EFFECT OF ORGANIC AMENDMENTS ON PLANT PARASITIC NEMATODES AND SOIL MICRO-ORGANISMS

By

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DECLARATION

I hereby declare that this thesis entitled "Effect of organic amendments on plant parasitic nematodes and soil micro-organisms" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any Degree, Diploma Associateship Fellowship or other similar title of any other university or society

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CERTIFICATE

Certified that this thesis entitled Effect of organic amendments on plant parasitic nematodes and soil micro organisms" is a record of research work done independently by K AJITH under my guidance and supervision and that it has not previously formed the basis for the award of any Degree Fellowship or Associateship to him

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INTRODUCTION

INTRODUCTION

Ecological problems caused by the practices of modern crop husbandry made man think about a much safer method of pest control A recent approach for the control of soil nematodes is based on the principle that the soil population at any time will be determined by habitat conditions and that the populations can be changed in any direction by making appropriate changes in soil environment

One of the cheapest and effective method for alternating soil environment is by amending the soil with decomposable organic materials Linford et al (1938) suggested for the first time the possible implications of organic amendments for the control of nematodes Organic amendments in the form of oil cakes have proved effective against root knot nematode populations (Singh et al 1980) Now a large number of plants are known to have nematode suppressant properties (Suatmadji 1969 Sayre 1971 Gommers 1973 & Siddiqui 1986) are considered promising agents of biological control Among these neem (Azadirachta indica A Juss) is widely distributed in the tropical and subtropical regions Nematicidal property of neem is also well established Eupatorium (Cromolaena odorata (L) R M King and H Robinson) another common perennial weed in

South India was also evaluated for its nematicidal properties (Subramoniom 1986) Here an attempt is being made to study the effect of neem and eupatorium leaves on the population of plant parasitic predatory and saprophytic nematodes and micro organisms The overall performance of these fauna on the yield of bhindi and cowpea were assessed in field experiments in rainy and summer season

REVIEW OF LITERATURE

1 REVIEW OF LITERATURE

Information available on various aspects related to present investigation on the effect of organic amendments on nematodes and soil micro organisms have been briefly reviewed here

1 1 Effect of organic amendments on plant parasitic nematodes and non parasitic nematodes

1 1 1 Effect of oilcakes and seed kernals

1 1 1 1 Root knot nematode

Pillai and Desai (1975) observed that second stage larvae of Meloidogyne javanica was effectively controlled by marotti cake (Hydrocarpus laurifolia) They also reported that undecomposed Calaphyllus inophyllum oil cake gave best control of M javanica in tobacco plants (1976)

Mustard groundnut linseed and castor cake reduced gall number (Zaiyd 1977) Groundnut cake was also found effective against root knot nematode (Trivedi et al 1978)

These cakes were effective against M incognita in turnip tomato carrot potato sugarbeet and radish (Siddiqui et al 1979) Mian and Rodriguez Kabana (1982) reported that soil amended with cotton seed oil cake and peanut cake reduced root galling caused by M arenaria in Cucurbita pepo Castor oil seed cake at 15 percent concentration controlled M incognita effectively High concentrations of castor oil seed cake were phytotoxic (Jaenh and Lambert 1983)

Spent mushroom was found superior to cake or ground seeds of Melia azadirach in reducing root knot index (Verma 1986) Neem seed kernal effectively reduced the root knots produced by M arenaria in tomato plants (Roosner and Zebitz 1987)

1 1 1 1 a Hatching inhibition

Cultural filterates of different fungi obtained from the rhizosphere of tomato C v Marglobe raised from seeds coated with oil cakes had nematicidal action and inhibited hatching of larvae of M incognita Highest mortality was exhibited by the cultural filterates of

Trichoderma viride because of high phenolic contents (Singh et al 1983)

1 1 1 2 Other Tylenchids

Prasad et al (1974) found that the population of Helicotylenchus Tylenchorhynchus and Pratylenchus in microplots was significantly reduced by combined application of wheat straw neem seed cake F Y M and N P K at 45 and 75 days after treatment (D A T) Higher doses of combinations of neem cake + N P K or 2 4 D mahua cake + 2 4 D and paddy husk + 2 4 D recorded low root knot index (Mishra and Prasad 1974)

Alam and Khan (1975) reported that neem cake mahua cake and mustard cake controlled phytonematodes in the field almost as effective as D D and Nemagon

Siddiqui et al (1979) reported that castor cake mustard cake and groundnut cake were effective in controlling Hoplolaimus indicus Tylenchorhynchus brassicae and Helicotylenchus spp in tomato carrot potato sugarbeet radish and turnip Application of neem cake greatly reduced

the total nematode population in oats and the succeeding Vigna unguiculata crop (Jain and Hasan 1980)

Singh et al (1980) recommended combined application of oil cakes and nematicides for effective control of nematode population since it was found superior to oil cakes alone and also only a low concentration of nematicide is required when mixed with oil cakes

Out of five oil cakes tried by Hasan and Jain (1984) cake of Azadiracta indica was most effective for the control of nematodes in berseem followed by bajra Neem seed kernal effectively reduced P penetrans population in soil (Roosner and Zebitz 1987)

1 1 1 3 Non- parasitic nematodes

Prasad et al (1974) observed an increase in the population of free living nematodes by a combined application of wheat straw neem seed cake F Y M and N P K

1 1 1 4 Plant growth characters and yield

Higher doses of neem cake + N P K or urea tillcake alone or in combination with N P K and groundnut

cake with urea or N P K gave high yield corresponding to long earheads in wheat Neem cake + N P K and higher doses of tillcake also provided more shoot length and higher yield (Mishra and Prasad 1974) They also reported that high yield of pods of mung was given by higher does of neem cake + N P K and tillcake + N P K Sharma et al (1981) found that number of tillers and shoot weight of wheat plants were increased in soil amended with mustard cake

Application of neem cake increased the fodder and seed yield of oats and V unguiculata (Jain and Hasan 1980) and A indica cake increased the fodder production in berseem and bajra Neem cake gave the maximum increase in photosynthetic pigment of oats leaves (Jain and Hasan 1984)

Higher doses (more than 1 5 percent) of castor oil seed cake when applied to soil was found to be phytotoxic (Jaenh and Lambert 1983)

Siddiqui et al (1979) found that mahua cake applied for nematode control in tomato potato carrot turnip, sugarbeet and radish was harmful to the crop

1 1 2 Green Leaves

1 1 2 1 Root knot nematode

Verhoop (1974) observed that Meloidogyne spp was suppressed by Tagetes minuta and T erecta when grown as rotation crops But when tomatoes were grown as test crop the number of Meloidogyne increased in high numbers

Root knot index and soil population of M incognita acrita were reduced when Tagetes patula and Sessamum orientalis were grown with Solanum melongena at a distance of 30cm in the same row or alternate rows (Varma et al 1978)

Espinosa (1980) found that chopped leves and stem ofChenopodium ambrosioides applied to soil inoculated with tomato root bits infected with Meloidogyne spp effectively reduced nematode population in tomato

Andropogon gayunus Brachiaria humidicola B mutica B riziziensis Panicum maximum and Hemartharia altissima were effective in controlling M incognita on Desmodium ovulifolium (Lerre et al 1981)

Mian and Rordriguez Kabana (1981) reported spent coffee grinds Crotalaria Kudzu (Pueraria lobata) or ramie (Boehmeria nivea) hays applied at one percent (w/w) were most effective in reducing root galling in C pepo

Plots manured by Crotalaria paulina C jun ea C spectabilis or Stizolobium deeringianum maintained significant reduction of nematode population for 2 years of soyabean crop whereas all other green manure crops reduced the nematode population (M javanica) immediately after application (Reck et al 1982)

Dutt and Bhatti (1986) concluded that application of chopped castor leaves (40g/Kg of soil) two weeks before the transplating of tomato effectively controlled M javanica

Roosner and Zebitz (1987) concluded that ground neem leaves were effective against M arenaria in tomato plants

1 1 2 2 Reniform nematode

Lal et al (1977) reported that A indica followed by sewage sludge and M azadirach controlled R reniformis

1 1 2 3 Other Tylenchids

Verhoop (1974) showed that Pratylenchus spp Helicotylenchus spp were suppressed by T minuta and T erecta when grown as rotation crops but Aphelenchus spp were not affected Tylenchus spp were suppressed by T minuta but not by T erecta

C procera gave maximum reduction of H indicus T brassicae T filiformis and A absari population out of 35 different plants tried by Haseeb et al (1978)

Raising resistant selections of oil radish and Sinapis alba as green manure crops reduced nematode population upto 30 percent (Heijbroek 1982)

Plots manured with C paulina C juncea C spectabilis or S deeringianum maintained significant reduction of P brachyurus population for 2 years of soyabean crop where as all other green manure crops reduced the nematode population immediately after the application (Resck et al 1982)

Ground neem leaves were found effective against P penetrans in tomato (Roosner and Zebitz 1987)

1 1 2 4 Plant growth characters and yield

Resck *et al* (1982) reported that application of *C paulina* *C juncea* and *Cyamopsis psoroloides* gave highest yield and low nematode population The growth and yield of tomato plants was improved by ground neem leaves (Roosner and Zebitz 1987)

1 1 3 Effect of dry leaf powder

1 1 3 1 Root knot nematode

Patel *et al* (1985) observed minimum galling after the application of dry leaf powder of *Clerodendron enermi* @ 1 5 per cent w/w and dry leaf powder of *Tagetes* or *Xanthium* reduced *M incognita* population greatly followed by*Vebesina* and *Artemisia* in trial with *Cucumis melo* (Sharma *et al* (1985)

1 1 3 2 Plant growth characters and yield

Patel *et al* (1985) observed increase in growth of okra after the application of *C enermi* (1 5 per cent w/w) but *C enermi* 2 per cent w/w showed phytotoxicity

1 1 4 Effect of Sea weeds

1 1 4 1 Root-knot nematode

The treatment with soluble sea weed kelp meal liquified sea weed alone and with spray adjuant or soil penetrant Cytokinin leaf mould or ethoprop reduced the nematode population in Bermuda grass turf (Tarjan and Frederick 1983) A marine alga Spatoglossum shroederi reduced root galling caused by M incognita M javanica and M arenaria (Paracer et al 1987)

1 1 4 2 Plant growth character and yield

Tarjan and Frederick (1983) reported that soluble sea weed kelp meal liquified sea weed alone and with spray adjuant or soil penetrant Cytokinin leaf mould or ethoprop increased the yield of Bermuda grass significantly S shroederi and Caulerpa prolifera were able to increase plant growth significantly (Paracer et al 1987)

1 1 5 Organic waste

1 1 5 1 Root-knot nematode

Treatment with manipueira a compost of waste of cassava manufacture effectively reduced galling index on tomato roots (Ponte and Franco 1981) This also reduced or eliminated infection by Meloidogyne spp in carrot (Sena and Dante 1982)

Cooseman (1982) reported that application of ten per cent of house hold waste and 20 per cent ground cocoabean waste to soil minimised root knot in lettuce Chicken litter found to reduce root galling caused by M arenaria in C pepo (Mian and Rodriguez Kabana 1982)

1 1 5 2 Other Tylenchids

Kushwaha et al (1983) recommended application of cattle urine for the control of plant parasitic nematodes

Bischoff (1985) reported that crop rotation and organic manure appliction in sugarbeet reduced the beet nematode Heterodera schachtii population

Chindo and Khan (1982) found that poultry manure @ 4t/ha was most effective in reducing the nematode population greatly by midseason but increased towards harvest

1 1 5 3 Plant growth characters and yield

Habischt (1975) reported the nematicidal property of raw and composted sewage sludge and that it significantly increased the mean plant dry weight

Treatment with manipueira increased the fresh weight of tomato plants compared to untreated control (Ponte and Franco, 1981) and it doubled the yield in carrot (Sena and Dante, 1982)

Bischoff (1985) reported that beneficial effect of organic manure was due to improved soil moisture content which compensated for nematode damage due to sugarbeet nematode in sugarbeet Higher doses of poultry manure resulted in vegetative growth and delayed flowering (Chindo and Khan 1986)

Application of cocoa pod husk increased pod yield and shoot weight of V unguiculata c v Ife Brown (Egunjobi 1985)

1 2 Effect of organic amendments on soil microflora

1 2 1 On fungi

Chattopadhyay and Mustafee (1978) reported that addition of organic matter increased the population of Fusarium solani F oxisporum F conglutianum Macrophomina phaseoli and Sclerotium rolfsii initially but after few days the population started declining The addition of organic matter increased microbial activity and antagonism and this process was responsible for the lysis of Phytophthora cinnamomi in soil (Nesbitt et al 1979)

According to Marshunova and Fedorova (1980) addition of green manure (lucerne pea vetch rye and mustard) inhibited microsclerotial germination of Verticilluim dahliae They also found that substances formed due to the addition of green mass of cruciferae family inhibit fungal growth

Soil amended with margosa cake rice husk castor oil cake and sawdust lysed F oxisporum f sp udum (Singh and Singh 1980)

Sheikh and Ghaffer (1980) showed that clover, lucerne and mustard amendments reduced sclerotial number of Macrophomina phaseolina considerably than by wheat at 75 to 100 per cent moisture holding capacity (M H C) but no organic amendment significantly reduced sclerotial count in dry soil

Zakaria and Lockwood (1980) reported that application of linseed cotton seed and soyabean meal reduced Fusarium population and did not reduce total fungal population Linseed and cotton seed were found to be phytotoxic to pea

Cooseman (1982) observed that application of ten per cent household waste increased microbiological activity in lettuce rootzone

Laxmanan and Nair (1984) reported that neem cake and groundnut cake under dry condition and ellupa cake gingely cake and neem cake under flooded condition were very

effective in reducing the viability of the sclerotia of Rhizoctonia solani Sclerotial viability was also reduced by green leaves of neem and Glyricidia

Rana and Gupta (1985) have seen that soil amended with various C and N sources and variation in soil pH had no apparent effect on the mycelium of P cactorum

1 2 2 Bacteria

Soil amended with margosa cake rice husk castor oilcake and sawdust increased the population of Bacillus subtilis (Singh and Singh 1980)

1 2 3 Actinomycetes

Zakaria and Lockwood (1980) reported that application of linseed cotton seed and soyabean meal did not reduce total bacterial and actinomycetes population

1 3 Combined effect of organic amendments on nematodes and soil microflora

Khan et al (1974) reported that soils amended with neem groundnut and castor cake increased the total

population of rhizosphere fungi of egg plant where as mahua cake adversely affected population of rhizosphere fungi Eventhough the population of total rhizosphere fungi increased in the case of neem groundnut and castor cakes the frequency of occurance of parasitic fungi like Colletotrichum atramentarium R solani and Fusarium sp were reduced Oilcake amendments also reduced the population of T brassicae H indicus H erythrinae R reniformis and larvae of M incognita in the rhizosphere of egg plant Initially saprozoic nematode population was increased in the case of groundnut and castor oil cake amended soil

Solov eva et al (1978) found the toxic effect of Festuca pratensis and Trallius europaeus on nematodes of Rhabditida and Panagrolaimus rigidis and soil microflora T eurapaeus was most toxic at flowering and seed ripening stage

Singh et al (1985) observed reduction in infestation of root knot nematode and improved growth of tomato in soil amended with sawdust along with castor mustard and neem cakes Total free phenols and aminoacids increased in infested plants grown in amended soil Frequency of saprophytic fungi was higher in all cases

except sawdust where both saprobic and parasitic fungi decreased

Haq et al (1986) found that soil treatment with D D D B C P phorate fensulfothion aldicarb carbofuran reduced soil population of plant parasitic nematodes and fungi in both presence and absence of tomatoes However in the absence of tomtoes the reduction was more rapid

Singh et al (1986) found that application of sawdust alone was effective in reducing the population of nematodes and fungi but was phytotoxic The damage was reduced by the addition of N source such as oil cakes cow dung leaf mould and urea Plants grown in combination treatment of sawdust and oil cakes had higher concentration of phenols and this may be the reason for the reduced multiplication of nematodes and better growth of plants

Bhattacharya and Goswami (1987) described the role of micro organisms in the decomposition of neem and groundnut cakes and their effect on nematode penetration development and population build up of M incognita They observed that their efficacy was better in unsterilized soil than sterilized soil

1 4 Effect of organic amendments as nematicides

1 4 1 Oil cakes and seed kernels

1 4 1 1 Root knot nematode

Aquous extracts of neem cake was most effective on the second stage larvae of M incognita followed by mahua cake karanji cake and mustard oil cake (Mishra and Prasad 1975)

Batnagar et al (1978) reported that aqueous extract of coconut oil cake was superior in controlling root knot nematode in okra

Pre treatment with crude seed extract of A indica Hannova undulata and H klaineana inhibited the penetration of M javanica juveniles into tomato roots Delipified extracts were more effective H klaineana inhibited penetration completely at 100 ppm a d significantly at 20 ppm in pot trials (Prot and KornProbst 1983)

Larvae of M incognita were repelled from the roots of tomato plants raised from seeds treated with nematicides and oil cakes (Singh et al 1984)

et al 1985)

Hatching inhibition

Hassan and Saxena (1979) studied the effects of the extracts of soils amended with oil cakes on hatching of M incognita has found that neem and mustard oil cakes were superior

Lanjeswar and Shukla (1986) found that eggs were more susceptible than larvae when exposed to oil cakes and fungicides

1 4 1 2 Other Tylenchids

Hussain and Gill (1975) found that seeds of plants with antihelminthic activity has nematicidal properties H indicus was the most susceptible nematode

Kharanji and neem cake extracts reduced M incognita population (Rao et al 1986)

Four fractions of neem oil were tested for their effects on mortality of M incognita Pure oil extracts were inactive whereas limonoids were highly active (Devakumar et al 1985)

Hatching inhibition

Hassan and Saxena (1979) studied the effects of the extracts of soils amended with oil cakes on hatching of M incognita has found that neem and mustard oil cakes were superior

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Seeds of Pogonum harmala Bramia arvensis Lepidium draba and Cephaloria syriaca have nematicidal properties against Tylenchulus semipenetrans when tested in vitro Seed extracts of C syriaca was most effective (Mohamed et al 1981) Mohamed et al (1982) found that seeds of Linium usitatisumum and Sida cardifolia proved to be highly toxic to nematodes

Mani et al (1986) reported that neem cake extract effectively reduced mobility of T semipenetrans (only 19 27 per cent mobility)

1 4 2 Green leaves

Aqueous extracts of Ocimum sanctum and O basiliarum leaves killed M incognita larvae in 160 minutes Active ingredients were identified as eugenol and linalool (Chatterjie et al 1982)

Sukul et al (1974) reported that ethanol extracts of Tragia involucrata killed M incognita within one hour in vitro Aqueous extracts of this plant and Polygonum hydropiper reduced both galling and population of M incognita on lady s finger without phytotoxicity

Among the petroleum ether chloroform and ethanol extracts of T involuctara Peristrophe bicalyculata and Acanthocephalus kademba tested petroleum ether extracts of A kademba and T involucrata were most effective aginst M incognita juveniles followed by chloroform extract of P bicalyculata (Chatterjee and Sukul 1980)

Aqueous extract of Mentha viridis Emblica officinalis and Cassia carandas showed significant activity against M incognita larvae in vitro (Haseeb et al 1982)

Mahmood et al (1982) reported that leaf extract of Anagalis arvensis have high toxicity against M incognita

All larvae of M javanica were immobilised within 24 hours in extracts of Argemone mexicana at 1 5 and 1 10 dilution on furthur dilution the effect was diminished When the extract was applied to okra in microplot infested with M javanica nematicidal properties were shown (Nath et al 1982)

Nandal and Bhatti (1983) screened some weed shrubs for their nematicidal properties against M javanica All 30 plants used killed nematodes at 1 5 dilution but at 1 40

only Amaranthus gracilis C album and R cinus communis gave highest control

Goswami and Vijayalakshmi (1986) reported that plant extracts of Andrographis paniculata Calendula officinalis Enhydra fluctuam and S khasianum reduced root galling of tomato plants and population of M incognita in pot trials and in vitro studies C officinalis and E fluctuam were most effective ard their extract killed larvae of M incognita in vitro

Rajvamshi et al (1985) showed that aged extracts of T patula is more effective in nematostatic qualities on Xiphinema basiri than fresh and autoclaved leaf extracts

Very high activity on larval mortality of M incognita was shown by Parthenium hystrophorus Datura strumonium and T erecta leaf extracts (Rao et al (1986)

Subramanium (1986) showed the nematicidal action of Eupatorium odoratum on M incognita larvae Even 1 20 dilution showed nematicidal properties after 48 hours exposure to the extracts

Effect on hatching

Haroon and Smart (1983) concluded that the root extracts of Digitaria decumbens delayed hatching of eggs of M incognita Extracts from older plants killed most of the larvae within ten days

Hasan and Jain (1984) found that egg hatch of M incognita was prevented at 1 10 and 1 25 concentration of P hysterophorus extracts Leaf extract was most effective and 1 50 concetration killed M incognita after 25 hours and 48 hours exposure to the extracts

Dry leaf extracts of C enermi at 10 per cent w/v concentration completely inhibited hatching of M incognita and M javanica and hatching did not take place in water when the egg mass was transferred to water after 26 days in the case of root extracts (Patel et al 1985)

C officinalis and E fluctuam effectively inhibited hatching of M incognita in vitro (Goswami and Vijayalakshmi 1986)

Tiyagi et al (1986) found that C flexuouses is highly toxic to M incognita

Davis and Rich (1987) recorded reduction in root galling by M incognita upon exposure to tobacco They also reported an increase in nicotine content in resistant varieties of tobacco

Maqbool et al (1987) reported that latex extracts (10 to 0 1 per cent dilution) of Euphorbia caducifolia and C procera were highly toxic to juveniles of M incognita and M javanica They confirmed this finding in pot culture using tomato and brinjal showing improved crop growth reduced nematode population under highest concentration of latex extracts

S shroederi a marine alga was found to control M incognita M javanica and M acrita in vitro at concentrations of 1 0 0 75 0 5 per cent (Paracer et al 1987)

Nandal and Bhatti (1986) reported significant reduction in hatching of M javanica in vitro by the leaf extracts of C procera D strumonium R communis and X strumarium but their efficiency was reduced with time

Rao et al (1986) showed very high activity on egg hatch by P hysterophorus D strumonium and T erecta leaf extracts

1 4 2 2 Reniform nematode

Cassia fistula Cordia myxa C carandas Colocasia antiquorum and Dalbergia sisso were found effective against R reniformis (Haseeb et al 1982)

The leaf extracts of A arvensis have high toxicity against R reniformis (Mahmood et al 1982)

Tiyagi et al (1986) showed C flexuouses highly toxic to R reniformis

1 4 2 3 Other Tylenchids

Sukul et al (1974) found that ethanol extract of T invalucrata killed plant parasitic nematodes within one hour in vitro

Hussain and Gill (1975) concluded that leaves or flowers of plants with antihelminthic activity have nematicidal properties also *H indicus* was most vulnerable

Egunjobi and Afalami (1976) reported that aqueous extracts of neem leaf has effectively reduced the population of *P brachyurus* and increased plant growth and yield of maize

Mohammed *et al* (1981) observed that the leaves of *Delphinium ajacis* *Urtica urens* *Eminium intortum* and flowers of *Papever stumarium* have nematicidal properties against *T semipenetrans* when tested *in vitro* Leaf extracts of *U urens* was most effective and application of macerated fresh *C ambrosoides* (0 5g in 10 ml) inactivated plant parasitic nematodes in 20 minutes (Espinosa 1982)

Nath *et al* (1982) found that aquous extracts and methanolic extract of garlic and synthetic diallyl disulphide were toxic to *A sacchari* and *T semipenetrans* *in vitro* While *P hysterophorus* extracts killed *H dihystera* (Hasan and Jain 1984)

Mani et al (1986) showed that the concentration and exposure time increased the mortality of T semipenetrans C flexuouses is highly toxic to T brassicae ard H irdicus (Tiyagi et al 1986) S shroederi a marine alga was found toxic to H galeatus Hirschmanriella caudacrana ard Belanolaimus triquetrum in vitro at concentrations of 1 0 0 75 and 0 5 per cent (Paracer et al 1987)

1 4 2 4 Non parasitic nematodes

Espinosa (1982) recorded that application of macerated fresh C ambrosoides (0 5g in 10ml) inactiviated saprophytic nematodes in 20 minutes

1 4 3 Roots and root extracts

1 4 3 1 Root knot nematode

Root exudates of margosa (A indica) was found to be toxic and inhibited hatching of M incognita (Alam et al 1975)

Root extracts of C enermi at 10 per cent w/v concentration inhibited hatching of M incognita and M javanica but hatching took place in water when the egg mass was transferred to water after 26 days (Patel et al 1985)

1 4 3 2 Reniform nematode

Root extracts of S hispidum and C sativa were found to be highly toxic to R reniformis (Haseeb et al 1978)

1 4 3 3 Other Tylenchids

Root exudates of margosa (A indica) was found to be highly toxic to T brassicae and it was the most sensitive nematode tested (Alam et al 1975)

Haseeb et al (1978) observed highest mortality of H indicus in root extracts of C ambrosoides Root extracts of C ambrosoides was most toxic to T brassicae

Periwinkle mustard and marigold root exudates were found to increase juvenile mortality of T semipenetrans (Mani et al 1986)

Effect on Hatching

Heijbroek (1982) found that root leachates of two selections of oil radish and S alba caused less larval hatch than that of sweet rape and sugarbeet of newly formed cysts of H schachtii under laboratory conditions

1 4 4 Essential oils

1 4 4 1 Root knot nematode

Sangwan et al (1985) reported that essential oil from C martini var motia C flexuoses and C winterianum contaning geraniol citral citranellol and citranellal were toxic to M javanica

1 4 4 2 Reniform nematode

Shoot extracts of S hispidum M azadirach C ambrosoides Nicotiana tabaccum and C sativum were toxic to R reniformis (Haseeb et al 1978)

1 4 4 3 Other tylenchids

Essential oil from Citrus aurantium C medica and plants of compositae family against Ditylenchus destructor in vitro showed that 100 percent mortality after 72 hours at 0 05 per cent concentration of extracts of plants come under compositae family and 93 3 per cent mortality in C medica (Nagvabdel khamed and Shapoval 1977)

Haseeb et al (1982) observed highest mortality of H indicus in shoot extracts of S hispidum M azadirach and Canabis sativa Shoot extracts of N tabaccum and C sativa were highly toxic to T brassicae

1 5 Effects of organic matter extracts as microbicides

Charya et al (1979) reported that the extracts of Lowsonia inermis pomegranate Prosopis juliflora roots and rose flowers were completely inhibiting the spore germination of Drechslera (Setosphaeria) rostrata and Curvularia lunata (Cochliobolus lunatus)

Kumar et al (1979) found that onion garlic kalanchoe P histopum cotton and P atropurpureus

extracts completely inhibited spore germination of Drechslera rostrata F oxisporum Alternaria alternata and Corynespora cassiicola in vitro

Cinnamomum camphora and Catheranthes roseus extracts were most effective against C lunata They inhibited growth, sporulation and spore germination A indica C viscosum Phyllanthus fraternus and Vitex negundo followed the above two (Bhowmick and Vardha 1981)

Acalypha indica most effectively inhibited A alternata followed by Camphor V negundo and A indica in vitro (Bhowmick and Choudhary 1982)

Choudhary and Sen(1982) reported that benzene extract of Piper nigrum was highly toxic to Sclerotium rolfsii moderately to R solani and least on Sclerotinia sclerotiarum The extract was more inhibitory on mycelial growth than sclerotial formation

Annapurna et al (1983) concluded that extracts of Polyalthia longifolia contains broad spectrum antimicrobial compounds

Aqueous extract of C roseus inhibited spore germination mycelial growth and sporulation of six test fungi (Bera and Saha 1983)

Singh and Singh (1985) reported that ether distillates from soil amended with 0 1 to 0 5 per cent concentration of neem oil cake inhibited growth of pathogen on agar discs

1 6 Effect of Nematicides on soil micro-organisms

Tu (1972) reported that there was an initial depression of population of bacteria and fungi after the application of four nematicides Dasanit D D carbofuran and Vortex Mineralization of organic nitrogen nitrification and oxidation of elemental sulphur were depressed

Singh and Prasad (1973) found out the suppressing and inhibitory effect of Dazomet on soil micro organisms Acetobacter Nitrosomonas and Nitrobacter were most sensitive to nematicide treatment and took time to re establish

Midha and Nandwana (1975) observed sensitivity of Aspergillus spp to Nemaphos but they did not respond to Dasanit D D D B C P Dasanit suppressed Fusarium spp and this genera was insensitive to E D B Myrothecium spp were unaffected by D B C P but was sensitive to Nemaphos application

Bapaiah et al (1976) reported that nodulation was unaffected by carbofuran application fensulfothion carbofuran and aldicarb were very effective in reducing nematode population and hence no inhibitory effect on Rhizobium and the plants have better root development

Kutzera and Hoffman (1976) found that F avenaceum F oxisporum F solani were insensitive V alboatrum V dahliae were moderately sensitive and Phialophora cinerescens was highly sensitive to fungistasis in methyl bromide treated soil The application of methyl bromide reduced actinomycetes and fungal flora for a considerable time

Rodriguez Kabana et al (1976) found that application of fensulfothion 8 9 kg ai/ha on groundnut crop

reduced damage by S rolfsii in early season but this was not apparent at harvest They also stated that in an in vitro study Fensulfothion inhibited the growth of S rolfsii and R solani but did not affect T harzianum which is an antagonist grown in the field soil Fensulfothion did not affect the mycelial growth but reduced production of sclerotial initials and prevented formation of sclerotia of S rolfsii and R solani

MATERIALS AND METHODS

2 MATERIALS AND METHODS

The two field experiments each were conducted in bhindi and cowpea for evaluating the effect of neem and eupatorium leaf on the nematode and microbial population

The experiments were carried out in Instructional Farm College of Agriculture Vellayani in an area infested by plant parasitic nematodes

The field experiments were laid out in randomised block design with six replications

2 1 Experiment with bhindi

	Rainy season	Summer season
Plot size	2x2m	2x2m
Spacing	60x45 cm	60x30 cm

2 1 1 Rainy Season

Neem and eupatorium leaf at two doses were used to assess their effect on nematodes and micro organisms during rainy season There were five treatments including control as detailed below

T_1 Neem leaf 150g/plant

T_2 Neem leaf 300g/plant

T_3 Eupatorium leaf 150g/plant

T_4 Eupatorium leaf 300g/plant

T_5 Control (untreated)

2 1 2 Summer season

The experiment with bhindi for summer season was also done as metioned in para 2 1 1

2 2 Experiment with cowpea

	Rainy season	Summer season
Plot size	2x2m	2x2m
Spacing	25x15cm	25x15cm

2 2 1 Rainy season

The experiment with cowpea for rainy season was done as described in Para 2 1 1 The treatments were as follows

T_1 Neem leaf 7 5t/ha

T_2 Neem leaf 15t/ha

T_3 Eupatorium leaf 7 5t/ha

T_4 Eupatorium leaf 15t/ha

T_5 Control (untreated)

2 2 2 Summer season

The experiment with cowpea for summer season was done as mentioned in para 2 2 1

Application of leaf

The required quantities of leaf were chopped and raked into the soil upto a depth of 30 cm 15 days prior to the sowing of seeds

Sowing

Seeds of cowpea and bhindi were dibbled at required spacing 15 days after treatment(D A T) in each season

Application of fertilizers

Fertilizers were applied as per package of practices recommended by K A U (1989) for the two crops in two seasons

Collections of soil samples

Soil samples from each plot were collected before application of green leaf for estimating the pretreatment

nematode population and population of micro organisms Soil samples were collected at sowing 15 30 45 and 60 days after sowing (D A S) and on the day of final harvest (75 D A S) Soil samples (100g) at depth of 30 cm were collected from five places in each plot from the rootzone to make a bulk of 500g/plot

From this bulk sample 200 g of soil was taken for the extraction of nematodes For the estimation of bacteria fungi and actinomycetes ten grams of soil sample was taken

Estimation of nematode population (Pretreatment)

Nematodes were extracted from the representative soil sample of 200g following the modified method of Christie and Perry (1951) and the nematodes thus extracted were counted

Estimation of population of soil micro organisms

The number of soil micro organisms viz bacteria fungi and actinomycetes in 10g soil were estimated by the dilution plate technique (Timonin 1940) Bacteria and

actinomycetes were estimated at 10^{3} and fungus at 10^{6} dilution

Kauster s medium was used for growing barteria and actinomycetes and Martin s Rosebergal agar was used for growing fungi

The composition of media used were as follows

Kauster s Agar medium

Glycerol 10 ml

Casein 0 3 g

Magnesium sulphate 0 5 g

Ferrous sulphate 0 1 g

Potassium nitrate 2 g

Sodium chloride 2 g

Dipotassium hydrogn phosphate 0 5 g

Calcium carbonate 0 2 g

Agar agar 15 g

Distilled water 1 L

pH 6 8 7

Martin s Rosebengal Agar medium

Peptone 5 g

Potassium dihydrogen phosphate 1 g

Magnesium sulphate 0 5 g

Dextrose 10 g

Rosebengal 33 mg

Agaragar 15 g

Distilled water 1 L

pH 6 6 5

After sterilization one percent streptomycin sulphate solution 3 ml/L was added

The bacterial fungal and actinomycetes colonies developed at two five and seven days after plating were recorded as colony farming units (c f u)

Counting the nematodes

The nematode suspension was made upto 100ml and an aliquot of five ml of suspension was pipetted out into a counting dish and the nematodes were counted under a stereoscopic microscope Both plant parasitic predatory

and non parasitic nematodes were counted and recorded seperately This process was repeated for two to three times The mean number was taken for the statistical analysis

Assessment of results

The effects of different treatments were estimated in terms of yield plant height number of leaves shoot weight root weight of plants nematode population and microbial population in soil under different treatments and period intervals

To compare the yield in the different treatments weight of fruits obtained from each plot was recorded The number of leaves height of plants and microbial population in soil were recorded at monthly intervals after application of the organic amendments The nematode counts (parasitic predatory and non parasitic)were taken as pretreatment and 15 days intervals after treatment

Ninety days after the application of organic amendments bhindi and cowpea plants were uprooted and the root weight shoot weight and nematode population in soil and roots and the microbial count were recorded

Nematode population in roots

The nematode population in roots were estimated from the uprooted plants from different treatments at the end of the experiment

The roots were cut into 5 cm long bits and stained using acid fuchsin (2 per cent) The plant parasitic nematodes attached to the roots were counted using lowpower (10x) magnification of microscope

Population of micro organisms in soil

Observations on the population of micro organisms were made before the application of leaf 15 45 and 75 D A S

The data were analysed by applying appropriate statistical techniques for comparing the average effect of various observations in bhindi and cowpea in rainy and summer seasons

RESULTS

3 1 1 Effect of organic amendments on nematodes

3 1 1 1 On Helicotylenchus spp

3 1 1 1 1 Rainy season

The results are presented in table 1 and fig 1 The pretreatment population was uniform and there was no significant difference in the soil population of Helicotylenchus spp in different plots The effect of neem and eupatorium leaf at two different levels (150 and 300 g/plant) showed that all treatments significantly reduced the Helicotylenchus population in the rootzone of bhindi Maximum reduction was given by neem leaf (150 g/plant) followed by eupatorium and neem leaf treatment @ 300 g/plant and eupatorium lower dose (150g/plant) All these treatments were on par and significantly superior to control

The population of Helicotylenchus spp counted at different intervals revealed that all treatments were superior to control upto 30 D A S, At 45 D A S application of neem leaf 150 and 300 g/plant were on par and was

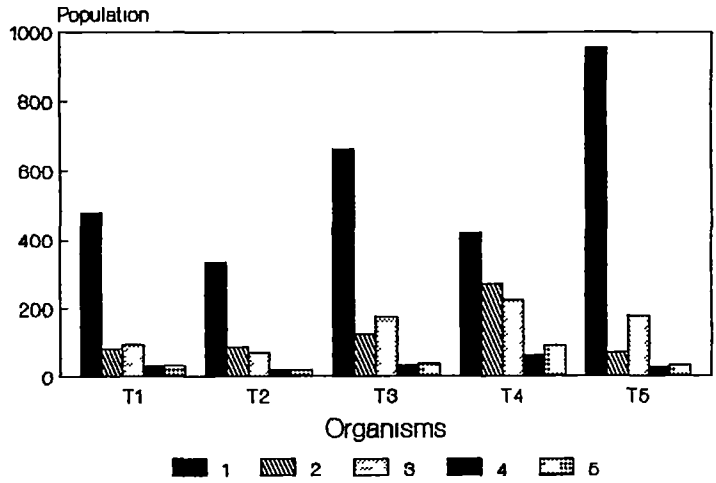
Table 1 Effect of organic amendments on the population of Hellcotylenchus spp at the rootzone of bhindi

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days) 0	15	30	45	60	75	Mean population
Rainy Season								
Neem leaf 150g/plant	7(2 61)	2(1 49)	2(1 30)	1(1 07)	3(1 63)	3(1 82)	3(1 72)	2(1 51)
Neem leaf 300g/plant	16(3 39)	2(1 49)	1(1 14)	1(1 14)	4(1 92)	7(2 61)	8(2 88)	3(1 86)
Eupatorium leaf 150g/plant	11(3 29)	3(1 65)	2(1 34)	3(1 88)	7(2 59)	4(2 00)	7(2 63)	4(2 02)
Eupatorium leaf 300g/plant	17(4 17)	3(1 70)	3(1 93)	4(1 94)	5(2 12)	5(2 21)	4(2 02)	4(1 95)
Untreated control	12(3 52)	8(2 74)	7(2 64)	9(3 02)	8(2 79)	7(2 69)	6(2 46)	7(2 72)
C D	N S						(0 711)	(0 629)
Summer Season								
Neem leaf 150g/plant	9(2 99)	2(1 50)	2(1 36)	1(1 14)	3(1 74)	4(1 97)	3(1 68)	2(1 56)
Neem leaf 300g/plant	10(3 11)	2(1 33)	1(1 00)	1(1 07)	4(2 03)	7(2 68)	9(2 95)	3(1 84)
Eupatorium leaf 150g/plant	11(3 24)	3(1 67)	2(1 40)	4(2 00)	7(2 65)	5(2 19)	7(2 61)	4(2 09)
Eupatorium leaf 300g/plant	9(2 99)	3(1 67)	2(1 48)	4(2 04)	5(2 25)	5(2 24)	5(2 25)	4(1 99)
Untreated control	9(2 94)	9(2 91)	8(2 90)	10(3 12)	9(3 01)	7(2 63)	6(2 42)	8(2 83)
C D	N S						(0 627)	(0 186)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

Fig 1 Effect of treatments on different organisms in the rootzone of bhindi in rainy season



Treatments

T1 - Neem leaves (150 g/plant)
T2 - Neem leaves (300 g/plant)
T3 - Eupatorium leaves (150 g/plant)
T4 - Eupatorium leaves (300 g/plant)
T5 - Untreated control

Organisms

1 - Plant parasitic nematodes
2 - Non-parasitic nematodes
3 - Bacteria
4 - Fungi
5 - Actinomycetes

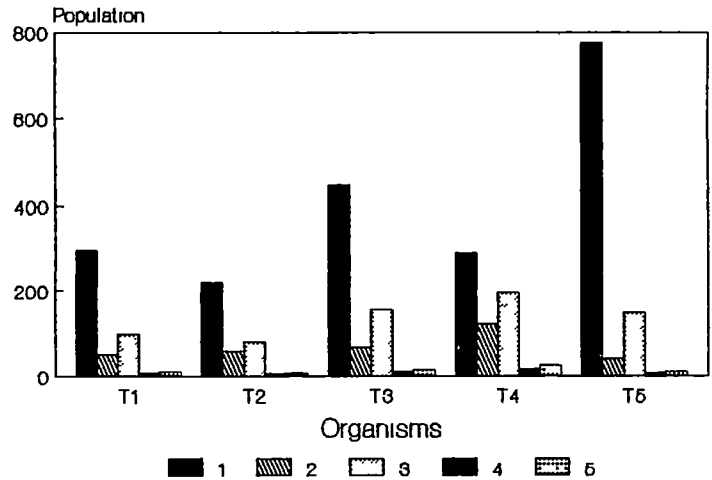
superior to control But from 60 to 75 D A S only neem leaf (150g/plant) was significantly superior to control At 75 D A S Helicotylenchus spp population was lower than pretreatment population under all treatments

3 1 1 1 2 Summer season

The data are presented in table 1 and fig 2 The pretreatment population of Helicotylenchus spp did not show significant variation among different treatment plots The effect of neem and eupatorium leaf at two different levels showed that all treatments significantly reduced the mean Helicotylenchus spp population in the rootzone of bhindi in summer season Maximum reduction was observed under neem leaf (150g/plant) and it was significantly superior to other treatments Neem and eupatorium leaf @ 300g/plant were on par and significantly superior to eupatorium leaf (150g/plant) and all these treatments were significantly superior to control

The Helicotylenchus spp population monitored at different intervals showed that all treatments were significantly superior to control upto 30 D A S At 45 D A S eupatorium leaf (150 g/per plant) was on par with control

Fig 2 Effect of treatments on different organisms in the rootzone of bhindi in summer season



Treatments

T1 - Neem leaves (150 g/plant)
T2 - Neem leaves (300 g/plant)
T3 - Eupatorium leaves (150 g/plant)
T4 - Eupatorium leaves (300 g/plant)
T5 Untreated control

Organisms

1 - Plant parasitic nematodes
2 - Non-parasitic nematodes
3 - Bacteria
4 - Fungi
5 - Actinomycetes

and all other treatments were significantly superior At 60 and 75 D A S only neem leaf (150g/plant) treatment was superior to control All treatments and control reduced Helicotylenchus spp population at 75 D A S below the pretreatment population

Pooled analysis for comparing the effect of different treatments did not show significant variations in the performance in rainy and summer season

3 1 1 2 On Rotylenchulus reniformis

3 1 1 2 1 Rainy season

The results are presented in table 2 and fig 1 The pretreatment population of R reniformis was uniform The effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) showed that neem and eupatorium leaf (300g/plant) treatment significantly reduced the mean R reniformis population Maximum reduction (65 27 per cent) was seen in neem leaf treatment followed by eupatorium leaf @ 300g/plant treatment (55 31 per cent) These two treatments were on par and significantly superior to other treatments and control

Table 2 Effect of organic amendments on the population of *Rotylenchulus reniformis* at the rootzone of bhindi

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days) – 0	15	30	45	60	75	Mean population
Rainy Season								
Neem leaf 150g/plant	427(2 63)	302(2 48)	355(2 55)	407(2 61)	468(2 67)	646(2 81)	741(2 80)	468(2 67)
Neem leaf 300g/plant	550(2 74)	229(2 36)	316(2 50)	324(2 51)	316(2 50)	363(2 56)	417(2 62)	324(2 51)
Eupatorium leaf 150g/plant	708(2 85)	562(2 75)	676(2 83)	631(2 80)	646(2 81)	661(2 82)	724(2 86)	646(2 81)
Eupatorium leaf 300g/plant	479(2 68)	257(2 41)	324(2 51)	447(2 65)	525(2 72)	513(2 71)	501(2 70)	417(2 62)
Untreated control	708(2 85)	776(2 89)	776(2 89)	891(2 95)	1000(3 00)	1047(3 02)	1148(3 06)	933(2 97)
C D	N S						(0 073)	(0 307)
Summer Season								
Neem leaf 150g/plant	275(2 44)	200(2 30)	234(2 37)	257(2 41)	251(2 40)	339(2 53)	380(2 58)	269(2 43)
Neem leaf 300g/plant	324(2 51)	162(2 21)	200(2 30)	195(2 29)	224(2 35)	245(2 39)	282(2 45)	214(2 33)
Eupatorium leaf 150g/plant	407(2 61)	324(2 51)	398(2 60)	363(2 56)	427(2 63)	513(2 71)	562(2 75)	427(2 63)
Eupatorium leaf 300g/plant	324(2 51)	170(2 23)	200(2 30)	288(2 46)	324(2 51)	355(2 55)	407(2 61)	282(2 45)
Untreated control	513(2 71)	468(2 67)	525(2 72)	646(2 81)	832(2 92)	977(2 99)	1072(3 03)	727(2 86)
C D	N S						(0 0802)	(0 278)

C D for comparing effect of seasons 0 077
Figures given in parenthesis are values after log x transformation

The R reniformis population monitored at different intervals revealed that all treatments except eupatorium leaf (150g/plant) at 15 D A S were significantly superior to control in reducing the population Application of neem leaf (300 g/plant) showed maximum reduction from 0 D A S to 75 D A S At 0 D A S and 15 D A S it was on par with eupatorium leaf (300g/plant) treatment and at 15 D A S it was also on par with neem leaf (150g/plant) treatment Neem leaf (300g/plant) treatment kept R reniformis population below pretreatment population whereas eupatorium leaf (300g/plant) treatment showed numerical increase in R reniformis population above pretreatment population from 45 to 75 D A S but the increase in population after 30 D A S was not statistically significant

3 1 1 2 2 Summer season

The results are presented in table 2 and fig 2 The pretreatment population was uniform The effect of neem and eupatorium leaf in two different levels (150 and 300g/plant) showed that all treatments except eupatorium leaf (150g/plant) significantly reduced the mean R reniformis population in soil Maximum reduction (70 44 per cent) was exhibited by neem leaf (300g/plant) treatment followed by

lower dose of neem leaf (150g/plant) treatment (62 85 per cent) and eupatorium leaf (300g/plant) treatment (61 05 per cent) These three treatments were statistically on par and significantly superior to control

The R reniformis population monitored at different intervals revealed that all the treatments were significantly superior to control in reducing nematode population Neem leaf (300g/plant) treatment showed maximum reduction in R reniformis population from 0 D A S to 75 D A S It was statistically on par with eupatorium leaf (300g/plant) treatment from 0 D A S to 15 D A S and was also on par with neem leaf (150g/plant) treatment at 15 D A S Only neem leaf (300g/plant) treatment reduced the population below pretreatment population at 75 D A S

Comparison of treatment effect on rainy and summer season (Table 2) revealed statistical significance in the effect of neem and eupatorium leaf at two different levels (150 and 300 g/plant) All the treatments showed significant increase in effectiveness in summer season in reducing R reniformis

3 1 1 3 On Meloidogyne incognita

3 1 1 3 1 Rainy season

The results are presented in table 3 The pretreatment population was uniform and there was no significant difference in the mean population of M incognita The effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) showed that neem and eupatorium leaf @ 300g/plant reduced the mean M incognita population in the soil samples collected from the rootzone of bhindi during rainy season Maximum reduction (66 66 per cent) was given by neem leaf (300g/plant) treatment followed by eupatorium leaf (300g/plant) treatment (50 per cent) All the treatments were better than control though the data did not show statistical significance

The M incognita population monitored at different intervals revealed that all treatments were superior to control in reducing M incognita population at 0 D A S At 15 D A S all treatments except neem leaf (150g/plant) treatment significantly reduced M incognita population It was also found that the population of M incognita was steadily decreasing towards 60 D A S with significant

Table 3 Effect of organic amendments on the population of Meloidogyne incognita at the rootzone of bhindi

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days)						Mean population
		0	15	30	45	60	75	
Rainy Season								
Neem leaf 150g/plant	29(5 41)	7(2 73)	3(1 82)	2(1 52)	2(1 54)	3(1 59)	2(1 43)	3(1 77)
Neem leaf 300g/plant	16(4 02)	2(1 36)	1(1 17)	2(1 26)	1(1 14)	2(1 36)	3(1 68)	2(1 32)
Eupatorium leaf 150g/plant	22(4 71)	5(2 15)	2(1 58)	3(1 66)	2(1 44)	2(1 26)	5(2 34)	3(1 73)
Eupatorium leaf 300g/plant	28(5 28)	4(2 05)	2(1 51)	2(1 49)	1(1 17)	1(1 19)	5(2 13)	3(1 59)
Untreated control	30(5 47)	25(5 02)	8(2 88)	5(2 14)	3(1 71)	1(1 07)	3(1 83)	6(2 44)
C D	N S						(1 075)	N S
Summer Season								
Neem leaf 150g/plant	15(3 81)	8(2 84)	7(2 62)	6(2 46)	4(2 11)	6(2 35)	3(1 84)	6(2 37)
Neem leaf 300g/plant	10(3 15)	3(1 84)	8(2 88)	4(1 94)	2(1 51)	5(2 14)	4(1 89)	4(2 03)
Eupatorium leaf 150g/plant	13(3 55)	10(3 18)	5(2 16)	6(2 46)	4(1 93)	2(1 36)	18(4 21)	7(2 55)
Eupatorium leaf 300g/plant	10(3 09)	9(3 02)	4(2 00)	4(1 94)	2(1 48)	3(1 85)	9(2 94)	5(2 21)
Untreated control	11(3 27)	31(5 58)	19(4 37)	11(3 39)	6(2 48)	2(1 40)	6(2 51)	11(3 29)
C D	N S						(1 037)	(0 371)

Figures given in parenthesis are values after $\sqrt{x}$ transformation Pooled mean not significant

decrease at 15 D A S when compared with 0 D A S But the population showed slight numerical increase at 75 D A S eventhough statistically the population was on par with 60 D A S All treatments reduced the population of M incognita below pretreatment at 75 D A S

3 1 1 3 2 Summer season

The results are presented in table 3 and fig 2 The pretreatment population was uniform and there was no significant difference in the soil population of M incognita in different plots The effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) showed that all treatments significantly reduced mean M incognita population in the soil collected from the rootzone of bhindi in summer season Maximum reduction (63 64 per cent) was seen in neem leaf (300g/plant) treatment followed by eupatorium leaf (300g/plant) treatment (54 55 per cent) All the treatments except eupatorium leaf (150g/plant) treatment were on par and significantly superior to control

The population of M incognita monitored at different intervals showed that all tretaments were superior to control upto 15 D A S At 30 D A S only neem leaf and

eupatorium leaf (300g/plant) treatments were significantly superior to control After 45 D A S eupatorium (150g/plant) treatment only reduced the population of M incognita significantly At 75 D A S all treatments except eupatorium leaf (150g/plant) kept M incognita population below pretreatment population Comparison of treatment effects on rainy and summer season revealed no significant difference among treatments in two seasons

3 1 1 4 On predatory nematodes

3 1 1 4 1 Rainy season

The results are presented in table 4 and fig 1 The pretreatment population of predatory nematodes in different plots were on par The effect of neem and eupatorium leaf in two different levels (150 and 300g/plant) showed that all treatments except neem leaf (150g/plant) treatment increased predatory nematode population significantly over control Maximum increase (314 29 per cent) was seen under eupatorium leaf (300g/plant) treatment and it was significantly superior to all other treatments Lower dose of eupatorium treatment also increased the predatory nematode population to 128 57 per cent and it was superior to other neem leaf treatments Effect of neem leaf (150 and 300g/plant)

Tab 4 Effect of organic amendments on the population of predatory nematodes at the rootzone of bhindi

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days) 0	15	30	45	60	75	Mean population
Rainy Season								
Neem leaf 150g/plant	7(2 68)	11(3 34)	11(3 35)	11(3 26)	12(3 48)	9(2 94)	8(2 90)	10(3 21)
Neem leaf 300g/plant	6(2 41)	15(3 82)	11(3 25)	12(3 53)	10(3 19)	11(3 28)	12(3 47)	12(3 42)
Eupatorium leaf 150g/plant	9(3 02)	16(3 94)	13(3 59)	24(4 90)	15(3 90)	16(3 94)	14(3 80)	16(4 01)
Eupatorium leaf 300g/plant	7(2 68)	14(3 77)	37(6 05)	26(5 06)	30(5 47)	33(5 74)	41(6 40)	29(5 41)
Untreated control	7(2 63)	7(2 60)	7(2 68)	6(2 46)	9(3 05)	7(2 69)	7(2 58)	7(2 68)
C D	N S						(0 997)	(0 657)
Summer Season								
Neem leaf 150g/plant	4(1 91)	9(2 92)	7(2 55)	6(2 48)	9(2 92)	5(2 22)	6(2 37)	7(2 58)
Neem leaf 300g/plant	5(2 27)	11(3 29)	6(2 49)	8(2 75)	10(3 18)	7(2 66)	8(2 86)	8(2 87)
Eupatorium leaf 150g/plant	4(2 04)	10(3 19)	8(2 81)	14(3 69)	8(2 85)	6(2 54)	3(1 74)	8(2 80)
Eupatorium leaf 300g/plant	3(1 76)	9(2 97)	15(3 87)	16(3 97)	15(3 84)	10(3 11)	11(3 29)	12(3 51)
Untreated control	5(2 29)	4(1 91)	4(2 08)	4(1 94)	6(2 43)	4(1 88)	4(1 93)	4(2 03)
C D	N S						(0 5004)	(0 666)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

treatments were also on par and increased the predatory nematode population above 70 per cent

The predatory nematode population monitored at different intervals revealed that eupatorium leaf (300g/plant) treatment was significantly superior to control from 0 D A S to 75 D A S This treatment was on par with eupatorium leaf (150g/plant) treatment 30 D A S At 0 D A S eupatorium leaf treatment at both levels (150 and 300g/plant) and neem leaf (300g/plant) treatment were on par and significantly superior to control All the treatments increased the predatory nematode population more than pre treatment population at 75 D A S

3 1 1 4 2 Summer season

The results are presented in table 4 and fig 2 The pretreatment population of predatory nematodes in different treatments were on par The effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) showed that all treatments except neem leaf (150g/plant) treatment increased the mean predatory nematode population in the soil collected from the rootzone of bhindi in summer season Maximum increase (200 per cent) was seen in eupatorium leaf

(300g/plant) treatment followed by neem leaf (300g/plant) with 100 per cent increase These two treatments were statistically on par and superior to other treatments and control The effect of application of lower dose of eupatorium was also superior to control but inferior to above two treatments

The predatory nematode population monitored at different intervals revealed that all treatments significantly increased predatory nematode population at 0 D A S when compared with control Eupatorium leaf (300g/plant) treatment was significantly superior to control in increasing the predatory nematode population from 0 D A S to 75 D A S It was on par with neem leaf (300g/plant) treatment at 0 60 and 75 D A S and also on par with eupatorium leaf (150g/plant) at 0 and 30 D A S All treatments except eupatorium leaf (150g/plant) was found to increase predatory nematode population more than pretreatment population at 75 D A S

Pooled analysis of the data (table 4) showed that the effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) over two seasons had no significant difference between the treatments in two seasons

3 1 1 5 On Saprophytic nematodes

3 1 1 5 1 Rainy Season

The results are presented in table 5 and fig 1 The pretreatment population showed no significant difference in different plots The effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) showed that eupatorium leaf at both levels (150 and 300g/plant) increased saprophytic nematode population significantly over control Maximum increase (296 72 per cent) was seen in eupatorium leaf (300g/plant) treatment followed by lower dose of eupatorium leaf (150g/plant) treatment with 73 77 per cent Eupatorium leaf (300g/plant) treatment was significantly superior to lower dose of eupatorium leaf (150g/plant) treatment which was also significantly superior to control

The saprophytic nematode population monitored at different intervals showed that eupatorium leaf (300g/plant) was significantly superior to control from 0 D A S to 75 D A S Eupatorium leaf (300g/plant) treatment was on par with eupatorium leaf (150g/plant) treatment at 0 D A S Neem leaf (300g/plant) treatment was on par with eupatorium leaf (150g/plant) treatment at 15 D A S and 30 D A S Eupatorium

Table 5 Effect of organic amendments on the population of saprophytic nematodes at the rootzone of bhindi

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days) 0	15	30	45	60	75	Mean Population
Rainy Season								
Neem leaf 150g/plant	49(6 97)	60(7 76)	95(9 73)	96(9 78)	70(8 35)	64(8 00)	45(6 70)	70(8 39)
Neem leaf 300g/plant	62(7 90)	65(8 08)	110(10 47)	100(9 99)	54(7 35)	65(8 07)	56(7 45)	73(8 57)
Eupatorium leaf 150g/plant	47(6 84)	80(8 97)	131(11 44)	114(10 69)	106(10 30)	114(10 67)	95(9 77)	106(10 31)
Eupatorium leaf 300g/plant	49(6 97)	109(10 44)	304(17 43)	241(15 53)	260(16 11)	308(17 54)	267(16 34)	242(15 57)
Untreated control	57(7 57)	60(7 73)	69(8 32)	63(7 94)	55(7 44)	57(7 58)	61(7 78)	61(7 80)
C D	N S						(1 667)	(2 435)
Summer Season								
Neem leaf 150gm/plant	34(5 87)	46(6 75)	64(7 98)	59(7 70)	44(6 64)	32(5 65)	27(5 20)	44(6 65)
Neem leaf 300gm/plant	41(6 38)	47(6 85)	66(8 12)	61(7 83)	50(7 19)	43(6 55)	34(5 82)	50(7 06)
Eupatorium leaf 150gm/plant	38(6 19)	54(7 35)	82(9 04)	69(8 32)	62(7 90)	49(6 97)	41(6 42)	59(7 67)
Eupatorium leaf 300gm/plant	40(6 32)	76(8 72)	182(13 48)	216(14 70)	121(10 98)	92(9 58)	68(8 22)	120(10 95)
Untreated control	48(6 92)	38(6 14)	45(6 70)	39(6 26)	37(6 11)	34(5 84)	32(5 67)	37(6 12)
C D	N S						(1 659)	(1 727)

Figures given in paranthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

leaf (150g/plant) treatment was significantly superior to control from 15 D A S to 75 D A S

3 1 1 5 2 Summer season

The results are presented in table 5 and fig 2 There was no significant difference in the pretreatment soil population of saprophytic nematodes The effect of neem and eupatorium leaf treatments at two different levels (150 and 300g/plant) showed that eupatorium leaf (300g/plant) treatment was significantly superior to all other treatments and control The increase in population of saprophytic nematodes in eupatorium leaf (300g/plant) treatment was 224 32 per cent over control

The saprophytic nematode population monitored at different intervals showed that eupatorium leaf (300g/plant) treatment showed significant increase from 0 D A S to 75 D A S and lower dose of eupatorium leaf (150g/plant) treatment showed significant increase from 15 D A S to 45 D A S But eupatorium leaf (300g/plant) treatment was significantly superior to eupatorium leaf (150g/plant) treatment at all intervals of observation

The pooled analysis of the data (Table 5) showed no significant difference in the effect of neem and eupatorium leaf at two different levels (150 and 300g/plant) over two seasons

3 1 2 Effect of organic amendments on the rhizosphere microflora

3 1 2 1 On bacteria

3 1 2 1 1 Rainy season

The results are presented in table 6 and fig 1 Mean bacterial population showed statistically significant variation among the treatments Maximum number of c f u were seen in eupatorium leaf treatment @ 300g/plant and it was significantly superior to all other treatments and control Neem leaf treatment significantly reduced the population of bacteria Among the neem leaf treatments maximum reduction was seen in higher dose of neem leaf and it was significantly superior to lower dose of neem leaf treatment

Bacterial population assessed at different intervals showed statistically significant variation Application of eupatorium leaves at both levels increased

Table 6 Effect of organic amendments on the population of bacteria (x 10^3) in the rhizophere of bhindi

Treatments	Initial bacterial population (cfu)	Population observed at different intervals after sowing (days) (cfu) 15	45	75	Mean population (cfu)
Rainy Season					
Neem leaf 150gm/plant	81 (8 97)	179 (13 36)	56 (7 50)	70 (8 37)	95 (9 74)
Neem leaf 300gm/plant	81 (9 01)	126 (11 23)	33 (5 70)	70 (8 38)	71 (8 44)
Eupatorium leaf 150gm/plant	91 (9 53)	264 (16 24)	81 (8 98)	210 (14 50)	175 (13 24)
Eupatorium leaf 300gm/plant	89 (9 42)	276 (16 60)	131 (11 44)	285 (16 88)	224 (14 97)
Untreated control	77 (8 78)	245 (15 66)	80 (8 95)	239 (15 46)	179 (13 36)
C D	N S			(0 63001)	(0 384)
Summer Season					
Neem leaf - 150gm/plant	58 (7 60)	124 (11 15)	130 (11 40)	56 (7 47)	100 (10 01)
Neem leaf - 300gm/plant	56 (7 46)	87 (9 35)	92 (9 61)	67 (8 17)	82 (9 04)
Eupatorium leaf 150gm?plant	63 (7 92)	183 (13 53)	235 (15 34)	79 (8 87)	158 (12 58)
Eupatorium leaf 300gm/plant	62 (7 85)	195 (13 98)	322 (17 95)	104 (10 19)	197 (14 04)
Untreated control	55 (7 40)	171 (13 06)	238 (15 44)	69 (8 29)	151 (12 27)
C D	N S			(1 226)	(0 776)

Figures given in parenthesis are values after $\sqrt{X}$ transformation c f u colony forming unit
Pooled mean not significant

the bacterial population upto 75 D A S where as neem leaves at both levels reduced the bacterial population at 75 D A S All the treatments except eupatorium leaf at higher dose recorded peak bacterial population at 15 D A S Eupatorium leaves at higher dose recorded maximum population at 75 D A S Untreated control also showed an increase in bacterial population when compared with initial population at 75 D A S

3 1 2 1 2 Summer season

The results are presented in table 6 and fig 2 The mean bacterial population showed statistically significant variation among the treatments Maximum c f u were seen in eupatorium leaf treatment @ 300g/plant and it was significantly superior to all other treatments and control Neem leaf (300 g/plant) significantly reduced the population of bacteria over the lower dose and control But the lower dose of neem was also superior to control

Bacterial population assessed at different intervals showed statistically significant variation Application of eupatorium leaf at higher level (300g/plant) increased bacterial population upto 75 D A S but numerical increase was noted at 15 D A S In eupatorium leaf treatment (300g/plant) peak population was obtained at 75

D A S Neem leaf teatments significantly decreased the bacterial population upto 45 D A S In these two treatments higher dose was significantly superior to lower dose Pooled analysis of the data pertaining to two seasons showed no significant variation

3 1 2 2 On fungi

3 1 2 2 1 Rainy season

The results are presented in table 7 and fig 1 The mean fungal population showed statistically significant variation All the treatments except neem leaves at higher dose was significantly superior to untreated control Maximum population was seen in eupatorium leaf treatment (300g/plant) and it was significantly superior to all other treatments Neem leaf (300g/plant) treatment significantly decreased the population of fungi

Pretreatment population of fungi was not statistically significant Application of eupatorim leaf at higher dose showed statistically significant increase at all intervals All other treatments except neem leaf at higher dose gave significant increase upto 45 D A S but at 15 D A S it gave statistically significant increase over control

Table 7 Effect of organic amendments on the population of fungi (x 10^6) in the rhizosphere of bhindi

Treatments	Initial fungal population (cfu)	Population observed at different intervals after sowing (days) (cfu) 15	45	75	Mean Population (cfu)
Rainy Season					
Neem leaf-150gm/plant	8 (2 76)	23 (4 84)	46 (6 80)	26 (5 11)	31 (5 58)
Neem leaf 300gm/plant	8 (2 84)	18 (4 18)	21 (4 62)	18 (4 24)	19 (4 35)
Eupatorium leaf 150gm/plant	8 (2 86)	24 (4 92)	47 (6 85)	31 (5 59)	34 (5 79)
Eupatorium leaf 300gm/plant	8 (2 85)	39 (6 21)	109(10 45)	52 (7 22)	63 (7 96)
Untreated control	7 (2 71)	14 (3 67)	44 (6 61)	30 (5 51)	28 (5 26)
C D	N S			(0 127)	(0 177)
Summer Season					
Neem leaf 150gm/plant	5 (2 30)	11 (3 30)	12 (3 52)	5 (2 19)	9 (3 00)
Neem leaf-300gm/plant	7 (2 57)	7 (2 72)	9 (2 91)	4 (1 99)	7 (2 54)
Eupatorium leaf 150gm/plant	8 (2 85)	10 (3 17)	16 (4 00)	7 (2 63)	11 (3 27)
Eupatorium leaf 50gm/plant	6 (2 44)	19 (4 35)	26 (5 09)	11 (3 27)	18 (4 24)
Untreated control	5 (2 29)	5 (2 29)	15 (3 90)	6 (2 36)	8 (2 85)
C D	(0 244)			(1 512)	(0 263)

CD for comparing effect of seasons 0 532

Figures given in paranthesis are values after $\sqrt{x}$ transformation c f u colony forming units

There after the fungal population started declining At 75 D A S fungal population was lower than control at both levels of neem leaf treatment

3 1 2 2 2 Summer season

The results are presented in table 7 and fig 2 The mean fungal population showed statistically significant variation Eupatorium leaf treatments (150 and 300g/plant) were significantly superior to control Maximum population was seen in eupatorium leaf treatment (300g/plant) with 125 per cent increase Application of eupatorium leaf at higher dose showed significant increase in fungal population monitored at 15 and 45 D A S All treatments showed maximum population at 45 D A S Eupatorium leaf increased (333 33 per cent) the total c f u at 45 D A S when compared with pretreatment population Then the population reduced at 75 D A S but was 83 33 per cent more than pretreatment population Neem leaf (300g/plant) treatment significantly decreased the population from 45 to 75 D A S

The pooled analysis of the data showed that the treatments differ in their performance in two different sesons All the treatments were superior at rainy season compared to summer season

3 1 2 3 On actinomycetes

3 1 2 3 1 Rainy season

The results are presented in table 8 and fig 1 The effect of neem and eupatorium leaf at two levels (150 and 300g/plant) showed that eupatorium leaf (150 and 300g/plant) significantly increased mean actinomycetes population whereas neem leaf (150 and 300g/plant) significantly reduced the actinomycetes population The increase in actinomycetes population under eupatorium leaf treatment (300g/plant) was 173 53 per cent and it was significantly superior to all other treatments The reduction in population of actinomycetes in neem leaf treatment (300g/plant) was 41 18 per cent

The actinomycetes population at different intervals (15 45 and 75 D A S) showed statistically significant variation (Table 8) Eupatorium leaf (300g/plant) treatment showed significantly higher population on 45 D A S and neem leaf (150 and 300g/plant) and eupatorium leaf (150g/plant) showed peak population at 75 D A S

Table 8 Effect of organic amendments on the population of antinomycetes (x 10^3) in the rhizosphere of bhindi

Treatments	Initial fungal population (cfu)	Population observed at different intervals after sowing (days) (cfu) 15	45	75	Me Po ti (c
Rainy Season					
Neem leaf 150gm/plant	10 (3 17)	12 (3 52)	22 (4 65)	77 (8 79)	32 (5
Neem leaf 300gm/plant	10 (3 10)	8 (2 88)	21 (4 61)	36 (6 02)	20 (4
Eupatorium leaf 150gm/plant	12 (3 45)	15 (3 82)	46 (6 80)	61 (7 80)	38 (6
Eupatorium leaf 300gm/plant	14 (3 76)	21 (4 59)	205 (14 33)	99 (9 94)	93 (9
Untreated contrl	9 (2 96)	10 (3 14)	37 (6 09)	68 (8 26)	34 (5
C D	(0 268)			(0 178)	(0 10
Summer Season					
Neem leaf 150gm/plant	7 (2 67)	9 (2 99)	12 (3 46)	13 (3 60)	11 (3
Neem leaf-300gm/plant	7 (2 60)	6 (2 38)	10 (3 11)	9 (2 92)	8 (2
Eupatorium leaf 150gm/plant	8 (2 82)	11 (3 32)	25 (4 97)	11 (3 32)	15 (3
Eupatorium leaf 150gm/plant	10 (3 18)	16 (3 96)	44 (6 61)	21 (4 59)	26 (5
Untreated control	7 (2 68)	7 (2 57)	19 (4 31)	8 (2 83)	11 (3
C D	(0 244)			(0 414)	(0 244

CD for comparing effect of seasons 0 487

Figures given in paranthesis are values after $\sqrt{x}$ transformation Pooled mean not significa

3 1 2 3 Summer season

The results are presented in table 8 and fig 2 The effect of neem and eupatorium leaf (150 and 300g/plant) treatments showed that eupatorium leaf (150 and 300g/plant) significantly increased the actinomycetes population and neem leaf (300g/plant) significantly reduced the population The increase in actinomycete population under eupatorium leaf treatment was 136 36 and 36 3 per cent in 300 and 150g/plant treatment respectively Neem leaf (300g/plant) treatment showed significant reduction of actinomycetes population (27 27 per cent)

Actinomycetes population at different intervals (15 45 and 75 D A S)showed statistically significant variation (Table 8) Eupatorium leaf (150 and 300g/plant) and neem (150g / plant) showed significantly higher population from 15 to 75 D A S over control and neem leaf (300g/plant) gave significant decrease at 45 D A S

The pooled analysis of the data showed that the effect of all the treatments was significantly superior in rainy season over summer season

3 1 3 Effect on biometric characters of bhindi plants

3 1 3 1 Number of leaves

3 1 3 1 1 Rainy season

Results are presented in table 9 The effect of different treatments showed statistically significant variation The neem and eupatorium leaf (300g/plant) treatments significantly increased the number of leaves in bhindi and these two treatments were on par and significantly superior to all other treatments Eupatorium leaf (300g/plant) gave maximum increase at 30 60 and 75 D A S followed by neem leaf (300g/plant) treatment and these two treatments were on par and significantly superior to other treatments and control Eupatorium leaf (300g/plant) gave 75 47 and 28 per cent increse in leaf number at 30 60 and 75 D A S respectively over control The neem leaf treatment (300g/plant) gave 70 46 and 28 per cent increase in leaf number over control at 30 60 and 75 D A S respectively

3 1 3 1 2 Summer season

Results are presented in table 9 The results showed statistically significant variation The neem and eupatorium leaf (300g/plant) treatment significantly

Table 9 Effect of organic amendments on the number of leaves and height of bhindi plants

Treatments	Number of leaves observed at			Height (cm) observed at		
	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS
Rainy Season						
Neem leaf 150g/plant	3 13	8 97	18 03	21 38	59 13	86 68
Neem leaf 300g/plant	5 00	13 00	22 97	34 98	83 35	106 53
Eupatorium leaf 150g/plant	3 06	8 67	17 95	22 88	59 23	82 85
Eupatorium leaf 300g/plant	5 13	13 03	23 06	35 75	84 18	100 17
Untreated control	2 93	8 86	17 97	21 06	58 77	78 07
C D	(0 497)✓	(1 008)	(1 3704)	(2 446)	(3 322)	(6 668)
Summer Season						
Neem leaf 150g/plant	3 77	9 57	20 27	21 93	63 75	89 92
Neem leaf 300g/plant	5 57	16 80	25 30	36 23	87 05	112 42
Eupatorium leaf 150g/plant	3 87	9 83	20 40	22 90	64 20	89 93
Eupatorium leaf 300g/plant	5 80	16 73	25 67	36 70	87 65	112 65
Untreated control	3 10	9 13	18 97	21 60	63 08	83 08
C D	(0 481)	(1 349)	(1 746)	(2 633)	(3 688)	(7 3007)

DAS Days after sowing

increased the number of leaves in bhindi and they were on par and significantly superior to all other treatments Eupatorium leaf (300g/plant) gave maximum leaf production on 30 and 75 D A S and neem leaf (300g/plant) treatment gave maximum effect at 60 D A S Eupatorium leaf (300g/plant) treatment gave 87,83 and 35 per cent increase over control at 30 60 and 75 D A S respectively and neem leaf (300g/plant) treatment gave 80, 84 and 33 per cent increase in leaf number over control at 30 60 and 75 D A S respectively

3 1 3 2 Height of bhindi plant

3 1 3 2 1 Rainy season

The results are presented in table 9 The effect of neem and eupatorium leaf in two different levels (150 and 300g/plant) showed significant variation in the height of bhindi plants during rainy season The neem and eupatorium leaf (300g/plant) treatments gave maximum increase in height and it was significantly superior to all other treatments at 30 60 and 75 D A S The effect of neem and eupatorium leaf @ 150g/plant was statistically on par

Neem leaf (300g/plant) gave 66 42 and 37 per cent increase in height of bhindi plants at 30 60 and 75 D A S respectively while eupatorium leaf treatment (300g/plant) gave 70 43 and 28 per cent increase at 30 60 and 75 D A S respectively

3 1 3 2 2 Summer season

Results are presented in table 9 The effect of neem and eupatorium leaf at two levels (150 and 300g/plant) showed statistically significant variation in the height of bhindi plants during summer season The neem and eupatorium leaf (300g/plant) treatment gave maximum increase in plant height and it was significantly superior to all other treatments The effect of neem and eupatorium leaf (300g/plant) treatment was on par

Neem leaf (300g/plant) treatment gave 68 38 and 35 per cent increase in height at 30 60 and 75 D A S respectively Eupatorium leaf (300g/plant) treatment gave 70 39 and 36 per cent increase at 30 60 and 75 D A S respectively

3 1 3 3 Yield

3 1 3 3 1 Rainy season

The results showed that application of neem and eupatorium leaf (300g/plant) treatment significantly increased the yield of bhindi in rainy season over control (Table 10) Neem leaf treatment (300g/plant) gave maximum yield (135 48 per cent) followed by eupatorium leaf (300g/plant) treatment (117 74 per cent)

3 1 3 3 2 Summer season

The results showed that application of neem leaf and eupatorium leaf (300g/plant) treatment significantly increased the yield of bhindi in summer season over control (Table 10) Neem leaf treatment (300g/plant) gave maximum yield (100 per cent) over control followed by eupatorium leaf (300g/plant) treatment with 94 29 per cent

3 1 3 4 Shoot weight

3 1 3 4 1 Rainy season

The results are presented in table 10 The effect of neem and eupatorium leaf treatment (150 and 300g/plant)

Table 10 Effect of Organic amendments on the yield, shoot weight, root weight of bhindi plants and on the population of nematode

Treatments	Yield (g)	Shoot weight (g)	Root weight (g)	Nematode population in 5cm root
Rainy Season				
Neem leaf 150g/plant	255 00	95 200	16 833	44 9
Neem leaf-300g/plant	486 67	111 317	23 467	27 6
Eupatorium leaf 150g/plant	210 00	94 583	16 683	44 8
Eupatorium leaf-300g/plant	450 00	109 250	22 833	26 8
Untreated control	206 67	91 267	15 133	47 5
C D	121 208	(3 0226)	(2 2594	3 83
Summer Season				
Neem leaf-150g/plant	1021 67	97 500	18 483	30 4
Neem leaf-300g/plant	1446 67	114 767	25 417	23 3
Eupatorium leaf-150g/plant	988 33	97 700	18 850	30 7
Eupatorium leaf-300g/plant	1405 00	114 767	24 850	23 3
Untreated control	723 33	92 433	16 917	39 1
C D	102 582	8 7842	3 0908	4 26

showed statistically significant variation Maximum increase in shoot weight was exhibited by neem leaf treatment (300g/plant) with 22 per cent increase followed by the treatment of eupatorium leaf (300/plant) with 20 per cent increase and these two treatments were statistically on par Neem and eupatorium leaf treatment at lower dose (150g/plant) was also on par and superior to control

3 1 3 4 2 Summer Season

The results are presented in table 10 The effect of neem and eupatorium leaf treatments (150 and 300g/plant) showed statistically significant increase in shoot weight The higher dose of neem and eupatorium leaf gave an increase of 114 77 per cent The higher dose of neem and eupatorium treatment only showed superiority of their effects over control Both the treatments were statistically on par and increased the shoot weight of bhindi plants (24 16 per cent) over control

3 1 3 5 Root weight

3 1 3 5 1 Rainy Season

The results are presented in table 10 The neem and eupatorium leaf (150 and 300g/plant) treatment showed

statistically significant difference between other treatments and control Neem and eupatorium (300g/plant) treatments were on par and significantly superior to other two treatments and control Maximum increase in root weight was given by neem leaf at 300g/plant (55 07 per cent) followed by eupatorium leaf at 300g/plant (50 88 per cent)

3 1 2 Summer season

The results are presented in table 10 The neem and eupatorium leaf (150 and 300g/plant) treatment showed statistically significant variation among the treatments and control The treatment effects of neem and eupatorium leaf (300g plant) were on par and significantly superior to other two treatments and control Neem and eupatorium leaf (300g plant) showed an increase in root weight of 50 25 and 46 8 per cent respectively

3 1 6 Nematode population in bhindi roots

3 1 6 1 Rainy season

The results are presented in table 10 The nematode population in roots of bhindi at 75 D A S showed significant difference between treatments and control

Maximum reduction in nematode population (43 6 per cent) was given by eupatorium leaf treatment (300g/plant) followed by neem leaf (300g/plant) treatment (41 9 per cent) These two treatments were statistically on par and superior to other two treatments and control

3 1 3 6 2 Summer season

The mean nematode population in bhindi roots 75 D A S showed significant difference between treatment and control Maximum reduction in population (40 49 per cent) was given by neem leaf (300g/plant) treatment followed by eupatorium leaf (300g/plant) treatment (40 41 per cent) These two treatments were statistically on par and significantly superior to other two treatments and control (Table 10)

3 2 Cowpea

3 2 1 Effect of organic amendments on nematodes

3 2 1 1 On Helicotylenchus spp

3 2 1 1 1 Rainy season

The results are presented in table 11 and fig 3 The effect of neem and eupatorium leaf treatment at two different levels (7 5 and 15 t/ha) showed that all

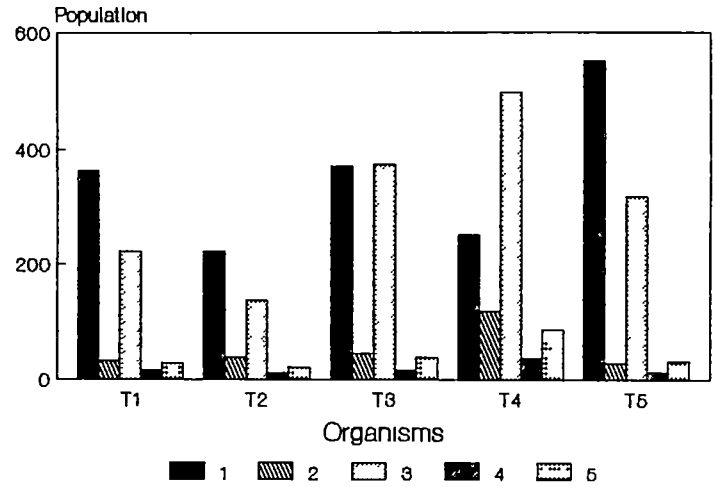
Table 11 Effect of organic amendments on the population of *Helicotylenchus* spp at the rootzone of cowpea

Treatments	Pretreatment population 200g	Population observed at different intervals after sowing (days) 0	15	30	45	60	75	Mean population
Rainy Season								
Neem leaf 7 5 t/ha	7(2 71)	2(1 45)	3(1 62)	2(1 26)	3(1 69)	4(1 98)	3(1 76)	3(1 63)
Neem leaf 15 t/ha	4(2 02)	2(1 56)	2(1 39)	2(1 32)	4(1 90)	10(3 24)	11(3 33)	5(2 12)
Eupatorium leaf 7 5t/ha	12(3 41)	2(1 58)	2(1 41)	4(1 91)	6(2 46)	5(2 14)	6(2 42)	2(1 58)
Eupatorium leaf 15 t/ha	20((4 44)	2(1 35)	1(1 16)	3(1 74)	3(1 85)	3(1 82)	4(1 99)	3(1 65)
Untreated control	17(4 16)	8(2 84)	8(2 81)	9(3 05)	8(2 79)	6(2 39)	3(1 71)	7(2 60)
C D	(0 798)						(0 893)	(0 348)
Summer Season								
Neem leaf 7 5 t/ha	6(2 38)	2(1 53)	2(1 48)	1(1 19)	3(1 87)	5(2 18)	3(1 81)	3(1 68)
Neem leaf 15 t/ha	5(2 19)	2(1 38)	2(1 24)	1(1 14)	5(2 18)	6(2 53)	8(2 81)	4(1 88)
Eupatorium leaf 7 5t/ha	6(2 38)	3(1 84)	2(1 34)	5(2 13)	6(2 50)	5(2 16)	7(2 64)	10)
Eupatorium leaf 15 t/ha	5(2 19)	3(1 60)	3(1 67)	3(1 77)	4(2 06)	4(1 93)	4(1 95)	3(1 83)
Untreated control	5(2 21)	8(2 82)	8(2 79)	8(2 86)	5(2 32)	7(2 62)	4(2 05)	7(2 58)
C D	N S						(1 159)	(0 363)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

Fig 8 Effect of treatments on different organisms in the rootzone of cowpea in rainy season



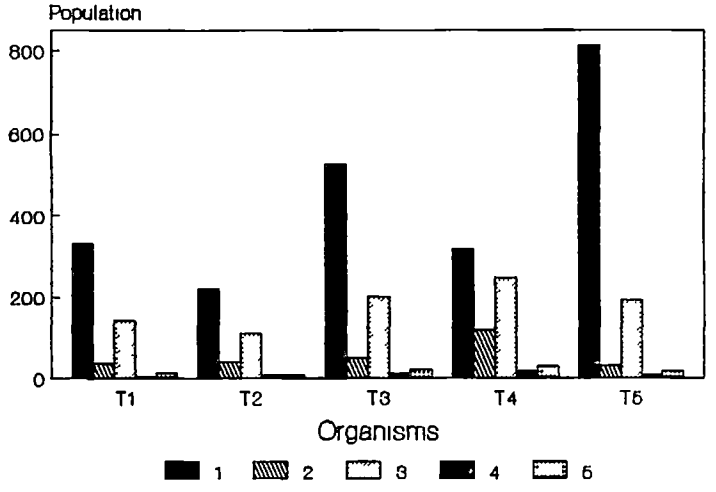
Treatments

T1 Neem leaves (150 g/plant)
T2 - Neem leaves (300 g/plant)
T3 Eupatorium leaves (150 g/plant)
T4 - Eupatorium leaves (300 g/plant)
T5 - Untreated control

Organisms

1 - Plant parasitic nematodes
2 - Non-parasitic nematodes
3 - Bacteria
4 - Fungi
5 Actinomycetes

Fig 4 Effect of treatments on different organisms in the rootzone of cowpea in summer season



Treatments

T1 - Neem leaves (150 g/plant)
T2 - Neem leaves (300 g/plant)
T3 Eupatorium leaves (150 g/plant)
T4 - Eupatorium leaves (300 g/plant)
T5 Untreated control

Organisms

1 - Plant parasitic nematodes
2 - Non-parasitic nematodes
3 - Bacteria
4 - Fungi
5 - Actinomycetes

levels (7 5 and 15t/ha) showed that all treatments were significantly superior to control in reducing the R reniformis population in soil collected from the rootzone of cowpea Maximum reduction (60 58 per cent) was given by neem leaf treatment (15t/ha) followed by eupatorium leaf (15t/ha) treatment (56 66 per cent) Neem and eupatorium leaf at higher dose (15t/ha) were on par and significantly superior to lower dose of neem and eupatorium leaf which were also on par and superior to control

The R reniformis population monitored at different periods showed that all treatments significantly reduced R reniformis population from 15 D A S to 75 D A S At 0 D A S all treatments except neem leaf at lower level (7 5t/ha) significantly reduced R reniformis population over control Neem leaf at higher dose (15t/ha) was most effective in reducing nematode population at 75 D A S though it was statistically on par with eupatorium leaf (15t/ha) treatment Neem leaf (15t/ha) treatment was statistically on par with eupatorium leaf treatment in all periods of observation except at 45 D A S Neem leaf (15t/ha) treatment was also on par with lower dose of neem leaf (7 5t/ha) and eupatorium (7 5t/ha) leaf treatment at 0 and 15 D A S Neem leaf (15t/ha) treatment at 75 D A S only

treatments significantly reduced the population of Helicotylenchus spp in the rootzone of cowpea Maximum reduction was given by eupatorium leaf (7 5 t/ha)treatment followed by neem leaf (7 5t/ha) treatment eupatorium leaf (15t/ha) and neem leaf (15 t/ha) treatment Eupatorium leaf treatment at both levels (7 5 and 15t/ha) and neem leaf (7 5t/ha) were on par and significantly superior to neem leaf (15t/ha) treatment which was significantly superior to control

The population of Helicotylenchus spp monitored at different intervals revealed that all treatments were significantly superior to control up to 30 D A S At 45 D A S neem leaf (7 5t/ha) and eupatorium leaf (15 t/ha) were significantly superior to control At 75 D A S all the treatments except neem leaf (15t/ha) were on par with control

3 2 1 1 2 Summer season

The results are presented in Table 11 and fig 4 The pretreatment population was uniform and there was no significant difference in the soil population of Helicotylenchus spp in different plots The effect of neem and eupatorium leaf treatments at two different levels (7 5 and 15 t/ha) showed that all treatments significantly

reduced the Helicotylenchus spp population in the soil collected from the rootzone of cowpea in summer season Maximum reduction was noticed in neem leaf treatment (7 5 t/ha) followed by eupatorium leaf treatment (15 t/ha) neem leaf (15 t/ha) treatment and eupatorium leaf (7 5 t/ha) treatment and these treatments were statistically on par

The Helicotylenchus spp population monitored at different periods showed that neem leaf treatment at both levels (7 5 and 15 t/ha) significantly reduced the population upto 30 D A S Eupatorium leaf (15 t/ha) kept the population above control only at 75 D A S but the population did not show statistically significant increase and all the treatments except neem leaf(15 t/ha) showed the same trend at 75 D A S

The pooled analysis of the data presented in table 11 showed that the effect of neem and eupatorium leaf at two different levels (7 5 and 15 t/ha) had no significant difference in the two seasons

3 2 1 2 On R reniformis

3 2 1 2 1 Rainy season

The results are presented in table 12 and fig 3 The effect of neem and eupatorium leaf at two different

Table 12 Effect of organic amendments on the population of Rotylenchulus reniformis at the rootzone of cowpea

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days) 0	15	30	45	60	75	Mean population
Rainy Season								
Neem leaf 7 5 t/ha	230(15 16)	309(17 59)	319(17 87)	381(19 53)	376(19 40)	453(21 28)	470(21 67)	382(19 56)
Neem leaf 15 t/ha	280(16 72)	246(15 70)	267(16 35)	227(15 06)	215(14 67)	211(14 54)	220(14 84)	231(15 19)
Eupatorium leaf 7 5t/ha	513(22 66)	281(16 79)	303(17 42)	415(20 37)	417(20 42)	435(20 85)	442(21 03)	379(19 48)
Eupatorium leaf 15 t/ha	446(21 12)	175(13 22)	197(14 03)	264(16 24)	306(17 50)	298(17 25)	303(17 42)	254(15 94)
Untreated control	528(22 97)	382(19 55)	481(21 94)	576(23 99)	709(26 63)	703(26 51)	711(26 66)	586(24 21)
C D	(0 147)						(2 782)	(2 2106)
Summer Season								
Neem leaf 7 5 t/ha	304(17 44)	234(15 30)	251(15 83)	299(17 29)	333(18 25)	413(20 33)	477(21 84)	329(18 14)
Neem leaf 15 t/ha	346(18 60)	178(13 36)	200(14 13)	176(13 26)	199(14 10)	241(15 54)	303(17 42)	214(14 64)
Eupatorium leaf 7 5t/ha	501(22 39)	347(18 64)	473(21 76)	509(22 57)	617(24 83)	690(26 27)	666(25 81)	544(23 31)
Eupatorium leaf 15 t/ha	437(20 91)	253(15 91)	271(16 47)	311(17 63)	342(18 48)	346(18 59)	387(19 66)	316(17 79)
Untreated control	595(24 39)	441(21 01)	684(26 15)	811(28 47)	935(30 58)	1099(33 15)	1070(32 71)	822(28 68)
C D	(0 098)						(4 015)	(2 469)

Figures given in parenthesis are values after $\sqrt{x}$ transformation Pooled mean not significant

significantly superior to control in reducing R reniformis population from 15 D A S to 75 D A S All treatments except eupatorium leaf (7 5t/ha) treatment was significantly superior to control at 0 D A S Neem leaf (15t/ha) treatment was statistically on par with eupatorium leaf (15t/ha) under all periods of observation except from 30 to 60 D A S Neem leaf (15t/ha) was also on par with lower dose of neem leaf (7 5t/ha) treatment at 0 and 15 D A S Neem and eupatorium leaf (15t/ha) treatment reduced the R reniformis population below pretreatment population at 75 D A S

The results of the pooled analysis presented in table 12 showed that effect of neem and eupatorium leaf treatments at two different levels (7 5 and 15t/ha) over rainy and summer season showed no significant variation

3 2 1 3 M incognita

3 2 1 3 1 Rainy season

The results are presented in table 13 and fig 3 The pretreatment population was uniform and there was no significant difference in soil population of M incognita in different plots The effect of neem and eupatorium leaf in

Table 13 Effect of organic amendments on the population of *M incognita* at the rootzone of cowpea

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days)						Mean population
		0	15	30	45	60	75	
Rainy Season								
Neem leaf 7 5 t/ha	34(5 85)	9(3 02)	5(2 34)	3(1 68)	3(1 67)	3(1 73)	2(1 43)	4(1 98)
Neem leaf 15 t/ha	16(4 00)	2(1 24)	6(2 35)	2(1 38)	1(1 14)	2(1 36)	3(1 69)	2(1 53)
Eupatorium leaf 7 5t/ha	32(5 68)	5(2 32)	2(1 57)	3(1 68)	2(1 38)	1(1 14)	7(2 57)	3(1 78)
Eupatorium leaf 15 t/ha	28(5 30)	5(2 28)	2(1 36)	2(1 38)	1(1 14)	2(1 45)	5(2 2)	3(1 63)
Untreated control	36(6 03)	34(5 84)	9(3 08)	6(2 41)	3(1 69)	1(1 14)	3(1 86)	7(2 66)
C D	N S						(0 639)	(0 295)
Summer Season								
Neem leaf 7 5 t/ha	14(3 8)	6(2 47)	5(2 31)	4(1 95)	4(1 94)	4(2 06)	2(1 41)	4(2 02)
Neem leaf 15 t/ha	13(3 67)	3(1 67)	5(2 32)	2(1 44)	2(1 31)	2(1 47)	3(1 70)	3(1 65)
Eupatorium leaf 7 5t/ha	25(5 01)	6(2 35)	3(1 74)	4(1 95)	2(1 50)	1(1 14)	6(2 53)	3(1 87)
Eupatorium leaf 15 t/ha	30(5 45)	5(2 16)	2(1 36)	2(1 43)	2(1 26)	2(1 44)	4(2 06)	3(1 62)
Untreated control	36(5 97)	22(4 71)	8(2 74)	5(2 25)	3(1 65)	1(1 14)	4(2 09)	6(2 43)
C D	N S						(0 918)	(0 331)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

two different levels (7 5 and 15t/ha) showed that all treatments were significantly superior to control Maximum reduction was given by neem leaf (15t/ha) treatment followed by eupatorium leaf (15t/ha) treatment

The M incognita population monitored at different period intervals showed that all treatments were significantly superior to control from 0 D A S to 30 D A S There after all treatments were on par with control

3 2 1 3 2 Summer season

The results are presented in table 13 and fig 4 The pretreatment population was uniform and there was no significant variation in the soil population of M incognita in different plots The effect of neem and eupatorium leaf at two different levels (7 5 and 15t/ha) showed that all treatments were significiantly superior to control in reducing M incognita population in the soil collected from the rootzone of cowpea A maximum reduction was noted under eupatorium leaf (15t/ha) treatment followed by neem leaf (15t/ha) treatment Higher dose of neem leaf treatment was superior to lower dose of neem

The M incognita population monitored at different periods showed significant reduction of population under all treatments at 0 D A S over control but at 15 D A S only eupatorium leaf (7 5 and 15t/ha) treatment showed significantly reduction in M incognita population There after the treatments were on par with control All treatments reduced M incognita population below pretreatment poplation at 75 D A S

The comparison of treatment effects over rainy and summer season showed that the effect of neem and eupatorium leaf treatments at two different levels (7 5 and 15t/ha) had no significant difference

3 2 1 4 Predatory nematodes

3 2 1 4 1 Rainy season

The results are presented in table 14 and fig 3 The pretreatment population was uniform and there was no significant variation in the soil population of predatory nematodes in different plots The effect of neem and eupatorium leaf treatment at different levels showed that all treatments except neem leaf (7 5t/ha) treatment significantly increased predatory nematode population in soil samples collected from the rootzone of cowpea Maximum

Table 14 Effect of organic amendments on the population on predeatory nematodes in the rootzone of cowpea

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days)						Mean population
		0	15	30	45	60	75	
Rainy Season								
Neem leaf 7 5 t/ha	2(1 36)	4(2 02)	4(2 12)	5(2 14)	5(2 33)	3(1 84)	3(1 62)	4(2 01)
Neem leaf 15 t/ha	3(1 87)	7(2 57)	3(1 85)	5(2 15)	6(2 52)	7(2 61)	6(2 45)	6(2 36)
Eupatorium leaf 7 5t/ha	2(1 39)	6(2 42)	3(1 81)	9(2 94)	5(2 30)	6(2 43)	2(1 58)	5(2 25)
Eupatorium leaf 15 t/ha	2(1 48)	6(2 51)	16(3 97)	11(3 35)	14(3 73)	13(3 58)	22(4 69)	13(3 64)
Untreated control	2(1 56)	3(1 83)	3(1 59)	2(1 44)	3(1 84)	3(1 64)	3(1 74)	3(1 68)
C D	N S						(0 3502)	(0 616)
Neem leaf 7 5 t/ha	2(1 26)	5(2 26)	5(2 32)	5(2 16)	6(2 39)	4(1 94)	4(1 89)	5(2 16)
Neem leaf 15 t/ha	2(1 38)	8(2 88)	5(2 22)	6(2 4)	7(2 61)	5(2 22)	6(2 43)	6(2 46)
Eupatorium leaf 7 5t/ha	1(1 19)	9(2 95)	4(2 04)	9(3 05)	5(2 33)	5(2 15)	3(1 73)	6(2 38)
Eupatorium leaf 15 t/ha	2(1 26)	8(2 75)	16(4 01)	16(4 06)	16(3 99)	9(2 98)	16(3 99)	13(3 63)
Untreated control	2(1 30)	3(1 79)	3(1 81)	3(1 81)	4(2 04)	2(1 43)	2(1 48)	3(1 73)
C D	N S						(0 525)	(0 296)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

increase (333 35 per cent) was under eupatorium leaf (15t/ha) treatment followed by neem leaf (15t/ha) treatment with 100 per cent increase and eupatorium leaf (7 5t/ha) treatment with 66 66 per cent Eupatorium leaf (15t/ha) was significantly superior to neem leaf (15t/ha) treatment which was on par with lower dose of eupatorium leaf (7 5t/ha) treatment

The predatory nematode population monitored at different periods showed significant difference from 0 D A S to 75 D A S under eupatorium leaf treatments (7 5 and 15t/ha) Neem leaf (15t/ha)treatment also found to be superior to control under all periods of observation except at 15 D A S Neem leaf (15t/ha) treatment was on par with eupatorium leaf (7 5t/ha) treatment except at 30 and 75 D A S Except for 0 D A S eupatorium leaf (15t/ha) treatment was found to be significantly superior to neem leaf (15t/ha) in all periods except at 0 D A S All treatments increased predatory nematode population at 75 D A S when compared with pre treatment population

3 2 1 4 2 Summer season

The results are presented in table 14 and fig 4 The pretreatment population was uniform and there was no

significant variation in the population of predatory nematodes in the soil from different plots The effect of neem and eupatorium leaf at two different levels (7 5t and 15t/ha) showed that all treatments significantly increased predatory nematodes in soil collected from the rootzone of cowpea Maximum increase (333 33 per cent) was under eupatorium leaf (15t/ha) treatment followed by neem leaf (15t/ha) treatment and eupatorium leaf (7 5t/ha) treatment with 100 per cent increase and neem leaf (7 5t/ha) treatment with 66 66 per cent Eupatorium leaf (15t/ha) treatment was significantly superior to neem leaf (15t/ha) treatment But neem leaf (15t/ha) treatment was on par with neem leaf (7 5t/ha) and eupatorium leaf (7 5t/ha) treatment All the treatments were significantly superior to control

The predatory nematode population observed at different period intervals showed that eupatorium leaf (15t/ha) treatment was superior to control from 0 D A S to 75 D A S Neem leaf (15t/ha) treatment was significantly superior to control in different intervals except at 15 D A S

Neem leaf (15t/ha) treatement was on par with eupatorium leaf (15t/ha) treatment at 0 D A S Neem leaf (15t/ha) treatment was on par with eupatorium leaf (7 5t/ha) treatment under all periods of observation except at 30 and 75 D A S At 30 D A S eupatorium leaf (7 5t/ha)

was significantly superior to neem leaf(15t/ha) All treatments increased predatory nematode population at 75 D A S when compared to pretreatment population

The results of the pooled analysis are presented in table 14 The effect of neem and eupatorium leaf at two different levels (7 5 and 15t/ha) over rainy and summer season showed no significant difference in treatment effects in two seasons

3 2 1 5 1 On Saprophytic nematodes

3 2 1 5 1 Rainy season

The result are presented in table 15 and fig 3 The pretreatment population was uniform and there was no significant variation in the population of saprophytic nematodes in the soil collected from different plots The effect of neem and eupatorium leaf treatments at two different levels(7 5 and 15t/ha) showed that only eupatorium leaf (15t/ha) treatment was significantly superior to control in increasing the saprophytic nematode population The increase given by eupatorium leaf(15t/ha) treatment was 73 79 per cent All other treatments were on par with control

Table 15 Effect of organic amendments on the population of saprophytic nematodes at the rootzone of cowpea

Treatments	Pretreatment population (200g)	Population observed at different intervals after sowing (days)					Mean population
		0	15	30	45	60	75	
Rainy Season								
Neem leaf 7 5 t/ha	20 (4 45)	23 (4 83)	40 (6 34)	46 (6 76)	31 (5 57)	23 (4 80)	16 (3 95)	29 (5 38)
Neem leaf 15 t/ha	27 (5 16)	29 (5 39)	40 (6 33)	43 (6 54)	33 (5 77)	36 (5 99)	27 (5 16)	34 (5 87)
Eupatorium leaf 7 5t/ha	24 (4 88)	33 (5 72)	37 (6 11)	47 (6 82)	41 (6 42)	44 (6 61)	39 (6 26)	40 (6 32)
Eupatorium leaf 15 t/ha	23 (4 76)	47(6 89)	131(11 44)	104(10 19)	117 (10 83)	97 (9 85)	133 (11 54)	103 (10 13)
Untreated control	27 (5 16)	29 (5 36)	28 (5 28)	26 (5 13)	23 (4 78)	27 (5 17)	27 (5 18)	27 (5 15)
C D	N S						(1 051)	(1 5403)
Summer Season								
Neem leaf 7 5 t/ha	21 (4 61)	29 (5 37)	51 (7 11)	46 (6 79)	31 (5 55)	26 (5 13)	18 (4 27)	32 (5 70)
Neem leaf 15 t/ha	26 (5 07)	35 (5 92)	46 (6 75)	52 (7 20)	35 (5 89)	29 (5 39)	26 (5 11)	37 (6 05)
Eupatorium leaf 7 5t/ha	22 (4 65)	34 (5 81)	48 (6 95)	50 (7 06)	43 (6 55)	36 (5 98)	48 (6 93)	45 (6 71)
Eupatorium leaf 15 t/ha	21 (4 63)	55 (7 41)	118(10 84)	152(12 31)	134(11 58)	85 (9 22)	101(10 06)	105(10 24)
Untreated control	29 (5 41)	30 (5 46)	33 (5 78)	37 (6 06)	27 (5 23)	21 (4 61)	23 (4 77)	28 (5 32)
C D	N S						(1 365)	(0 661)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

The saprophytic nematode population monitored at different intervals showed that eupatorium leaf(15t/ha) treatment was significantly superior to control from 0 D A S to 75 D A S Eupatorium leaf(7 5 and 15t/ha) treatments increased saprophytic nematode population at 75 D A S than pretreatment population

3 2 1 5 2 Summer season

The results are presented in table 15 and fig 4 The pretreatment population was uniform and there was no significant variation in the soil population of saprophytic nematodes in different plots The effect of neem and eupatorium leaf treatments in two different levels (7 5 and 15t/ha) showed that all treatments except neem leaf (7 5t/ha) treatment significantly increased saprophytic nematode population in the soil collected from the rootzone of cowpea Maximum increase of 71 3 per cent was given by eupatorium leaf(15t/ha) treatment followed by lower dose of eupatorium leaf (7 5t/ha) treatment with 60 71 per cent increase Eupatorium leaf (15t/ha) treatment was superior to eupatorium leaf(7 5t/ha) treatment which was on par with neem leaf (15t/ha) treatment Neem leaf(15t/ha) treatment was significantly superior to lower dose of neem leaf (7 5t/ha) which was on par with control

The saprophytic nematode population monitored at different periods showed that eupatorium leaf (15t/ha) treatment was significantly superior to control at all periods of observation Eupatorium leaf(7 5t/ha) treatment significantly increased the saprophytic nematode population over control at 60 and 75 D A S Eupatorium leaf(7 5t/ha) and neem leaf (15t/ha) treatments were on par upto 60 D A S but eupatorium leaf(7 5t/ha) was significantly superior at 75 D A S

The results of the pooled analysis presented in table 15 showed that the effect of neem and eupatorium leaf at two different levels (7 5 and 15t/ha) during rainy and summer season had no significant variation

3 2 2 Effect of organic amendments on the rhizosphere microflora

3 2 2 1 On bacteria

3 2 2 1 1 Rainy season

The results are presented in table 16 and fig 3 Mean bacterial population also showed statistically significant variation among the treatments Maximum numbers of c f u were recorded in eupatorium leaf (7 5 and 15t/ha)

Table 16 Effect of organic amendments on the population of bacteria (x 10^3) in the rhizosphere of Cowpea

Treatments	Initial bacterial population (cfu)	Population observed at different intervals after sowing (days) (cfu) 15	45	75	Mean population (cfu)
Rainy Season					
Neem leaf 7 5t/ha	65 (8 06)	153 (12 38)	564 (23 74)	75 (8 68)	223 (14 93)
Neem leaf 15 t/ha	67 (8 19)	109 (10 43)	285 (16 39)	65 (8 04)	139 (11 79)
Eupatorium leaf 7 5t/ha	72 (8 47)	248 (15 74)	802 (28 31)	194 (13 94)	374 (19 33)
Eupatorium leaf 15t/ha	67 (8 19)	247 (15 73)	1175 (34 28)	287 (16 94)	498 (22 32)
Untreated control	72 (8 46)	224 (14 95)	647 (25 44)	175 (13 21)	319 (17 87)
C D	N S			(3 175)	(1 419)
Summer Season					
Neem leaf 7 5t/ha	72 (8 51)	166 (12 89)	196 (14 00)	76 (8 69)	141 (11 86)
Neem leaf 15t/ha	77 (8 80)	118 (10 88)	132 (11 47)	80 (8 96)	109 (10 44)
Eupatorium leaf 7 5t/ha	70 (8 38)	243 (15 62)	307 (17 53)	90 (9 49)	202 (14 21)
Eupatorium leaf 15t/ha	77 (8 76)	271 (16 45)	398 (19 95)	118 (10 85)	248 (15 75)
Untreated control	82 (9 07)	241 (14 88)	291 (17 07)	94 (9 69)	193 (13 88)
C D	N S			(2 149)	(0 978)

Figures given in parenthesis are values after $\sqrt{x}$ transformation Pooled mean not significant
c f u colony forming unit

treatment and it was significantly superior to all other treatments and control Application of neem leaf (7 5 and 15t/ha) showed significant reduction in the population of bacteria

Bacterial population assessed at different period showed statistically significant variation Application of eupatorium leaf (15t/ha) increased bacterial population significantly at 45 and 75 D A S Neem leaf (15t/ha) treatment significantly reduced the population 15 D A S to 75 D A S At 75 D A S two doses of neem leaf treatments were on par

3 2 2 1 2 Summer season

The results are presented in table 16 and fig 4 Mean bacterial population showed significant variation among the treatments Maximum c f u were observed in eupatorium leaf treatment @ 15t/ha and it was significantly superior to all other treatments and control while neem leaf (7 5 and 15t/ha) treatment significantly reduced the population of bacteria Bacterial population assessed at differnt intervals showed statistically significant variaion Application of eupatorium leaf (15t/ha) increased

the bacterial population at 45 D A S Neem leaf (15t/ha) caused significant reduction in bacterial population at 15 and 45 D A S while eupatorium (15 t/ha) significantly increased the population during this period

The pooled analyis of the data (rainy and summer season) showed no significant variation in the treatment effects in different seasons

3 2 2 2 On fungi

3 2 2 2 1 Rainy season

The results are presented in table 17 and fig 3 The analysis of co variance revealed statistically significant variation in mean fungal population Eupatorium leaf treatment (15t/ha) was found to be significantly superior to control and all other treatments

Application of eupatorium leaf (7 5 and 15t/ha) and neem leaf (7 5t/ha) treatment showed significant variation at different period intervals All treatments recorded their peak population 45 D A S Neem leaf (15t/ha) treatment did not give significant increase at 45 D A S when compared to 15 D A S but all other treatments gave significant increase Eupatorium leaf (15t/ha) significantly increased fungal population at all period intervals over control

Table 17 Effect of organic amendments on the population of fungi (10^6) in the rhizophere of Cowpea

Treatments	Initial bacterial population (cfu)	Population observed at different intervals after sowing (days) (cfu)			Mean population (cfu)
		15	45	75	
Rainy Season					
Neem leaf 7 5t/ha	9 (2 93)	11 (3 24)	26 (5 14)	12 (3 41)	16 (3 93)
Neem leaf 15 t/ha	7 (2 71)	11 (3 33)	15 (3 86)	9 (3 01)	12 (3 40)
Eupatorium leaf 7 5t/ha	13 (3 56)	11 (3 29)	29 (5 38)	15 (3 85)	17 (4 17)
Eupatorium leaf 15t/ha	8 (2 85)	17 (4 12)	74 (8 60)	34 (5 82)	38 (6 18)
Untreated control	7 (2 72)	5 (2 23)	25 (4 96)	16 (4 04)	14 (3 74)
C D	(0 472)			(1 233)	(0 729)
Summer Season					
Neem leaf 7 5t/ha	10 (3 1)	11 (3 30)	14 (3 74)	3 (1 79)	6 (2 35)
Neem leaf 15t/ha	9 (2 98)	11 (3 34)	13 (3 59)	3 (1 81)	9 (2 91)
Eupatorium leaf 7 5t/ha	14 (3 67)	12 (3 46)	19 (4 38)	8 (2 80)	13 (3 55)
Eupatorium leaf 15t/ha	10 (3 12)	18 (4 24)	28 (5 30)	11 (3 35)	19 (4 30)
Untreated control	8 (2 81)	6 (2 39)	17 (4 11)	6 (2 50)	9 (3 00)
C D	(0 515)			(0 777)	(0 483)

Figures given in parenthesis re v lues after $\sqrt{x}$ transformation

Pooled mean not significant

3 2 2 2 2 Summer season

The results are presented in table 17 and fig 4 The mean fungal population also showed statistically significant variation All treatments except neem leaf at both levels were significantly superior to untreated control Maximum population was seen in eupatorium leaf (15t/ha) treatment and it was significantly superior to all other treatments

Application of eupatorium leaf at both levels (7 5 and 15t/ha) showed statistically significant variation in all periods All treatments increased fungal population at 15 D A S Eupatorium leaf (15t/ha) treatment was only superior to control at all periods

The pooled analysis of the data (rainy and summer) showed no significant variation among treatment effects in different seasons

3 2 2 3 On actinomycetes

3 2 2 3 1 Rainy season

The results are presented in table 18 and fig 3 The effect of neem and eupatorium leaf (7 5 and 15t/ha) treatments showed that eupatorium leaf (15t/ha) treatment

Table 18 Effect of organic amendments on the population of actinomycetes($\times 10^3$) in the rhizosphere of Cowpea

Treatments	Initial bacterial population (cfu)	Population observed at different intervals after sowing (days) (cfu)			Mean population (cfu)
		15	45	75	
Rainy Season					
Neem leaf 7 5t/ha	10 (3 09)	12 (3 44)	23 (4 82)	68 (8 23)	30 (5 5)
Neem leaf 15 t/ha	9 (2 96)	8 (2 80)	23 (4 74)	38 (6 17)	21 (4 57)
Eupatorium leaf 7 5t/ha	14 (3 71)	18 (4 25)	49 (6 97)	59 (7 65)	40 (6 29)
Eupatorium leaf 15t/ha	12 (3 43)	22 (4 68)	198 (14 06)	88 (9 37)	88 (9 37)
Untreated control	9 (3 06)	11 (3 35)	36 (6 02)	62 (7 88)	33 (5 75)
C D	N S			(1 406)	(0 712)
Summer Season					
Neem leaf 7 5t/ha	16 (3 98)	11 (3 32)	13 (3 59)	14 (3 72)	13 (3 54)
Neem leaf 15t/ha	10 (3 19)	8 (2 78)	11 (3 34)	8 (2 83)	9 (2 98)
Eupatorium leaf 7 5t/ha	16 (3 98)	18 (4 26)	35 (5 9)	18 (4 25)	23 (4 80)
Eupatorium leaf 15t/ha	14 (3 67)	23 (4 83)	51 (7 17)	22 (4 72)	31 (5 57)
Untreated control	11 (3 27)	13 (3 59)	31 (5 54)	15 (3 87)	19 (4 33)
C D	N S			(0 797)	(0 551)

Figures given in parenthesis are values after $\sqrt{x}$ transformation

Pooled mean not significant

significantly increased (166 67 per cent) the mean actinomycets population While neem leaf (15t/ha) treatmemt significantly reduced the actinomycets population and neem leaf treatment significantly increased the population

The actinomycetes population monitored at different intervals (15 45 and 75 D A S) showed statisticaly significant variation (table 18) Eupatorium leaf (15t/ha) treatment showed significant increase in population from 45 to 75 D A S Neem leaf (15t/ha) treatment significantly reduced the actinomycetes population at 75 D A S

3 2 2 3 2 Summer season

The results are presented in table 18 and fig 4 The effect of neem and eupatorium leaf (7 5 and 15t/ha) treatments showed that eupatorium leaf (15t/ha) significantly increased mean actinomycetes population where as neem leaf (7 5 and 15t/ha)treatments significantly reduced the actinomycetes population The increase in actinomycetes population under eupatorium leaf (15t/ha) treatment was 63 16 per cent and it was significantly superior to all other treatments The reduction in actinomycetes population under neem leaf (15t/ha) treatment was 52 63 per cent

The actinomycetes population at different periods (15 45,75 D A S) showed statistically significant variation (table 18) Eupatorium leaf (15t/ha) treatment showed significantly higher population at all periods while neem leaf (15t/ha) treatment reduced the population at all periods

Pooled analysis of the data showed that there was no significant variation in the treatment effect in two seasons (rainy and summer)

3 2 3 Effect on biometric characters of cowpea plant

3 2 3 1 Number of leaves

3 2 3 1 1 Rainy season

The results are presented in table 19 The effects of different treatments showed statistically significant variation The neem and eupatorium leaf @ 15 t/ha gave statistically significant increse in mean leaf number at 60 and 75 D A S At 30 D A S neem leaf (7 5 and 15 t/ha) treatments only gave significant increse in leaf number Eupatorium leaf (15t/ha) treatment gave 80 and 59 per cent increase in leaf number at 60 and 75 D A S where as neem leaf (15t/ha) treatment gave 26 78 and 60 per cent increase in leaf number at 30 60 and 75 D A S

Table 19 Effect of organic amendments on the number of leaves and height of cowpea Plants

Treatment	Number of leaves observed at			Height (cm) observed at		
	30 DAS	60 DAS	75 DAS	30 DAS	60 DAS	75 DAS
Rainy Season						
Neem leaf 7 5 t/ha	4 93	9 27	9 36	12 15	23 36	28 98
Neem leaf 15 t/ha	5 30	14 40	15 30	12 50	28 30	50 27
Eupatorium leaf 7 5 t/ha	4 40	9 07	9 93	9 87	23 33	37 25
Eupatorium leaf 15 t/ha	4 43	14 53	15 17	10 48	29 40	50 62
Untreated control	4 20	8 07	9 57	8 70	22 75	36 35
C D	(0 434)	(0 785)	(0 575)	(1 6404)	(1 468)	(1 566)
Summer Season						
Neem leaf 7 5 t/ha	4 98	9 33	9 53	9 83	23 87	29 25
Neem leaf 15 t/ha	5 32	15 00	15 43	12 78	29 03	50 55
Eupatorium leaf 7 5 t/ha	4 57	9 37	10 13	10 10	24 03	37 55
Eupatorium leaf 15 t/ha	5 47	14 93	15 47	10 82	30 15	52 32
Untreated control	4 30	8 33	9 63	8 95	23 36	36 52
C D	(0 566)	(0 853)	(0 641)	(1 575)	(1 687)	(2 9905)

DAS Days after Sowing

3 2 3 1 2 Summer season

The results are presented in table 19 The different treatments showed significant variation The neem leaf at both levels (7 5 and 15t/ha) and eupatorium leaf (15t/ha) treatments significantly increased the number of leaves in cowpea at 30 D A S and they were on par and significantly superior to other treatments But at 60 and 75 D A S neem and eupatorium leaf at 15t/ha only gave statistically significant increase in number of leaves of cowpea

Neem leaf (15t/ha) treatment increased the number of leaves by 24 80 and 60 per cent at 30 60 and 75 D A S respectively and eupatorium leaf increased the number of leaves by 27 79 and 61 per cent at 30 60 and 75 D A S respectively

3 2 3 Height of cowpea plants

3 2 3 2 1 Rainy season

The results are presented in table 19 The effect of neem and eupatorium leaf (7 5 and 15t/ha) treatments showed statistically significant variation in the height of cowpea plants during rainy season The neem leaf(7 5 and 15t/ha) treatments and eupatorium leaf (15t/ha) treatment

gave significant increase in height of cowpea plants at 30 D A S but at 60 and 75 D A S neem leaf (15t/ha) and eupatorium (15t/ha) treatment gave significant increase over control The neem (15t/ha) and eupatorium leaf (15t/ha) treatments were on par at 60 and 75 D A S but neem leaf (7 5 and 15t/ha) differed significantly from eupatorium leaf (15t/ha) treatment at 30 D A S

Neem leaf (15t/ha) treatment gave 43 24 and 38 per cent increase in height at 30 60 and 75 D A S and eupatorium leaf (15t/ha) treatment gave 21 29 and 39 per cent increase at 30 60 and 75 D A S respectively over control

3 2 3 2 1 2 Summer season

The results are presented in table 19 The effect of neem and eupatorium leaf (7 5 and 15t/ha) treatments showed statistically significant variation in the height of cowpea plants during summer season The neem and eupatorium leaf (15t/ha) treatment gave maximum increase in height and it was significantly superior to all other treatments at 30 60 and 75 D A S The effect of neem and eupatorium leaf (15t/ha) treatments on height of cowpea plant were statistically on par at all periods except at 30 D A S

Neem leaf (15t/ha) showed an increase of 21 29 and 43 per cent at 30 60 and75 D A S respectively

3 2 3 3 Yield

3 2 3 3 1 Rainy season

The results showed that application of neem and eupatorium leaf @ 15t/ha significantly increased the yield of cowpea in rainy season over control (Table 20) The increase in yield was 50 37 and 42 68 per cent in neem and eupatorium treatment respectively

3 2 3 3 2 Summer season

The results are presented in table 20 The effects of neem and eupatorium leaf (7 5 and15t/ha) showed statistically significant increase in yield of cowpea plants in rainy season Neem and eupatorium leaf (15t/ha) treatments were on par and gave 45 03 and 40 59 per cent increase in yield respectively

3 2 3 4 Shoot weight

3 2 3 4 1 Rainy seaons

The results are presented in table 20 The effect of neem and eupatorium leaf treatments (7 5 and15t/ha) showed

Table 20 Effect of organic amendments on the yield shoot weight, root weight plants and on the population of nematode

Treatments	Yield (g)	Shoot weight (g)	Root weight (g)	Nematode tion in 5
Rainy Season				
Neem leaf 7 5 t/ha	695 83	12 100	2 783	23 7
Neem leaf 1ɔ t/ha	1010 00	16 733	5 200	12 3
Eupatorium leaf 7 5 t/ha	731 67	12 200	3 067	26 6
Eupatorium leaf 15 t/ha	958 33	16 300	5 067	13 4
Untreated control	671 67	11 817	2 833	26 1
C D	(153 404)	(2 8319)	(0 6297)	(3 69)
Summer Season				
Neem leaf 7 5 t/ha	795 83	12 267	2 933	25 4
Neem leaf 15 t/ha	1143 33	16 95	5 383	13 3
Eupatorium leaf 7 5 t/ha	831 67	12 467	3 183	26 6
Eupatorium leaf - 15 t/ha	1108 33	16 383	5 200	14 3
Untreated control	788 33	11 617	2 983	30 2
C D	(164 52)	(2 5857)	(0 6414)	(3 02)

that neem and eupatorium (15t/ha) treatments gave statistically significant increase in shootweight over control Maximum increase was given by neem leaf (15t/ha) treatment (41 6 per cent) followed by eupatorium leaf (15t/ha) treatment with 37 94 per cent increase and these two treatments were statistically on par and significantly superior to all other treatments and control

3 2 3 4 2 Summer season

The results are presented in table 20 The effect of neem and eupatorium leaf (7 5 and 15t/ha) showed statistically significant variation in shootweight over control Maximum increase was recorded in neem leaf (15t/ha) treatment (45 91 per cent) followed by eupatorium leaf (15t/ha) treatment with 41 03 per cemt

3 2 3 5 Root weight

3 2 3 5 1 Rainy season

The results are presented in table 20 The neem and eupatorium leaf @15t/ha showed statistically significant increase in rootweight over control and other treatments Neem leaf (15t/ha) gave maximum increase in rootweight of 55 07 per cent followed by eupatorium leaf (15t/ha)

treatment (50 88 per cent) These two treatments were statistically on par

3 2 3 5 2 Summer season

The results are presented in table 20 The effect of neem and eupatorium leaf (7 5 and 15t/ha) showed that neem and eupatorium leaf @ 15t/ha increased rootweight of cowpea significantly in summer season Maximum increase was seen in neem leaf (15t/ha) treated plots (80 46 per cent) followed by eupatorium leaf (15t/ha) treated plots with 74 32 per cent increase

3 2 3 6 Nematode population in cowpea roots

3 2 3 6 1 Rainy season

The results are presented in table 20 The nematode population in roots of cowpea at 75 D A S showed statistically significant difference between treatments and control Maximum reduction in nematode population (52 87 per cent) was recorded in neem leaf (15t/ha) treatment followed by eupatorium leaf (15t/ha) treatment with 48 66 per cent These two treatments were statistically on par

4 DISCUSSION

In the present study neem and eupatorium leaves at two doses were tested for their effect on plant parasitic nematodes infesting bhindi and cowpea and the non parasitic nematodes and soil micro organisms (bacteria fungi and actinomycetes) at the rootzone of the crops during rainy and summer seasons The leaves were individually incorporated to the soil 15 days prior to sowing The results were assessed in terms of the nematode and microbial population build up in soil obsereved at different intervals after treatment growth characteristics of the plant and yield

The results presented in para 3 1 1 1 revealed that eupatorium and neem leaves at both levels reduced the mean populations of Helicotylenchus spp population significantly at the rootzone of bhindi during rainy season But in summer season neem leaf treatment (150g/plant)was significantly superior to other three treatments Two levels of eupatorium and lower dose of neem leaf treatment reduced the Helicotylenchus spp in the cowpea rootzone in rainy season and all the four treatments were on par and superior during summer season (Para 3 2 1 1) The effect of lower dose of neem persisted upto 75 D A S (termination of the experiment) while that of the higher dose persisted only

upto 45 D A S in bhindi during rainy season The two doses of eupatorium persisted upto 30 D A S only in this season In summer season also the persistance was maximum in neem leaf treatment (150g per plant) upto 75 D A S In cowpea the effect of neem (150g/plant) and eupatorium (300g/plant) persisted in the rootzone upto 45 D A S during rainy season while neem leaf treatments (2 leavels) only retained its effect in summer season upto 30 D A S The pooled analysis for comparing the treatment effects in two seasons on bhindi and cowpea did not show significant variations Among the plants reported to have nematode suppressant properties neem was considered as a promising one The effectiveness of preplanting or sowing application of neem cake against plant parasitic nematodes in vegetables have been repo^r^ted earlier (Singh and Sitaramaih 1966 Khan et al 1969 and Kamalakshiamma 1986) But the beneficial effect of neem leaf for the control of Helicotylenchus spp was not reported earlier Roosner and Zeibitz (1987) reported the effectiveness of ground neem leaves for controlling Pratylenchus penetrans in tomato The effectiveness of eupatorium leaf for the control of P penetrans was reported by Premkumar (1971)

Results in para 3 1 1 2 and 3 2 1 2 revealed that neem and eupatorium leaf (300g/plant) significantly reduced the mean population of R reniformis in bhindi during rainy and summer seasons But in cowpea higher dose of neem leaf treatment established superiority in summer The persistance of the effect of neem leaf (300g/plant) on bhindi and cowpea was retained upto 75 D A S (termination of experiment) while those of remaining treatments lasted only upto 30 D A S in bhindi In cowpea persistent effect of higher dose of neem and eupatorium leaf were on par upto 30 D A S The pooled analysis of the data showed that the seasonal effect was not significant in bhindi and cowpea The effectiveness of neem leaf reported here is in conformity with the reports made by Lal et al (1977) But the effectiveness of eupatorium leaf and the persistance study are reported for the first time in vegetables against R reniformis

M incognita population was reduced (below 50 per cent) by neem and eupatorium leaves in bhindi during rainy season and there was no significant variations among treatment (para 3 1 1 3) In summer season two doses of neem and lower dose of eupatorium were on par and significantly reduced the M incognita population in the bhindi rootzone In cowpea (para 3 2 1 3) higher dose of

neem was significantly superior to lower dose and eupatorium treatments Eupatorium treatments were on par and significantly superior to control but inferior to neem in both seasons Persistent effect of these leaves was seen significant compared to control upto 15 D A S in rainy and summer season in bhindi and cowpea Pooled analysis showed that the data was not significantly varying in the two seasons These findings are similar to the reports of Roosner and Zeibeitz (1987) Effectiveness of eupatorium leaf reported here is in agreement with the findings of Premkumar (1971)

Eupatorium leaf treatment (higher dose) significantly increased the predatory nematode population in the rootzone of bhindi and cowpea The higher dose of eupatorium persisted its effect upto 75 D A S in bhindi and cowpea during the two seasons Neem leaf (higher dose) was on par with this treatment from 60 to 75 D A S in bhindi in summer season Pooled analysis of the data did not show seasonal variations in the effect on both crops Many workers have reported adverse effect of oil cakes and organic amendments on plant parasitic nematode population and free living forms (Mankau 1962) The increase in population of predatory nematodes caused by the addition of

3 2 3 6 2 Summer season

The results are presented in table 20 The effects of neem and eupatorium leaf (7 5 and 15t/ha) showed that all treatments significantly reduced nematode population in cowpea roots in summer season Maximum reduction (55 96) was seen in neem leaf (15t/ha) treated cowpea plants followed by eupatorium leaf at 15t/ha with 52 49 per cent increase

DISCUSSION

4 DISCUSSION

In the present study neem and eupatorium leaves at two doses were tested for their effect on plant parasitic nematodes infesting bhindi and cowpea and the non parasitic nematodes and soil micro organisms (bacteria fungi and actinomycetes) at the rootzone of the crops during rainy and summer seasons The leaves were individually incorporated to the soil 15 days prior to sowing The results were assessed in terms of the nematode and microbial population build up in soil obsereved at different intervals after treatment growth characteristics of the plant and yield

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Eupatorium leaf treatment (higher dose) significantly increased the predatory nematode population in the rootzone of bhindi and cowpea The higher dose of eupatorium persisted its effect upto 75 D A S in bhindi and cowpea during the two seasons Neem leaf (higher dose) was on par with this treatment from 60 to 75 D A S in bhindi in summer season Pooled analysis of the data did not show seasonal variations in the effect on both crops Many workers have reported adverse effect of oil cakes and organic amendments on plant parasitic nematode population and free living forms (Mankau 1962) The increase in population of predatory nematodes caused by the addition of

eupatorium and neem leaf reported in para 3 1 1 4 and 3 2 1 4 may be due to availablity of decomposing organic materials which produce chemicals stimulatory to the growth of predatory nematodes

The results described in para 3 1 1 5 and 3 1 2 5 revealed that higher dose of eupatorium was significantly superior to other treatments in increasing the mean saprophytic nematodes in the rootzone of bhindi and cowpea during the two seasons In cowpea during summer season higher dose of neem also increased the saprophytic nematode population but inferior to eupatorium treatment The lower dose of eupatorium significantly increased the saprophytic nematodes from 15 to 75 D A S in rainy and 15 to 45 D A S in summer season in bhindi and in cowpea higher dose only persisted in rootzone upto 75 D A S in two seasons Prasad et al (1974) had reported that organic amendments increased the free living nematodes in soil The stimulatory effect of eupatorium on saprophytic nematode population on saprophytic nematode population was studied for the first time Saprophytic nematodes were found to be inactivated by macerated fresh Chenopodium ambrosioides in vitro (Espinosa 1982)

Results in para 3 1 2 and 3 2 2 revealed that eupatorium leaf (300g/plant) significantly increased the mean bacterial population in the rootzone of bhindi and cowpea during rainy and summer seasons while neem leaf treatment (300g/plant) significantly reduced the mean population of bacteria The effect of eupatorium higher dose and two doses of neem persisted in the soil upto 75 D A S in bhindi during two seasons and in cowpea during the rainy season In summer season the effect of higher dose of neem and eupatorium persisted in the soil only upto 45 D A S During this period lower dose of these treatments were inferior to higher dose but superior to untreated control Singh (1960) reported an increase in population due to neemcake But neem leaf is found to have an inhibitory effect in this experiment The stimulatory effect of eupatorium leaf on the bacteria was reported for the first time

It could be concluded from the data presented in para 3 1 2 2 and 3 2 2 2 that the mean fungal population in the rootzone of bhindi treated with 2 levels of eupatorium leaf significantly increased In cowpea eupatorium higher dose had similar effect during rainy season Neem leaf treatment (higher dose only) significantly decreased the

fungal population in bhindi but in cowpea lower dose of neem also significantly decreased the population Effect of higher dose of eupatorium persisted in the rootzone of both the crops upto 75 D A S in two seasons Lower dose of eupatorium was on par with higher dose upto 45 D A S in bhindi and cowpea rootzone during rainy season Neem leaf treatment (higher dose) persisted in the rootzone of bhindi upto 75 D A S in rainy season and in summer season the decreasing trend was there but not statistically significant The pooled analysis of the data revealed that bhindi rootzone all the treatments the effect was significantly higher in rainy season than in summer season The inhibitory effect of neem on fungi was reported earlier (Bhownick and Vardha 1981 and Singh and Singh 1988) An increase in the fungal population caused by neem cake was observed by Khan et al (1974) and Singh et al (1985) The effect of eupatorium on fungi was studied for the first time But addition of organic amendments were proved benificial to soil fungi such as Curvularia viridae (Jayaraj 1991)

The mean actinomycetes population increased during rainy and summer season by the addition of eupatorium leaf while decreased by the addition of neem leaf at both levels Higher dose of these leaves were more effective to lower

dose But in cowpea higher dose of eupatorium and neem leaf only gave similar result The population monitored at different intervals showed that higher dose of eupatorium had its effect upto75 D A S in the two seasons Higher dose of neem persisted its effect on the rootzone of bhindi and cowpea upto 75 and 45 D A S during the rainy and summer seasons respectively The persistent effect of organic amendments on actinomycetes has not been reported

Application of neem and eupatorium leaves as presowing treatment influenced the growth of bhindi and cowpea plants The results presented in para 3 1 3 and 3 2 3 showed that the leaf production at higher levels was significantly higher at 30 60 and 75 D A S in both the seasons When comparing the treatment effects in two seasons on bhindi summer season showed higher increase at different intervals In cowpea crop there was no seasonal variation (para 3 2 3 1) These results are in conformity to the reports of Premkumar (1971)

As regards the height of the plants neem and eupatorium leaf treatments at higher dose significantly increased the height at 30 60 and 75 D A S in bhindi and cowpea and in both the seasons Lower dose of neem leaf

treatment was on par with higher dose at 75 and 30 D A S in rainy season of bhindi and cowpea respectively The height is a yield contributing character for bhindi and cowpea crop This finding is in agreement with that of the reports of Kamalakshiamma (1986)

The results in para 3 1 3 4 and 3 2 3 4 showed that shoot weight of bhindi and cowpea plants were improved by the application of higher dose of neem and eupatorium leaf in both seasons In bhindi during rainy season lower dose of neem and eupatorium also significantly improved the the shoot weight There was no difference in the effect of neem and eupatorium leaf treatment in seasonwise in two crops This finding also in agreement with the reports of Kamalakshiamma (1986)

The root weight is another important parameter contributing to the yield of crops From the results presented in para 3 1 3 5 and 3 2 3 5 it is seen that higher dose of neem and eupatorium leaf significantly increased the root weight of bhindi and cowpea in rainy and summer seasons In bhindi lower dose of neem and eupatorium was also significantly superior to control during two seasons Several reports are available on the improvement of root weight of crops by addition of organic amendments and green

leaves (Patel et al 1985 Kamalakshiamma 1986 Paracer et al 1987 and Jayaraj 1991)

From the results presented in para 3 1 3 3 and 3 2 3 3 it was obsereved that higher dose of neem and eupatorium leaf treatments were equally effective in increasing the yield of bhindi and cowpea in the two seasons Lower dose of neem and eupatorium also significantly increased the yield of bhindi during summer season Neem and eupatorium leaf treatments gave 135 45 and 100 117 74 and 94 29 per cent increase in yield of bhindi over untreated control during rainy and summer season respectively But in cowpea the yield ranged from 45 to 50 percent The beneficial effect of neem and neem products were reported earlier also (Mishra and Prasad 1974 Jain and Hasan 1980 Hasan and Jain 1984)

Neem and eupatorium leaf treatments significantly reduced the root population of nematodes in bhindi during the two seasons Higher dose of neem and eupatorium were superior to lower dose In cowpea however the lower dose of eupatorium was on par with higher dose of neem and eupatorium during the summer season The reduction in root population may be due to the reduction in the population of

nematodes in soil due to some toxic principles in the decomposing leaf tissues or the increase in the predatory and saprophytic fauna in turn might have reduced the population of parasitic nematodes by predation and or by competition for space and other requirements The increase in microbial flora due to the addition of eupatorium leaves observed in this study may also contribute to the reduction in population of nematodes in root This finding is similar to the reports of Prot and Korn Probst (1983) Patel et al (1985) and Jayaraj (1991)

The present investigation thus concluded that the plant parasitic nematodes like Helicotylenchus Rotylenchulus and Meloidogyne can be effectively managed by neem or eupatorium leaf treatments (300g/plant) in bhindi and cowpea during the two seasons Lower dose (150g/plant) of neem was found sufficient to suppress the Helicotyliuchus spp Effect of these treatments generally persisted upto 75 D A S in rainy season and 45 D A S in summer season The effect of lower doses also persisted upto 30 D A S The predatory and suprophytic nematode population build up in the rootzone was enhanced by higher dose of eupatorium and this effect persisted upto 75 D A S in the rootzone of bhindi But in cowpea the effect on saprophytic fauna persisted only upto 60 D A S The

microbial population (bacteria fungi and actinomycetes) was increased by the treatment of higher dose of eupatorium and decreased by neem leaf treatment For the population build up of fungi even the lower dose of eupatorium was found sufficient The effect of this treatment persisted upto 75 D A S during rainy and 60 D A S in summer season There was seasonal variation in population built up of fungi and maximum effect was in rainy season The biometric characters (number of leaves height shoot weight and root weight) and yield increased significantly by the higher dose of neem and eupatorium For increasing the height lower dose of neem and for yeild lower dose of neem and eupatorium also were found effective Nematode population in the root was significantly reduced by the higher dose of neem and eupatorium in bhindi while lower dose were also found effective in protecting cowpea roots The inhibitory effect of neem and eupatorium on the population of plant parasitic nematodes in the soil at rootzone and in the roots was reflected in the growth and yield of the crops

SUMMARY

SUMMARY

Field experiments were conducted to test the effect of neem and eupatorium leaves at two different doses on nematodes and soil micro organisms in bhindi and cowpea rootzone in rainy and summer seasons The leaves were tested individually by incorporating into the soil fifteen days prior to sowing The results were assessed in terms of nematode population in soil at different intervals biometric characters yield and the nematode population in the root

The mean population of Helicotylenchus spp in the root zone of bhindi and cowpea were reduced significantly by the application of neem and eupatorium leaves at two levels during both seasons But in summer seasons neem leaf (150g/plant) treatment was significantly superior to other three treatments in bhindi The population monitored at different intervals showed that all treatments significantly reduced Helicotylenchus spp population up to 30 D A S in bhindi and cowpea during rainy and summer seasons Pooled analysis did not show significant difference among the treatments in bhindi and cowpea in two seasons

The mean population of R reniformis in the rootzone of bhindi was significantly reduced by the application of neem and eupatorium leaves at higher dose during both seasons But in cowpea higher dose of neem leaf treatment established superiority in summer

Higher dose of neem and eupatorium leaf treatments reduced the M incognita population below 50 percent in bhindi during rainy and summer season Higher dose of neem and eupatorium along with lower dose of eupatorium leaf were effective in reducing the M incognita population in the root-zone of cowpea in two seasons The persistance of the effect of neem leaf (300g/plant) on bhindi and cowpea was retained upto 75 D A S while the remaining treatment lasted only upto 30 D A S in bhindi

Predatory and saprophytic nematodes in the rootzone of bhindi and cowpea were increased significantly by higher dose of eupatorium in bhindi and cowpea The effect of these treatments persisted upto 75 D A S

The presowing application of eupatorim leaf at higher level showed significant increase in bacterial population at the rootzone of bhindi and cowpea in the rainy

and summer season where as neem leaf at higher dose significantly reduced the bacterial population in the rootzone of bhindi and cowpea in both seasons Effect of eupatorium (higher dose) and neem (both doses) persisted in the rootzone upto 75 D A S (termination of the experiment)

The mean population of fungi in the rootzone of bhindi showed an increase in population under all treatments except neem leaf at higher dose during rainy season while only eupatorium leaf at higher level increased the population in bhindi during the summer season In cowpea only eupatorium leaf at both levels increased the fungal population significantly during rainy and summer seasons

The mean actinomycetes population in the rootzone of bhindi during rainy and summer season increased by the application of eupatorium leaf while it decreased by the addition of neem at both levels In cowpea higher doses of eupatorium and neem leaves gave this effect

The biometric characters (number of leaves height of the plants shoot weight and root weight) of bhindi and cowpea plants and yield were improved significantly by the

presowing application of neem and eupatorium at higher dose The increase in the leaf production due to the above two treatments was well indicated in bhindi plants giving an increase of 70 87 per cent at 30 D A S

As regards the population of nematodes in bhindi and cowpea roots neem and eupatorium treatments at higher dose revealed statistically significant reduction over other treatments and untreated control

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* Orginals not seen

APPENDICES

APPENDIX – 1

ABSTRACT OF ANOVA AND ANCOVA (TABLE 1 5)

Pretreatment population

SOURCE	df	Helicotylenchus Rainy	Helicotylenchus Summer	Rotylenchulus reniformis Rainy	Rotylenchulus reniformis Summer	Meloidogyne incognita Rainy	Meloidogyne incognita Summer	Predatory nematodes Rainy	Predatory nematodes Summer	Saprophytic nematodes Rainy	Saprophytic nematodes Summer
Treatment	4	2 3021	* 0 0913	0 0586	** 0 0668	2 2383	0 5514	0 2793	0 3048	1 2560	0 8719
Error	20	2 0501	0 0701	0 0817	0 0607	8 3192	1 0012	0 5642	0 4093	3 8332	2 3371
		POPULATION AFTER DIFFERENT PERIOD INTERVALS AFTER SOWING									
Treatment	4	7 0871	** 8 0338	* 1 1447	** 1 5379	6 1217	** 8 4752	** 39 4664	** 10 2693	**364 5195	** 130 948
Error 1	20	1 6385	** 0 1437	0 3897	0 3196	2 7735	0 5700	1 7840	1 8339	24 5218	12 3429
Period	5	** 2 6229	** 3 2437	** 0 2330	** 0 3762	* 7 1899	** 9 4599	0 5251	** 1 8743	** 29 9	** 38 5320
Interaction	20	** 0 8054	** 1 0230	* 0 0202	** 0 0107	2 0625	** 3 6512	** 1 6991	** 0 7895	** 8 9126	** 5 2249
Error 2	125	0 3878	0 3005	▲ 0 00406	▲ 0 0049	0 8845	0 8229	0 7612	0 1916	2 1254	2 1057
		POOLED ANALYSIS (SEASONS)									
Treatment	4	** 2 6317		** 0 4453		2 4403		** 7 278		** 77 7257	
Error 1	40	0 8911		0 3543		1 6717		1 8089		18 4323	
Period	5	** 1 0179		** 0 0996		** 2 6057		** 0 1849		* 9 7339	
Interaction	20	** 0 3222		** 0 0037		0 7673		** 0 3373		** 1 4343	
Seasons	1	0 273		** 0 4643		6 2261		14 1238		89 2046	
Interaction between Period & Season	5	0 0050		0 00167		0 2231		** 0 2097		1 6569	
Interaction between Treatment & Season	4	0 0064		** 0 0056		0 088		1 0271		4 9884	
Interaction between Period, Treatment & Season	20	0 0069		** 0 0015		0 0823		0 0941		* 0 9329	
Error 2	250	0 3442		▲▲ 0 0045		0 8538		0 4764		2 1156	

* Significant at 5 /

** Significant at 1 /

▲ Degrees of freedom for Error 2 124

▲▲ Degrees of freedom for Error 2 248

APPENDIX – 2

ABSTRACT OF ANOVA AND ANCOVA (TABLE 11–15)

Pretreatment population

SOURCE	df	Helicotylenchus Rainy	Helicotylenchus Summer	Rotylenchulus reniformis Rainy	Rotylenchulus reniformis Summer	Meloidogyne incognita Rainy	Meloidogyne incognita Summer	Predatory nematodes Rainy	Predatory nematodes Summer	Saprophytic nematodes Rainy	Saprophytic nematodes Summer
Treatment	4	** 6 0443	0 0594	** 76 4602	** 47 2625	3 9731	6 1746	0 2542	0 0296	0 5259	0 7680
Error	20	0 4389	0 4298	9 1679	3 4119	3 1695	5 5257	0 1642	0 1193	1 2663	1 1538
		POPULATION AFTER EFFERENT PERIOD INTERVALS AFTER SOWING									
Treatment	4	** 7 6041	**4 4142	** 404 8435	** 1397 473	7 4057	* 3 9173	**20 0358	** 18 0573	**149 8733	** 142 0632
Error 1	20	0 3707	0 5460	14 1715	14 7992	0 3603	0 4537	1 5718	0 3613	9 8154	1 8090
Period	5	** 2 1567	1 9617	** 68 8724	** 186 7656	** 10 2601	* 5 8875	** 0 3276	** 1 3749	** 8 7597	** 17 4693
Interaction	20	** 1 6282	1 0008	** 11 4994	** 13 9898	** 3 3545	** 1 8717	** 1 3093	** 0 8440	** 4 6129	** 3 6810
Error 2	125	0 3725	1 0285	2 1793	5 7843	0 3126	0 6442	0 0939	2 2106	0 8451	1 4248
		POOLED ANALYSIS (SEASONS)									
Treatment	4	* 1 6647		** 240 2778		* 1 6699		** 0 4761		** 48 6044	
Error 1	40	0 3992		13 7611		0 4083		0 9665		5 8122	
Period	5	* 0 6820		** 39 6297		* 2 8006		** 0 1347		* 4 1760	
Interaction	20	* 0 4003		3 6613		** 0 8447		** 0 3427		** 1 1577	
Seasons	1	0 0004		40 2207		0 001		0 1308		0 6149	
Interaction between Period & Season	5	0 0232		** 3 0297		0 05480		0 1137		0 5048	
Interaction between Treatment & Season	4	0 1106		** 20 2412		0 0478		0 0259		0 0182	
Interaction between Period, Treatment & Season	20	0 0412		** 0 5829		0 0459		0 0412		0 1994	
Error 2	250	0 7060		4 0138		0 4784		0 0522		1 1349	

* Significant at 5 /

** Significant at 1 /

▲ Degrees of freedom for Error 2 124

▲▲ Degrees of freedom for Error 2 248

APPENDIX – 3

ABSTRACT OF ANOVA AND ANCOVA (TABLE 6–8)

Pretreatment population

SOURCE	df	Bacteria		Fungu		Actinomycetes	
		Rainy	Summer	Rainy	Summer	Rainy	Summer
Treatment	4	0 5858	0 3227	** 0 026	** 0 3204	0 619	* 0 3239
Error	20	1 1065	0 482	0 1015	0 041	0 0516	0 0719
		POPULATION AFTER DIFFERENT PERIOD INTERVALS AFTER SOWING					
Treatment	4	**134 9495	** 71 9829	**31 9348	** 7 7149	** 32 233	** 7 2445
Error 1	20	0 3175	1 3001	** 0 0347	** 0 1519	0 0216	0 1343
Period	2	**292 6748	**223 3784	41 2472	14 658	**177 0781	**16 7696
Interaction	8	** 10 7756	** 11 443	3 5883	** 0 6826	** 23 0435	** 1 7408
Error 2	50	0 3068	1 1614	0 0241	0 1922	0 0206	0 1612
		POOLED ANALYSIS (SEASONS)					
Treatment	4	** 33 9916		** 5 9226		** 11 5672	
Error 1	40	0 8088		0 0895		0 0741	
Period	5	** 21 111		* 7 3678		** 21 3126	
Interaction	20	0 8704		0 5202		2 8687	
Seasons	1	1 1015		50 3785		52 7589	
Interaction between Period & Season	5	64 4766		1 8144		10 99709	
Interaction between Treatment & Season	4	0 842		0 7167		1 8651	
Interaction between Period, Treatment & Season	8	2 8467		0 2097		1 2279	
Error 2	250	0 7311		1 0835		0 0909	

* Significant at 5 %

** Significant at 1 %

APPENDIX – 4

ABSTRACT OF ANOVA AND ANCOVA (TABLE 16–18)

Pretreatment population

SOURCE	df	Bacteria Rainy	Bacteria Summer	Fungus Rainy	Fungus Summer	Actinomycetes Rainy	Actinomycetes Summer
Treatment	4	0 196	0 4355	0 7418	0 6301	* 0 5929	* 0 8497
Error	20	3 298	0 5626	0 16	* 0 1831	** 0 2484	** 0 3893
		POPULATION AFTER DIFFERENT PERIOD INTERVALS AFTER SOWING					
Treatment	4	** 295 1074	** 78 9994	** 22 2797	** 7 5174	** 60 2812	** 18 7597
Error 1	20	5 4702	2 0664	1 2946	0 6038	1 0941	0 6543
Period	2	**1641 277	**332 4463	** 42 8756	** 23 5741	**153 3789	** 16 8206
Interaction	8	** 32 6458	** 10 7933	** 3 5655	** 0 819	** 20 7344	** 1 893
Error 2	50	7 7913	3 5704	1 3429	0 5284	1 5271	0 4911
		POOLED ANALYSIS (SEASONS)					
Treatment	4	** 56 5629		** 4 2034		** 11 5003	
Error 1	40	3 7682		0 9256		0 8489	
Period	2	** 261 6331		* 9 0036		** 18 1456	
Interaction	8	** 5 3143		** 0 5364		** 2 7012	
Seasons	1	118 7149		6 9771		31 7018	
Interaction between Period & Season	5	67 7764		2 1496		10 2708	
Interaction between Treatment & Season	4	5 8838		0 4665		1 5553	
Interaction between Period, Treatment & Season	8	1 992		0 1825		1 0892	
Error 2	250	0 9096		0 917		0 0277	

* Significant at 5 /

** Significant at 1 /

APPENDIX – 5

ABSTRACT OF ANOVA TABLE 9 and 19

Bhindi

SOURCE	df	HEIGHT OF PLANT						NO OF LEAVES					
		30 DAS		60 DAS		75 DAS		30 DAS		60 DAS		75 DAS	
		Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy *	Summer	Rainy	Summer
Treatment	4	**335 6494	**370 7583	**1100 84	**1009 898	**880 0508	**1161 867	**7 4053	** 8 542	** 31 5712	** 95 1353	** 45 615	** 58 5422
Error	20	4 3842	4 7806	7 9414	9 3758	31 9859	36 7469	0 1773	0 1596	0 7322	1 2538	1 3513	2 1028
Cowpea													
Treatment	4	** 15 3807	** 12 4813	**60 168	** 62 6040	**536 9493	** 583 582	**1 222	** 1 4539	** 59 4186	** 64 8814	** 56 9333	** 58 4513
Error	20	1 9362	1 711	1 5501	1 9611	1 7648	6 166	0 1356	0 221	0 4443	0 5013	0 2382	0 2834

APPENDIX – 6

ABSTRACT OF ANOVA TABLE 10 and 20

Bhindi

SOURCE	df	Yield		Shoot weight		Root weight		Nematode population on roots	
		Rainy	Summer	Rainy	Summer	Rainy	Summer	Rainy	Summer
Treatment	4	** 110750	** 558362	**512 6406	**668 9531	** 89 4861	**92 8691	**628 1787	**257 0401
Error	20	10570	7255	6 5859	53 1984	3 6729	10 5268	10 5318	13 0985
Cowpea									
Treatment	4	** 150371	** 187488	** 36 3585	** 38 0977	** 9 1047	** 9 2578	**288 5235	**350 739
Error	20	16224 2	18660 8	5 7698	4 6096	0 2853	0 2836	9 7822	6 3171

** Significant at 1 %

EFFECT OF ORGANIC AMENDMENTS ON PLANT PARASITIC NEMATODES AND SOIL MICRO-ORGANISMS

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ABSTRACT

Field experiments conducted to evaluate the effect of neem and eupatorium leaves at two levels on plant pa asitic and non parasitic nematodes and soil micro organisms in the rootzone of bhindi and cowpea in rainy and summer seasons revealed that neem and eupatorium leaf treatments (300g/plant or 15 t/ha) were found effective in co_ rolling Helicotylenchus spp R reniformis and M incognita in the rootzone Lower dose (150g/plant) of neem was found sufficient to suppress the Helicotylenchus sp in the rootzone of bhindi Effect of these treatments pe sisted up to 75 D A S in rainy season and 45 D A S in summer season The effect of lower doses also persisted up o 30 D A S

The predatory and saprophytic nematode population bu d up in the rootzone was enhanced by higher dose of eupatorium The effect on predatory fauna persisted up to 75 D A S in the rootzone of two crops But in cowpea the effect on saprophytic fauna persisted only up to 60 D A S

The microbial populations (bacteria fungi and ac nomycetes) were increased in the rootzone of bhindi and cowpea in two seasons by the application of eupatorium leaf

at higher dose where as neem leaf (higher dose) reduced the microbial population Only the fungal population increased by the application of neem leaf at higher dose during rainy season There was seasonal variation in population build up of fungi and maximum effect was seen in rainy season

The biometric characters (number of leaves height of plant root weight and shoot weight) and yield of bhindi and cowpea increased significantly by the higher dose of neem and eupatorium leaf For increasing the height lower dose of neem and for yield lower dose of neem and eupatorium also were found effective The population of nematodes in the roots at the termination of experiment was significantly reduced by the higher dose of neem and eupatorium in bhindi while lower dose was found effective protecting cowpea roots