidogyne javanica* [14] while the clone IAC 77-52 was found to be tolerant to *P. zeae* [15]. Similar work has been conducted in other crops, and has resulted in improved resistant cultivars. For example, Thompson *et al.* (2011) [17] reported increased resistance to root-lesion nematodes was achieved in Australian chickpea by hybridising commercial cultivar (*Cicer arietinum*) with wild relatives (*C. reticulatum* and *C. echinospermum*). Wild relatives of sugarcane were also reported to be highly resistant to Pachymetra root rot [16, 9]. Thus, introgression of resistant genes of these wild species and other close relatives of sugarcane has the potential to provide the industry with improved varieties that could help manage many difficult-to-control soil pathogens.

Conclusion

In conclusion, this paper describes a number of experiments that have been designed for screening large number of sugarcane clones for resistance to root knot and lesion nematode. These methods are already being used to screen clones for resistance to the two species of nematode. Similar works have been conducted in other crops and resulted to develop improved resistant cultivars. In the present experiment, the clone C 260628 was found to be moderately resistant to *Pratylenchus zeae*. The two clones C 260628 and CoC 24 were found to be resistant against the root knot nematode. The clone C 260628 was moderately resistant and CoC 24 was tolerant against the lesion nematode.

Table 1: Screening of sugarcane varieties / clones against root knot nematode, *Meloidogyne incognita*

Sl. No.	Clone / variety	Gall index	No. of galls / plant	Reaction
1	C 33004	3	25	MR
2	C 33005	3	13	MR
3	C 33008	3	16	MR
4	C 33018	3	16	MR
5	C 33024	3	35	S
6	C 33025	3	21	MR
7	C 33028	3	17	MR
8	C 33032	3	38	S
9	C 33035	3	19	MR
10	C 33042	3	15	MR
11	C 33046	3	40	S
12	C 33049	3	17	MR
13	C 33050	3	15	MR
14	C 33051	3	16	MR
15	C 33056	3	20	MR
16	C 33060	3	14	MR
17	C 33062	3	18	MR
18	C 33064	3	33	S
19	C 33074	3	22	MR
20	C 33075	3	15	MR
21	C 33082	3	36	S
22	C 33105	3	18	MR
23	C 33108	3	39	S
24	C 33114	3	14	MR
25	C 33122	3	17	MR
26	C 260628	2	7	R
27	CoC 24	2	9	R

MR – Moderately Resistant, S – Susceptible, R – Resistant

Table 2: Screening of sugarcane varieties / clones against lesion nematode, *P. zeae*

Sl. No.	Clone /variety	Lesion index in root (%)	Level of Resistance
1	C 33004	15	T
2	C 33005	16	T
3	C 33008	11	T
4	C 33018	13	T
5	C 33024	23	S
6	C 33025	15	T
7	C 33028	14	T
8	C 33032	26	S
9	C 33035	12	T
10	C 33042	17	T
11	C 33046	21	S
12	C 33049	16	T
13	C 33050	14	T
14	C 33051	12	T
15	C 33056	10	T
16	C 33060	18	T
17	C 33062	17	T
18	C 33064	28	S
19	C 33074	14	T
20	C 33075	12	T
21	C 33082	30	S
22	C 33105	13	T
23	C 33108	27	S
24	C 33114	12	T
25	C 33122	16	T
26	C 260628	9	MR
27	CoC 24	11	T

T- Tolerant, S-Susceptible, MR-Moderately Resistant

Acknowledgement

We would like to thank Professor and Head, Sugarcane Research Station, Tamil Nadu Agricultural University, Cuddalore for supplying clones provide funding for conducting the experiments.

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