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Performance of Potato and Maize as First Intercrop, Dhaincha (Green manure) as Second Intercrop with Paired Row Sugarcane in Old Himalayan Piedmont Plain

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ABSTRACT

An experiment was conducted at Regional Sugarcane Research Station, Thakurgaon farm during 2002-03 crop season to evaluate the performance of potato and maize as first intercrop and dhaincha (green manure) as second intercrop with paired row sugarcane for higher economic return and batter soil health in Old Himalayan Piedmont Plain. Significantly highest cane yield of 84.03 t ha^{-1} and potato yield of 13.94 t ha^{-1} were produced in the treatment T_1 which resulted the highest net profit of Tk. 76,877.00 ha^{-1}. The highest net profit as derived by T_1 was found 55.19 percent higher than T_0 (control). Among the different maize intercropping treatments, the variety Pacific 988 gave the highest economic return followed by Barnali irrespective of single and double rows population. In general, maize as intercrop adversely affected on millable cane production as well as on cane yield. The yield reduction due to maize intercroping in different treatments varied from 5.42 to 16.79 percent, but single row maize as intercrop in paired row cane was found less adverse than double rows in producing the yield parameters of cane and cane yield. The maize variety Pacific 988 with single row population (T_7) significantly produced higher yield of 3.26 t ha^{-1} where the cane yield was 71.06 t ha^{-1} and it was found statistically identical to T_0. In consideration of total net profit (cane + maize) the treatment T_7 exhibited the second highest net profit of Tk. 59,686.00 ha^{-1} and which was found 20.47 percent higher than that of T_0. Results revealed that either potato or single row maize with dhaincha (green manure) as second intercrop can be cultivated profitably in paired row sugarcane.

Key words : Sugarcane paired row intercrop, potato, maize, Dhaincha.

INTRODUCTION

Maize is a short durable, high yielding potential cereal crop in Bangladesh .It has multiple use all over the world and occupied 3rd position after rice and wheat as cash crop (Khatun, 1990). In Bangladesh maize is cultivated as an alternate cash crop of pulses, oil seed, winter vegetables and sugarcane. People are also habituated to use maize as food and feed owing to its high food value. Plants debris of maize is a good source of fuel and released energy was found 75% equivalent of coal thermal unit (Khatun, 1990). Northern region of the country is the main maize-producing belt. During the last decade maize production increased from 3,040 ton to 1,00,000 ton, which is about 33 times higher than the past and 86% of which produced in rabi season (Begum, 2002). At present demand

of maize is increasing day by day due to its less production cost and high cost benefit ratio (Hossain and Ismail, 2002). Maize can be cultivated in both robi and kharif season' under the climatic condition of Bangladesh. Now a days maize cultivation has become popular and farmers are showing interest to cultivate maize (Ahammed and Haque, 2002). Thus potential sugarcane area of the northern districts is being reduced gradually. Maize has the advantage to cultivate as intercrop in rows like other short durable winter crops in between two sugarcane rows instead of growing it as single crop, there by farmers can easily grow maize as intercrop with paired row sugarcane. Yield of cane was not significantly affected by different maize intercropping treatments in paired row cane (Anon., 1997). Maize had no significant adverse effect on yield of sugarcane and did not reduce the cane yield of long season plant cane and yield of sugar is unaffected (Anon. 1992). But no adequate research work has been done in Bangladesh for growing maize as intercrop with sugarcane.

In view of the above facts, the present research work was undertaken to evaluate the effect of potato and maize as first inter crop and dhaincha (green manure) as second intercrop with paired row sugarcane.

MATERIALS AND METHOD

The experiment was carried out at Regional Sugarcane Research Station, Thakurgaon farm during the cropping season 2002-03. The following 8 treatments were tested in RCBdesign with 3 replications:

T_0 = pure stand cane in conventional row (control)
T_1 = paired row STP cane (PRC) + potato -dhaincha
T_2 = PRC + Maize (Barnali) double rows- dhaincha
T_3 = PRC + Maize (Barnali) single row - dhaincha
T_4 = PRC + Maize (Khai Bhutta) double rows- dhaincha
T_5 = PRC + Maize (Khai Bhutta) single row - dhaincha
T_6 = PRC + Maize (Pacific 988) double rows - dhaincha
T_7 = PRC + Maize (Pacific 988) single row - dhaincha

The cane variety Isd 31 was used as planting material in the experiment and planted in the 1st week of November, 2002 with 2 month aged soil bed settlings. Plantation was done in STP method in a plot size of 8m x 6m. Paired row system of planting was followed only in the intercropping treatments and the remaining treatment was planted in conventional row. The treatment T_0 with pure stand conventional cane and the treatment T_1 with potato intercropping were considered as 1st and 2nd standard respectively. As 1st intercrop, potato variety Cardinal in three rows and maize varieties Barnali, Khaibutta and Pacific 988 were planted both in single and double rows in the subsequent week of cane plantation. After harvesting of 1st intercrop potato and maize, dhaincha was grown as second intercrop for green manuring purposes. Dhaincha was incorporated with the soil after two months at flowering initiation stage. Recommended fertilizer doses for cane were followed. All the plots of the experiment were irrigated 5 times at early growth of the crop followed by proper agronomical management. Necessary pest control measure were followed in all the plots. Data on the different crop parameters were collected in time and analyzed properly.

RESULTS AND DISCUSSION

From the results it revealed that significantly highest number of tillers and millable cane were produced by the treatment T_0 (control) where sole cane was grown in conventional row. Irrespective of varieties both single and double rows maize as intercrop found detrimental to tiller and millable cane production. But the single row maize in the treatments T_3, T_5 and T_7 irrespective of varieties was found less adversative than double rows in producing number of millable cane. However, the effects were statistically similar.

Table 1. Yield and economic return of growing potato and maize as intercrop with paired row sugarcane in old Himalayan piedmont plain, RSRS, Thakurgaon 2002-03.

Treatments	Millable cane ($x1o^3$ ha^{-1})	Cane yield (t ha^{-1})	Cane yield increase/decrease for intercrop (%)	Brix at harvest (%)	Yield of intercrop (t ha^{-1})	Total cost of cultivation Cane + intercrop (Tk ha^{-1})	Total sale procced cane + intercrop (Tk. ha^{-1})	Net profit cane + intercrop (TK.ha^{-1})	Additional loss/profit for intercrop (Tk ha^{-1})
T_0	114.00 a	78.07 ab		18.60	-	36333	85877	49544	-
T_1	103.05 b	84.03 a	7.63(+)	19.93	13.94 a	71306	148193	76887	27343.00
T_2	78.12 e	64.96 c	16.79(-)	19.16	4.02 a	50786	103616	52830	3286.00
T_3	85.20 cd	73.84 abc	5.42(-)	18.67	2.62 c	44560	102184	57624	8080.00
T_4	83.88 cde	69.54 bc	10.93(-)	18.33	2.83 bc	50786	99134	48348	-1196.00
T_5	86.17 c	72.73 bc	6.84(-)	19.03	2.39 c	44560	99123	54563	5019.00
T_6	80.00 de	66.07 c	15.37(-)	18.07	4.09 a	50786	105397	54611	5067.00
T_7	83.45 cde	71.06 bc	8.97(-)	19.37	3.26 b	44560	104246	59686	10142.00

Figures with same letters in a column do not differ significantly at 5% level as per DNMR Test
Price of crop: Sugarcane TK. 1100 t^{-1} Potato = TK.4000 t^{-1} Maize =TK.8000 t^{-1}

From the Table 1 it is evident that significantly highest cane yield of 84.03 t ha^{-1} was produced by the treatment T_1 where potato was intercropped with paired row sugarcane followed by T_0 with the second highest cane yield. The highest cane yield of T1 was supported by higher number of millable cane stalk. The cane yield was increased 7.63% for potato intercropping. But all the maize intercropping treatments irrespective of varieties and plant population were not found congenial to sugarcane growth and it decreased the cane yield from 5.92-16.72%. It was also found that intercropping maize led to significant reduction in cane and sugar yield (Anon., 1986). Again for maize yield, the treatments T_2, T_4 and T_6 with double rows maize irrespective of variety found statistically superior to single row maize. Similar results also obtained by Anon., (1997) who found that two lines maize intercropping between two paired rows of cane yielded better than one row maize intercropping. Significantly the lowest cane yield of 64.96 t ha^{-1} was produced by the treatment T_2 where two rows maize were grown as intercrop. These results were supported with the results of anonymous, 1980 who also observed that two rows of maize significantly loss of cane and sugar yield where one row maize with some interplant spacing did not show any adverse effect. All the treatments with single row maize produced higher cane t ha^{-1} than double rows. The best overall productivity was obtained by anonymous, 1983 by growing one row of maize in every interrow of uniformly spaced cane.

Results from Table 1 further reveal that neither potato nor maize as intercrop influenced the % brix in cane. The highest and lowest brix% of 19.93 and 18.70 were

recorded in the treatments T_1 and T_6 respectively but they were identical.

The Table 1 shows that the treatment T_1 (sugarcane + potato) gave the highest net profit of Tk. 76,887.00 ha^{-1} followed by the treatment T_7 and T_3 with the profit of Tk. 59,686.00 and Tk. 57,624.00 ha^{-1} respectively where single row maize were grown as intercrop with paired row sugarcane. In consideration of additional income over control, it revealed that Tk. 27,343.00, 10,142.00 and 3,495.00 ha^{-1} were obtained by the treatments T_1, T_7 and T_3 respectively .The highest additional income for the maize intercropping treatment T_7 was found 2.70 times less than that of intercrop potato.

It may be concluded that though potato intercropping with sugarcane gave double income in comparison to maize yet its cost of cultivation is very high (Tk. 34,973.00 ha^{-1}). Generally medium and marginal farmers cannot afford such high cost for growing potato as intercrop. On the other hand, with one-forth of the cost of potato farmers can profitably grow maize as intercrop with sugarcane. Therefore, it may be suggested that single row maize of any highbred or high yielding variety can be profitably grown as intercrop in paired row cane by the farmers with a minimum investment to get higher additional income from their cane field.

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Survey of Plant Parasitic Nematodes of Sugarcane in Bangladesh

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ABSTRACT

The results of present study revealed that *Meloidogyne* spp. were the most widely distributed plant parasitic nematodes of sugarcane in Bangladesh. Soil samples collected from ten mill zones contained root-knot nematodes. In the country, *Meloidogyne* spp. are widely distributed and attack the most of the crop species. They were also reported earlier as pests of sugarcane in Bangladesh. The other plant parasitic nematodes recorded in present study as pests of sugarcane were *Hoplolaimus, Longidorus, Pratylenchus, Trichodorus, Tylenchorhynchus and Xiphinema*. The populations of plant parasitic nematodes ranged from 114.1 to 773.3/litre soil in ten mill zones, namely, PBSM, NBSM, JSM, RJSM, SHSM, ZBSM, TSM, STSM, Carew & Co. and FSM. The highest population was found in SHSM Zone, which was significantly higher as compared to other nine mill zones. The maximum of 682.3 plant parasitic nematodes per kilogram of roots were collected from FSM Zone, which was significantly higher as compared to other nine mill zones. In all mill zones, the lowest population of Meloidogyne spp. was recorded in soil collected before planting. The populations increased gradually with the progress of time after planting of sugarcane. The maximum populations of the nematode were found in soils collected at harvesting stage from all mill zones.

Key words : Sugarcane, parasitic nematodes, population.

INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the major industrial cash crops in Bangladesh. It is the principal sugar crop from which white sugar and "Gur" are produced. Among various factors for low yield of cane and sugar recovery in the country, diseases play an important role. Till now, 38 sugar cane diseases have been identified in Bangladesh. Among them, root-knot and root-lesion are caused by nematodes (Rahman *et al.*, 1993). The low yield of sugarcane in Bangladesh is attributed to poor growth of cane resulting from shallow, reduced, thickened and distorted root system which is caused by the parasitic nematodes to a large extent especially in some northern mill zone areas. About 30 genera and 50 species of nematodes have been found associated with sugarcane roots in different sugarcane growing countries of the world (Winchester, 1969).

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Of the nematode genera, species of *Pratylenchus, Xiphinema, Tylenchorhynchus, Trichodorus, Helicotylenchus, Hoplolaimus* and *Meloidogyne* cause much more damage than the other nematode genera (Chona and Swarup, 1960; Williams, 1963 and Jayaram *et al.*, 1966).

Association of parasitic nematodes with sugarcane in Bangladesh was reported by Timm and Ameen (1960) and Mc Aleese (1982). Eight genera of plant parasitic nematodes e.g. *Hoplolaimus* sp., *Criconemoides* sp., *Helicotylenchus* sp., *Zygotylenchus* sp., *Hemicycliophora* sp., *Meloidogyne* sp., *Tylenchus* sp. and *Xiphinema* sp. were found to be associated with sugarcane in Bangladesh with Hoplolaimus indicus being the most predominant (Mian and Tsuno, 1988). Williams (1969) reported that root-knot nematodes, Meloidogyne spp. are very common in sugarcane fields. The species usually reported are Meloidogyne javanica, M. incognita but Meloidogyne arenaria and Meloidogyne thames have also been recorded. Survey conducted by Timm and Ameen (1960) and Mian and Ali (1986) revealed the association of parasitic nematodes with some important crop species commonly grown in the country and postulated that among the species recorded, the most important nematodes were species of Meloidogyne.

A preliminary investigation on nematode of sugarcane in Bangladesh was carried out by Sugarcane Research and Training Institute and severe nematode infestation was recorded in some sugar mill zones (Anon., 1981).

A survey of sugarcane fields in the Punjab, Pakistan was undertaken to ascertain the kinds and number of plant parasitic nematodes present. The most abundant genera associated with sugarcane were *Helicotylenchus, Hoplolaimus, Meloidogyne, Pratylenchus, Trichodorus* and *Tylenchorhynchus* (Anwar *et al.*, 1986).

In a survey of sugarcane in Sao Paulo State, Brazil, Pratylenchus and *Helicotylenchus* were widely distributed and *Meloidogyne javanica, M. incognita* and *M. arenaria* and an unidentified *Ditylenchus* sp. caused considerable damage to sugarcane (Novaretti *et al.*, 1974). The most abundant genera of plant parasitic nematodes found associated with sugarcane in *Barbados* were *Aphelenchus, Helicotylenchus, Pratylenchus, Tylenchus, Rotylenchulus, Criconemoides* and *Meloidogyne* (Brathwaite, 1976).

Siswojo (1981) reported that the most important nematodes found in soil samples taken from 8 sugarcane factories in Java from 1976 to 1978 were *Helicotylenchus, Pratylenchus, Meloidogyne* and *Criconemoides*. The most important in root samples were *Meloidogyne* and *Pratylenchus*.

Sugarcane roots and soil samples collected from Mohan farm of Thakurgaon Sugar Mill, Protap farm of Setabgonj Sugar Mill and Carew & Co (Darshana) were found to be associated with various plant parasitic nematodes including *Meloidogyne* spp (Anon., 1983).

Examination of over 2000 samples during 1982/4 covering 5261 ha in a sugarcane area in Brazil showed *Meloidogyne, Pratylenchus, Helicotylenchus, Paratrichodorus* and *Criconemella* to be the most common and present in the highest numbers where P. Zeae, p. brachyurus, M. Javanica and M. arenaria were particularly prevalent (Gomes and Novaretti, 1985).

In a survey of soil samples from sugarcane fields in Uttar Pradesh. India, Meloidogyne incognita was the most frequently encountered plant parasitic nematode, followed by *Helicotylenchus indicus, Hoplolaimus indicus, Tylenchorhynchus mashhodi, Longidorus* sp, and *Xiphinema* sp. (Akhtar and Wani, 1992).

A survey of plant parasitic nematodes of sugarcane in Bihar, India showed that *Tylenchorhynchus goldeni, T. nudus, Helicotylenchus dihystera, H. indicus, Hoplolaimus indicus, Meloidogyne incognita* and *Pratylenchus zeae* were the most frequently found (Haider and Nath, 1996).

Very little work has so far been done regarding survey of plant parasitic nematodes of sugarcane. This experiment has been undertaken to findout the plant parasitic nematodes associated with sugarcane in Bangladesh.

MATERIALS AND METHODS

A comprehensive survey was conducted to study the population of plant parasitic nematodes of sugarcane. The survey was conducted during 1998-99 throughout sugarcane growing areas of 10 sugarcane mill zones, namely, Pabna Sugar Mills (PBSM), North Bengal sugar mills (NBSM), Joypurhat sugar mills (JSM), Rajshahi sugar mills (RJSM), Shyampur sugar mills (SHSM), Zeal Bangla sugar mills (ZBSM), Thakurgaon sugar mill (TSM), Setabgonj sugar mill (STSM), Carew & Co. and Faridpur sugar mills (FSM) in Bangladesh (Fig. 1). From each sugarcane field 20 and 5 spots were selected randomly for collection of soil and root samples respectively. About one litre soil was collected from each plot of a sugarcane field just before planting (October/November), at the middle of growing period (May/June) and at the harvesting stage of cane (November/December). Soils cores were collected from the root zones around the sugarcane stool, at a depth of 15 cm with a soil auger. All soil cores collected from a field were mixed thoroughly and 15 kg of the composite soil sample of each field was brought to the laboratory for nematode extraction and other studies. In a crop season, root samples of sugarcane were collected at the middle of growing stage and at harvesting stage from the selected fields of all 10 mill zones. Sugar plants were uprooted from five spots of each selected field and roots were cut from the base of the stalks. The roots collected from field were washed with tap water, mixed together and 250 g of root samples was obtained from each field to extract nematodes associated with the roots. Nematodes were extracted from soil and root following modified Whitehead's tray method (Whitehead and Hemming, 1965).

The nematodes extracted from soil and root-samples were grouped as plant parasitic and non plant parasitic nematodes based on presence of stylet. The plant parasitic nematodes were identified upto genus level comparing their morphology and morphometrics with the description of Commonwealth Institute of Parasitology (previously CIH). The root-knot nematodes were identified upto species level studying their morphology and perineal pattern (Taylor and Sasser, 1978). The populations of identified genera of plant parasitic nematodes extracted from soil and root samples were counted. For counting, nematode suspension was mounted on a counting slide (1ml capacity) and observed under a dissecting steriomicroscope. Their population was expressed as number of individual nematode per litre of soil and per kilogram of roots. The population of root-knot nematodes associated with soil was determined using bioassay technique. About 250 cm3 of each of the samples collected from 10 sugar mill zones was poured into 15 cm earthen pot. Two 25 days old tomato/brinjal seedlings (susceptible variety) grown on nematode free soil was transplanted in each pot. The remaining part of the pot was filled with formalin sterilized sandy loam soil. The 15 cm pots were placed in 20 cm earthen pots to protect them from contamination with surrounding soil of the potyard. The seedlings were allowed to grow for 21 days providing necessary fertilizer and

irrigation. At the end of the growing period, the tomato plants were removed from pots to minimize pot damage. The root systems were washed in running tap water to clean associated dirt and stained with lactophenol cotton blue (Taylor and Sasser, 1978) to count nematode population in roots.

Figure 1. Sugar mills zones surveyed

Legend :

- PBSM = Pabna Sugar Mills
- RJSM = Rajshahi Sugar Mills
- TSM = Thakurgaon Sugar Mills
- Carew & Co. = Carew & Company Sugar Mills
- NBSM = North Bengal Sugar Mills
- SHSM = Shyampur Sugar Mills
- STSM = Setabgonj Sugar Mills
- JSM = Joypurhat Sugar Mills
- ZBSM = Zeal Bangla Sugar Mills
- FSM = Faridpur Sugar Mills

RESULTS AND DISCUSSION

A total of seven genera of plant parasitic nematodes namely *Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus, Trichodorus, Tylenchorhynchus* and *Xiphinema* were found to be associated with roots and soils of sugarcane collected from ten different sugar mill zones (Table 1). Among them, *Meloidogyne, Hoplolaimus* and *Longidorus* were found in all mill zones. *Pratylenchus* was found in PBSM, NBSM, JSM, RJSM, SHSM, ZBSM and STSM zones. Xiphinema was found in SHSM and FSM zones and Trichodorus occurred only in JSM. In every mill zone higher number of genera were recorded from soil than sugarcane root. It was found that genus Meloidogne consisted of at least two species viz. *M. incognita* and *M. javanica*. They were identified by studying perineal pattern of mature females (Taylor and Sasser, 1978). These two species are common nematode pests of many crops in Bangladesh (Mian, 1986). In the country, Meloidogyne spp. are widely distributed and attack the most of the crop species (Mian and Ali, 1986). They were also reported earlier as pests of sugarcane in Bangladesh (Mian and Tsuno, 1988). The other plant parasitic nematodes recorded in present study as pests of sugarcane were *Hoplolaimus, Longidorus, Pratylenchus, Trichodorus, Tylenchorhynchus* and *Xiphinema*. These genera have also been reported earlier as sugarcane pests from Bangladesh (Mian and Tsuno, 1988) and from other sugarcane growing countries of the world (Williams, 1969; Spaull, 1981; Siswojo, 1981; Anwar *et al.*, 1986 and Akhtar and Wani, 1992).

The population of plant parasitic nematodes associated with soils and roots collected from ten different sugar mill zones are shown in the Table 2. Their populations ranged from 114.1 to 773.3/litre soil in ten zones. The highest population was found in SHSM zone, which was significantly higher as compared to other nine mill zones. The minimum number of nematodes were recorded in soil from TSM, which was preceded by FSM, ZBSM and STSM. The maximum of 682.3 plant parasitic nematodes per kilogram of roots were collected from FSM Zone, which was significantly higher as compared to other nine mill zones. In other mill zones, their populations ranged 88.2-150.8/kg root, which was statistically similar. The mean populations of plant parasitic nematodes in soil collected before planting, at middle stage and at harvesting stage of sugarcane were 182.6, 472.1 and 790.8/litre soil respectively. The differences among their populations at different stages of soil collection were significant (Fig. 2).

Before planting of sugarcane, the nematode populations in soils collected from different mill zones ranged 35.0-413.3/litre soil. The highest population was found in SHSM, which was statistically similar to RJSM. On the other hand, the lowest population was recorded in FSM. At the middle stage, their populations increased in all mill zones. The maximum increase was observed in JSM zone. The increase of nematode population continued in soils of NBSM, RJSM, SHSM, Carew & Co and FSM upto harvesting stage. However, the increase was not significant in FSM zone. In five mill zones (PBSM, JSM, ZBSM, TSM and STSM), their populations decreased with the progress of time after the middle stage and the decrease was significant in PBSM, ZBSM and STSM zones (Table 3). The mean populations of plant parasitic nematodes associated with sugarcane root collected at middle of cane growth and at harvesting stage were 165.0 and 185.7, respectively (Fig. 3).

Table 1. Plant parasitic nematodes associated with soils and roots of sugarcane collected from ten sugar mill zones, 1999.

Sugar mill zones	Plant parasitic nematodes from soil and root	
	Soil	Root
PBSM	*Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus, Tylenchorhynchus*	Hoplolaimus, Pratylenchus
NBSM	*Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus, Tylenchorhynchus*	*Hoplolaimus*
JSM	*Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus, Tylenchorhynchus, Trichodorus.*	*Hoplolaimus, Longidorus, Trichodorus*
RJSM	*Trichodorus, Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus, Tylenchorhynchus*	*Hoplolaimus, Longidorus*
SHSM	*Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus, Tylenchorhynchus, Xiphinema*	*Hoplolaimus, Longidorus, Xiphinema*
ZBSM	*Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus*	*Hoplolaimus, Longidorus*
TSM	*Hoplolaimus, Longidorus, Meloidogyne*	*Hoplolaimus, Longidorus*
STSM	*Hoplolaimus, Longidorus, Meloidogyne, Pratylenchus*	*Hoplolaimus, Longidorus*
Carew & Co	*Hoplolaimus, Longidorus, Meloidogyne*	*Hoplolaimus, Longidorus*
FSM	*Hoplolaimus, Longidorus, Meloidogyne, Xiphinema*	*Hoplolaimus, Longidorus*

PBSM=Pabna Sugar Mills, NBSM=North Bengal Sugar Mills, JSM=Joypurhat Sugar Mills, RJSM=Rajshahi Sugar Mills, SHSM=Shyampur Sugar Mills, ZBSM=Zeal Bangla Sugar Mills, TSM=Thakurgaon Sugar Mills, STSM=Setabgonj Sugar Mills, Carew & Co=Carew and Company Sugar Mills, FSM = Faridpur Sugar Mills.

Table 2. Population of plant parasitic nematodes associated with soils and roots of sugarcane collected from ten sugar mill zones, 1999.

Sugar mill zones	Population of nematodes/ litre soil	Population of nematodes/ kg root
Pabna Sugar Mills	514.0 d	90.3 b
North Bengal Sugar Mills	621.0 bc	128.3 b
Joypurhat Sugar Mills	635.4 b	88.2 b
Rajshahi Sugar Mills	666.4 b	127.5 b
Shyampur Sugar Mills	773.3 a	90.3 b
Zeal Bangla Sugar Mills	365.2 e	143.0 b
Thakurgaon Sugar Mills	114.1 g	150.8 b
Setabgonj Sugar Mills	369.0 e	137.5 b
Carew and Company Sugar Mills	576.2 c	115.5 b
Faridpur Sugar Mills	183.7 f	682.3 a

Values of per litre soil are averages of nine observations and those of per kg root are averages of six observations and those within the same column with a common letter(s) do not differ significantly (P=0.05) by DMRT.

Table 3. Population of plant parasitic nematodes in soils of sugarcane field collected at three different times from ten sugar mill zones, 1999.

Sugar mill zones	Population of nematodes/litre soil at three times of collection		
	Before planting	Middle stage	Harvesting stage
Pabna Sugar Mills	82.3 no	888.7 d	571.0 f
North Bengal Sugar Mills	129.0 mno	147.31 mn	1587.0 a
Joypurhat Sugar Mills	117.7 mno	915.7 d	873.7 d
Rajshahi Sugar Mills	355.0 g	613.3 ef	1031.0 c
Shyampur Sugar Mills	413.3 gh	675.7 e	1231.0 b
Zeal Bangla Sugar Mills	193.3 klm	542.3 f	360.0 gh
Thakurgaon Sugar Mills	115.7 mno	129.0 mno	97.7 no
Setabgonj Sugar Mills	313.3 ij	444.7 g	349.0 hi
Carew and Company Sugar Mills	71.0 no	133.3 mn	1524.0 a
Faridpur Sugar Mills	35.0 o	231.0 jkl	284.3 h-k
Mean	182.6	472.1	790.8

Values are averages of three observations and those within the same column and row with a common letter(s) do not differ significantly (P=0.05) by DMRT.

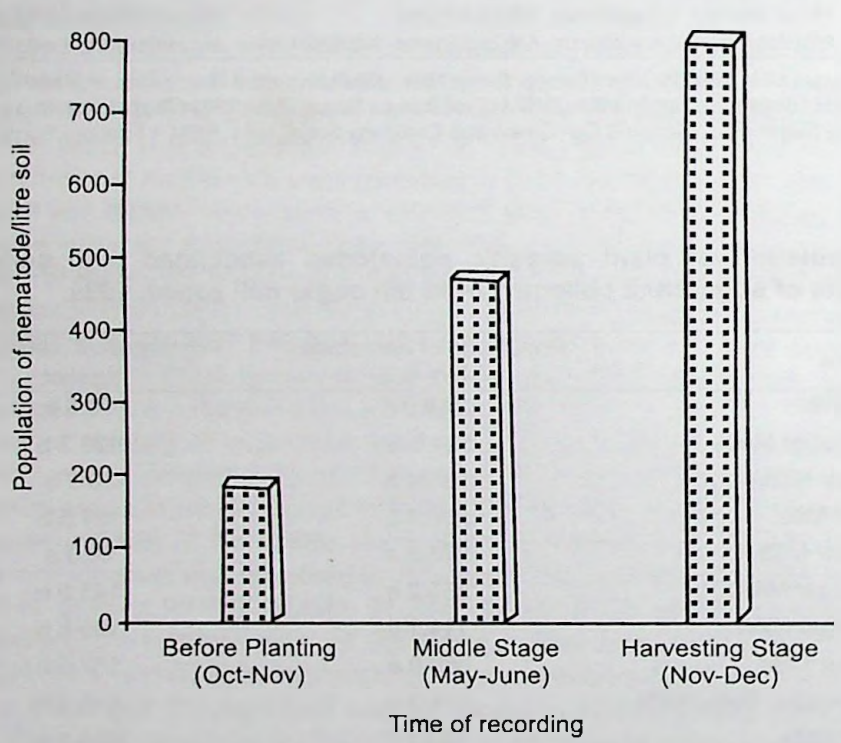

Figure 2. Population of plant parasitic nematodes in soil of sugarcane fields collected at different times of a crop season.

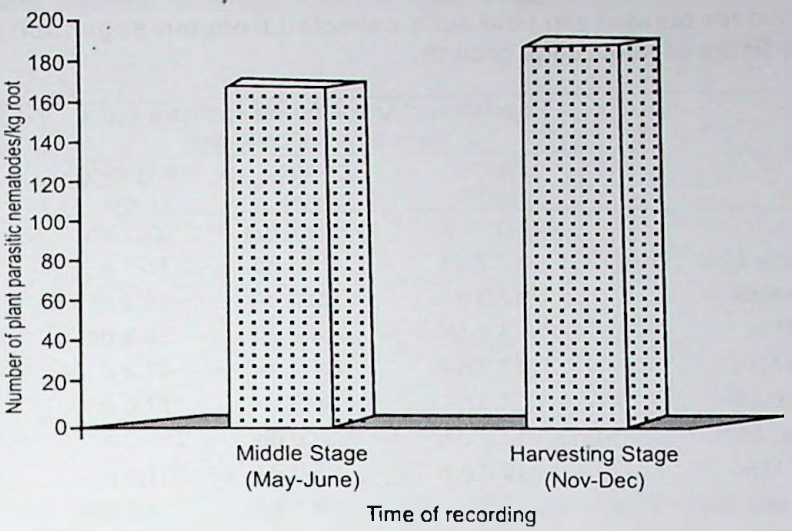

Figure 3. Population of plant parasitic nematodes associated with sugarcane root collected at middle and harvesting growth stage of cane.

The populations of *Meloidogyne* spp. in soils collected from ten sugar mill zones were estimated through bioassay using tomato and brinjal as test plants. It was estimated on the basis of numbers of mature females of Meloidogyne spp and galls developed in roots of tomato and brinjal (Tables 4 and 5). In all mill zones, the lowest population was recorded in soil collected before planting. The populations increased gradually with the progress of time after planting of sugarcane. The maximum populations of the nematode were found in soils collected at harvesting stage from all mill zones. However, their populations at harvest were significantly higher in NBSM, RJSM, ZBSM, TSM and STSM as compared to earlier times of soil collection. The lowest population was recorded in Carew & Co., FSM, PBSM and JSM areas (Table 4). In all mill zones, the maximum root gall were recorded in tomato/brinjal planted in soil collected at harvesting time, which was followed by middle stage and before planting. However, severity of gall was significantly higher as compared to other two stages of soil collection in PBSM, NBSM, RJSM, SHSM, ZBSM, STSM and Carew & Co. zones. The numbers of galls at three times of soil collection were significantly different in the area of TSM (Table 5).

Table 4. Population of *Meloidogyne* spp. in root galls of tomato and brinjal planted for bioassay in field soils collected from ten sugar mill zones at three times of sugarcane growth.

Sugar mill zones	Population of *Meloidogyne* spp./litre soil at three times of collection			Mean
	Before planting	Middle stage	Harvesting stage	
Pabna Sugar Mills	6.7 fgh	9.7 fgh	23.7 dh	13.3
North Bengal Sugar Mills	3.7 gh	7.3 fgh	76.7 c	29.2
Joypurhat Sugar Mills	17.3 d-h	29.3 d-g	31.3 ef	26.0
Rajshahi Sugar Mills	4.0 gh	4.7 gh	38.3 de	15.7
Shyampur Sugar Mills	17.7 d-h	31.7 def	43.3 d	30.9
Zeal Bangla Sugar Mills	1.3 h	18.2 d-h	77.0 c	32.2
Thakurgaon Sugar Mills	17.7 d-h	38.0 de	315.0 a	123.6
Setabgonj Sugar Mills	15.0 e-h	25.0 d-h	131.0 b	57.2
Carew and Company Sugar Mills	1.3 h	8.3 fgh	14.0 e-h	7.9
Faridpur Sugar Mill	3.0 h	15.7 e-h	17.0 d-h	11.9
Mean	8.8	46.5	49.1	

Data are means of bioassay tests of tomato and brinjal
Values are averages of three observations and those within the same column and row with a common letter(s) do not differ significantly (P=0.05) by DMRT.

Table 5. Number of galls in roots of tomato and brinjal planted for bioassay in field soils collected from ten sugar mill zones at three times of sugarcane growth.

Sugar mill zones	Number of galls/litre soil at three times of collection			Mean
	Before planting	Middle stage	Harvesting stage	
Pabna Sugar Mills	6.3 h-n	7.7 h-n	21.7 c-g	11.9
North Bengal Sugar Mills	3.0 k-n	4.3 i-n	24.3 cde	10.5
Joypurhat Sugar Mills	15.7 e-h	23.3 c-f	24.7 cde	21.2
Rajshahi Sugar Mills	2.3 lmn	3.7 j-n	21.3 c-g	9.1
Shyampur Sugar Mills	14.7 e-i	16.0 e-h	27.0 cd	19.2
Zeal Bangla Sugar Mills	1.0 h	14.0 c-j	56.3 b	23.7
Thakurgaon Sugar Mills	13.3 f-k	30.0 c	91.0 a	44.8
Setabgonj Sugar Mills	12.0 g-m	16.3 d-h	57.7 b	28.7
Carew and Company Sugar Mills	1.0 n	4.7 i-n	13.0 f-l	6.2
Faridpur Sugar Mills	2.0 mn	14.3 e-h	15.7 c-h	10.7
Mean	7.1	13.4	35.3	

Data are means of bioassay tests of tomato and brinjal
Values are averages of three observations and those within the same column and row with a common letter(s) do not differ significantly (P=0.05) by DMRT.

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