CONTROL OF NEMATODE PARASITES OF BRINJAL WITH INSECTICIDE AND NEMATICIDE GRANULES

BY

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THESIS

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CERTIFICATE

This is to certify that the thesis herewith submitted contains the results of bonafide research work carried out by Shri P.C. Vergis, under my supervision. No part of the work embodied in this thesis has been submitted earlier for the award of any degree.

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INTRODUCTION

Plant parasitic nematodes have come to be recognised as major pests of cultivated crops. Crop losses due to these pest organisms in U.S.A. for instance has been assessed by FAO (1968) as 8% for maize, 6% for rice, 3% for wheat, 6% for cotton (lint), 4% for lucerne, 10% for soyabeans, 10% for apples, 12% for Peaches, 5% for grapes, 4% for cherries, 15% for figs, 10% for strawberries, 11% for citrus, 18% for lima beans, 16% for carrots, 15% for sweet maize, 25% for cucumbers, 12% for green peas and 10% for tomatoes. The overall crop loss due to the nematodes has been put at about 10% according to these estimates.

Phytonematology has established itself as a separate branch of agricultural science though it is still in its infancy in India. The farmers in Kerala do not adopt shifting cultivation practices and cultivate in the traditional practice of monocropping which provide ideal condition for nematode build up. The net result is reduced production.

Preliminary studies have revealed that Kerala soils abound in various types of nematodes including potential pests of crops like the burrowing nematode Radopholus similis (Nair et al. 1966), the citrus nematode Tylenchus semipenetrans (Nair 1965), the root-knot nematode Meloidogyne incognita, the spiral nematode Helicotylenchus carebensis and the rice root nematode Hirchmaniella oryzae. Many unidentified species of Helicotylenchus, Rotylenchus Pratylenchus and Criconemoids have also been observed in association with crops like banana, sugarcane, coconut, tea, coffee and cardamom. Much remains to be done on the parasitic nematodes infesting the various crops of Kerala and to assess the role they play in affecting crop production. The root-knot nematode (Meloidogyne sp.) is the most common pest attacking a variety of crops. The vegetable crops of Kerala suffer most, a number of parasitic nematodes are found associated with them causing fading and stunting resulting in considerable loss (Ramakrishnan 1968).

As yet there is no practice of adopting

nematode control measures among the cultivators.

Among the different methods existing for the control of nematodes, application of nematicides is the most effective one. It is now known that some insecticides also possess nematicidal properties (Prasad *et al*. 1964). The present studies were taken up with a view to ascertain the effect of some available insecticides and nematicides. Chemicals available in granular formulation alone were tried in view of the convenience in application.

The literature on the control of plant parasitic nematodes using chemicals have been reviewed.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Following is a review of literature on the control of plant parasitic nematodes:-

Bessey (1911) reported carbon disulphide as a good chemical for destroying root-knot nematodes in the field.

Chloropicrin was tested by Mathews (1919) at Rothamstead and it was found a good nematocide.

Ayyar (1933) reported the efficacy of a few chemicals like potassium cyanide and calcium cyanide in reducing nematode population.

Howard et.al. (1939) studied the nematocidal properties of chloropicrin and carbon disulphide in green house soil infested with *Meloidogyne* sp. They found that chloropicrin could delay nematode infection until an extensive root system developed and the tomato plants produced normal yield. Though root development depanded on soil treatment the yield was not directly proportional to nematode control.

Young (1939) compared the nematocidal action of chloropicrin and sodium cyanide against *Meloidogyne* sp. and found that chloropicrin alone was effective.

Lammerts (1940) applied a proprietory

preparation containing 50% ethyl mercury iodide to heavily infested soil in which tomatoes were grown. Root knot nematodes were completely erradicated by the treatment @ 2 to 3 gallons/sq.ft.

Christie and Cobb(1940) found methyl bromide a good soil nematocide eventhough it was phytotoxic.

Preliminary tests of methyl bromide by Taylor and Mc Beth(1940) as a nematicide against *Meloidogyne* sp., proved that it was an effective soil treatment against root-knot nematodes as well as other free living nematodes.

Chitwood(1941) obtained best results by soil injection of a mixture of chloropicrin and ethylene chloride against *Meloidogyne* sp.

Carter(1943) reported that DD mixture was an excellent nematocide when injected into the soil at 12" intervals @ 200 lbs/acre.

Heating or use of chemicals like formalin, carbon disulphide or chloropicrin were recommended as effective methods of soil sterilization (Anon 1944).

Gemmel(1944) applied chloroacetate @ 3,5 & 7 cwts per acre against nematode infestation. There was considerable yield difference in treated plots over control and the root infestation in different treatments were 38%, 29% and 20% respectively as against 67% in the control.

Jacks (1944) tried cresylic acid, napthalene formalin, calcium chlor-acetate, carbon disulphide, DD mixture and silver proteinate as fumigants to control root-knot rematodes infecting tomato plants. Cresylic acid and DD while controlling the eel worm caused root injury. Carbon disulphide gave poor control. Formalin delayed the infection sufficiently to make the plants grow well. Silver proteinate, calcium chlor-acetate and naphthalene did not give any effective control.

Chaffed Napier grass, applied in trenches, in soil heavily infected by root-knot nematodes enabled Nattrass (1944) to grow a normal crop of potatoes under glass.

Watson (1944) found that mulching with any decayable vegetable material, controlled root-knot infestation and the benefit lasted long.

Carter (1945) found that soil treatments with DD mixture was as good as chloropicrin treatment. DD was also safer and cheaper in application. He further observed that the yield of a crop should be the best crieterion for assessing the efficacy of a nematocide.

Christie (1945) conducted some preliminary tests to determine the efficacy of some fumigants in controlling root-knot nematodes in soil. The most promising one was ethylene dibromide followed by DD and chloropicrin.

Jacks (1945) obtained promising results in eel worm control by treating soil in pot experiments with DD and chloropicrin.

Fjelddalen (1948) reported Parathion as an effective nematocide.

Ichikawa et al (1955) testing the soil diffusion pattern of 1,2 - dibromo-3-chloropropane (Nemagon) found that interval between treatment and sampling was important when the nematocidal properties of fumigants were evaluated.

Manzelli (1955) reported O-2, 4-dichlorophenyl O,O-diethyl-phosphorothioate as a non-volatile residual nematocide.

Robert, E. Adams (1955) noticed increased growth of young peach and apple trees in soil treated with benzene hexachloride (10% gamma isomer) and it was attributed to the control of *Xiphinema*, sp.

Lear (1956) reported the nematicidal properties of sodium methyl dithiocarbamate.

Stone (1956) could kill about half the

population of potato eel worms in the top 3" soil in glass house and double the yield by application of solubilised phenols and cresols @ 1 gallon/sq.yd at 5% strength on light sandy loam.

Bradbury et al (1957) investigated the nematicidal action of sodium azide and organic acid azides on root eel worms both in green house and field and they were found effective.

Stone (1957) noticed 93.9% and 91.5% kill of potato root eel worms in the top 9" soil layer in two glass houses when injected with DD @ 400 lbs/acre. When DD was combined with solubilised cresols and used as a surface seal the kill in the upper 3" soil layer was higher.

Grainer (1958) found that yellow oxide of mercury in timely mixed with infected soil controlled nematodes.

Nirula (1958) obtained satisfactory control of Meloidogyne javanica in potato when DD and Nemagon were applied.

Prasad (1962) tried diazinon, dieldrin and folidol as 0.2% soil drench to control the root lesion nematode Pratylenchus pratensis affecting tomatoes and found that diazinon reduced the damage and nematode population.

Das-Gupta (1963) noticed high yield and lower root-knot index in tomato by applying DD in soil. He observed that parathion and diazinon reduced the nematode population for a short period near the soil surface.

Peachey (1963) protected tomato plants from root-knot infestation by applying sodium flouroacetate, sodium flouroacetamide as well as maleic hydrazide. He observed that all methyl isothio cyanate liberators controlled potato root eel worms when there was adequate soil preparation and sealing after application.

Prasad <u>et.al</u>. (1964) studied the relative toxicity of thirteen insecticides to the second instar larvae of <u>Meloidogyne javanica</u>. The order of toxicity was found as phosdrin>Ethyl parathion>Thimet>Methyl parathion>Dieldrin>Diazinon > Malathion > Endrin > Aldrin > Heptachlor > Lindane > Chlordane > P,P' DDT.

Baines <u>et.al</u>. (1965) controlled the citrus nematode population (<u>Tylenchus semipenetrans</u>) by the application of 2,4 - dichlorophenyl methane sulfonate.

Castro <u>et.al</u>. (1965) tested the nematocidal properties of a number of a - halo carbonyl derivatives, taking 1,3 - dichloropropene as standard, against the citrus nematode, <u>Tylenchus semipenetrans</u> and root-knot nematode <u>Meloidogyne</u> sp. The a, B - dihalocrylate and propionate esters were found highly effective.

Methyl 2-3 dichloro crylate and methyl a-B -dibromocrylate were found more toxic to *Tylenchus semipenetrans* and methyl 2,3 - dichloro crylate to *Meloidogyne* sp.

Epps *et al* (1965) obtained excellent control of the soyabean cyst nematode *Heterodera glicines* in a four year microplot tests using brozone, DD, telone and methyl bromide. None of the fumigants erradicated the nematodes and the result obtained by them indicated that:-

(a) the nematocides applied under coverage with plastics and without coverage were equally effective.

(b) the nematode population was greatly reduced even with low levels of nematocides.

(c) the nematode population declined in the absence of soya bean and increased rapidly when soya beans were planted.

Trials at Philippines (Anon 1967) on the control of nematode species - belonging to the genera *Meloidogyne*, *Helichotylenchus*, *Hoplolaiimus*, *Pratylenchus*, *Tylenchorhynechus*, and *Hemicycliophora* gave significant increases in crop yield during 1965 and 1966 seasons. The yields of cucumber grown in plots treated with dowfume W85, nemagon 20G, argrene 25G and nemafos 10G were significantly higher than those of the controls plots. Argrene, nemagon and nemafos treated plots matured earlier. Okra also responded markedly to the above nematocides as well as to DD, dowfume MC-2 and temik 10G. Other crops like peanut and bitter gourd also showed an increase in yield due to the control of nematodes. The increases in flue-cured tobacco leaf - area was significant in argrene and DD treated plots. Significant beneficial carry over effects to the subsequent crops were exhibited in the case of lima beans and cowpea.

Field experiments conducted by Cannadian Department of Agriculture (1957) showed that DD, telone, vapam and vorlex effectively controlled the root lesion nematode Pratylenchus penetrans and had no deleterious effects on the smoking quality of the tobacco.

~~George C.~~ G.C. Martin (1967) noticed extremely effective nematode control for both plant and ratooned sugarcane by the application of ethylene dibromide, DD, nemagon and dorlone.

John *et al* (1967) studied the effects of che ical treatment on *tylenchus semipenetrans* a parasite of Citrus plants. Treating thirty year old citrus trees with D B C P (Dibromochloropropane)

@ 56 or 37 litres/ha improved the tree growth and increased the yield and average size of fruits. Within two years over 99% control of nematodes was obtained.

Kaai (1967) found 98% reduction in the population of stem nematode affecting onions when treated with nemafos and O-phenyl N, N'Dimethyl phosphorodiamide (Nellite). Application of nemafos 3 weeks after sowing gave better control then treatments 10 days prior to sowing or 6 weeks after.

Smart *et. al.* (1967) observed good control of root-knot nematode affecting strawberry by the application of nemafos @ 4.5 kg active ingredient/ha. He could notice no phytotoxicity with the treatment of nemafos but D B C P apparently caused some root injury.

Thirumala Rao T. (1967) observed that galls caused by *Meloidogyne incognita* were absent in tomatoes treated with nemagon, vapam, nemafos, diazinon and metasystox while ekatox and VC-13 EC reduced galling. Maximum number of galls were found in control plots followed by plots treated with solvirex and ethylene dibromide. It was also seen that DD, nemagon, vapam and nemafos accelerated plant growth while phytotoxic signs were seen in diazinon treated plots. Plants in

DD, EDB, vapam, VC-13 and solvirex treated plots showed thick stem as well as broad and healthy leaves. In metasystox and diazinon treated plots plants showed poor thickening of stem, lowest leaf area and minimum number of flowers and fruits. Maximum root elongation was recorded in nemagon treatment and maximum root weight in EDB treated plots.

The Cyprus Agricultural Research Station (1968) conducted experiments on the control of _Tylenchus semipenetrans_ in citrus using 1,2 Dibromo-3-chloropropane (DBCP) and obtained high reduction in population but no statistical difference could be seen either in the number or weight of fruits. In banana there was no statistical difference in root infestation by the spiral and root-knot nematodes when DBCP was applied @ 1 gallon/acre in irrigation water.

The Department of Agriculture, Western Australia (1968) achieved success in controlling root lesion nematodes _Pratylenchus coffae_ and _Pratylenchus penetrans_ affecting apples by soil fumigation.

FAO (1968) in its report pointed out that nematodes are major factors in crop production, destroying about 10% of all crops in the United States. The most desirable method of assessing crop loss caused by nematodes, recommended by FAO, was the result of soil fumigation.

Mankai (1968) obtained considerable reduction of root-knot diseasewith the use of organic amendments. Crops in chemically fertilized plots remained heavily diseased but the infectivity and survival of the nematodes were reduced in organically amended soil.

Syed Shahabuddin Hussain (1968) found that nemafos was an effective systemic poison against root-knot nematodes eventhough a little phytotoxicity was observed in tomato.

Alan F. Bird (1969) found that the population of Meloidogyne javanica was higher in Tobacco plants affected with Ring spot virus and Mosaic virus than in uninfected plants.

Wrey Birchfield (1969) conducted field tests with granular and liquid nematicides and obtained excellent control of sugarcane nematodes resulting in higher yield and increase sugar content of the crop.

Fizoz Hameed (1970) found that organic additives from neem and chrysanthemum followed by tagets profoundly minimised the incidence of Meloidogyne sp. affecting tomato and resulted an increase in the growth of plants.

MATERIALS AND METHODS

MATERIAL AND METHODS

Chemicals used as nematicides:

Proprietory/ common name	Active ingrediant	Source of supply
Dol-Granule 10G	Benzene Hexachloride $C_6 H_6 Cl_6$	Pesticide (India) LTD.
Dasanit - 5G	0,0-diethyl 0 - (4 methyl sulfinyl phenyl)monothio phosphate	Bayer (India) LTD.
Solvirex - 5G	0-0-diethyl S-2 (ethylthio)ethyl phosphorodithioate $C_8 H_{19} O_2 PS_3$	Sandoz (India) LTD.
Thimet - 10G	0,0,Diethyl S-2-(ethylthio)-methyl phosphorodithioate $C_7 H_{17} O_2 PS_3$	Cynamid (India) LTD.
Diazinon - 5G	Diethyl 2-isoprophyl -6-methyl-4-pyrimidinyl-phos-phorothionate. $C_{12} H_{20} N_2O_3 PS$	Tata Fison LTD.
Insecticide 6626-5G	0,0-diethyl-thiono phosphoric acid -0-(quinoxalyl-(2)) ester.	Sandoz (India) LTD.
Nemafos - 10G	0-0-diethyl 0-2-pyrazinyl-phosphoro-thionate. $C_8 H_{13} O_3 PSN_2$	Cynamid (India) LTD.
Endrin - 2G	1,2,3,4,10,10-hexa-chloro 6,7-epoxy-1,4,4a,5,6,7,8,8a-Octahydro exo-1,4, exo-5-8, dimethano -napthalene.	Pesticide (India) LTD.

Site used for the experiment:

The experiment was carried out in the Farm attached to the Agricultural College and Research Institute, Vellayani. The soil was red loam with a sandy clay texture. A root-knot nematode infested area, was chosen for the purpose.

Seeds and Seedlings:

Brinjal seeds of the variety Pusa purple (cluster) obtained from the Botany Division, Agricultural College and Research Institute, Vellayani were used. Thirty days old seedlings raised in pots filled with heat sterilized soil were used for the experiments.

Nematode sieves:

Three sieves of meshes 60, 200 and 325 per square inch manufactured by Daul manufacturing Company, Chicago were used for sieving out the nematodes from the soil.

Polythene troughs:

Four troughts of size 32 cm. diameter were used for washing the soil samples.

Baermann funnel:

Glass funnels of 10 cm diameter with 9" long rubber tube and a pinch cock fitted at its tail end constituted the Baermann funnel. 25 numbers of such funnels were used for filtering the nematodes from the soil washings.

Tissue paper:

"Sateena" white facial tissue paper of size 21 cm x 16 cm was used for filtering the nematodes.

Wire gauze:

Wire gauzes of 20 mesh per sq.inch were used as supports for the tissue paper in the Baermann funnels. The gauze pieces were made into a dish like shape to fit into the funnels.

Other equipment:

They included funnel stands, wash bottles, beakers, specimen tubes, test tubes, spirit lamp, cavity blocks, nematode counting slide, pippetts, talley counter, polythene bags, specimen tube stand and Meopta-binoculars.

Chemicals used:

40% formalin diluted to 10% was used for preserving the nematodes.

7 : 10 : 5 standard fertilizer mixture was used for fertilizing brinjal plants in the field.

METHODS

Design and lay out:

The experiment was laid out in Randomised Block Design with three replications. The experimental field was divided into blocks and plots by putting strong bunds.

The crop was in the field from December to May covering mainly the summer season :

Gros Plot	..	2.4 M x 2.4 M
Net Plot	..	1.8 M x 1.8 M
Main bunds	..	0.5 M
Sub bunds	..	0.3 M
Net area of each plot	..	3.24 Sq.M.
Total area	..	392 Sq.M.

Preparatory cultivation in the mainfield:

The main field was first thoroughly ploughed. Each plot was dug upto a depth of 2 feet, clods broken and soil pulverised to a fine tilth. Each plot received a basal application of 2 kg of well powdered cattle manure.

Application of fertilizers and manures:

50 gms of standard vegetable mixture (7:10:5) was applied around each plant at monthly interval. Mulching cum green leaf manuring (with Glyricidia) also was done.

Planting the seedlings in the experimental field:

Four seedlings were transplanted to each plot with a spacing of 90 cm x 90 cm.

Irrigation:

Watering was done twice daily for the first month and once daily subsequently. This ensured a high moisture content in the soil which is a pre-requisite for the proper survival of nematodes.

Application of Nematocides:

Required quantities of chemicals for various plot, were applied at different intervals, as detailed in the treatment combination. The chemicals were sprinkled on the soil surface and raked to a depth of 30 cm.

Treatments:

24 treatments and one control were included in the experiments as detailed below:-

T_1	Endrin 2% granules	@ 8 kg a.i/ha pre-planting application
T_2	Endrin 2% granules	@ 8 kg.a.i/ha applied 45 days after planting
T_3	Endrin 2% granules	@ 8 kg.a.i/ha pre-planting and 45 days after planting.
T_4	Diazinon 5% granules	@ 8 kg.a,i/ha pre-planting application.

T_5	Diazinon 5% granules	@ 8 kg.a.i/ha applied 45 days after planting
T_6	Diazinon 5% granules	@ 8 kg.a.i/ha applied at pre-planting and 45 days after transplanting
T_7	Lindane 10% granules	@ 8 kg.a.i/ha pre-planting application
T_8	Lindane 10% granules	@ 8 kg.a.i/ha applied 45 days after planting
T_9	Lindane 10% granules	@ 8 kg.a.i/ha at pre-planting and 45 days after transplanting
T_{10}	Solvirex 5% granules	@ 30 kg granules/ha pre-planting application
T_{11}	Solvirex 5% granules	@ 30 kg granules/ha applied 45 days after transplanting
T_{12}	Solvirex 5% granules	@ 30 kg granules/ha applied pre-planting and 45 days after transplanting
T_{13}	Nemafos 10% granules	@ 13.3 a.i/ha pre-planting application
T_{14}	Nemafos 10% granules	@ 13.3 a.i/ha applied 45 days after planting
T_{15}	Nemafos 10% granules	@ 13.3 a.i/ha applied at pre-planting and 45 days after planting
T_{16}	Dasanit 5% granules	@ 20 kg.a.i/ha pre-planting application

T_{17}	Dasanit 5% granules	@ 20 kg.a.i/ha applied 45 days after planting
T_{18}	Dasanit 5% granules	@ 20 kg.a.i/ha applied at pre-planting and 45 days after planting
T_{19}	Thimet 10% granules	@ 16 kg.a.i/ha pre-planting application
T_{20}	Thimet 10% granules	@ 16 kg.a.i/ha applied 45 days after planting
T_{21}	Thimet 10% granules	@ 16 kg.a.i/ha applied at pre-planting and 45 days after planting
T_{22}	Sandoz insecticide 6626 - 5% granules	@ 16 kg.a.i/ha pre-planting application
T_{23}	Sandoz insecticide 6626 - 5% granules	@ 16 kg.a.i/ha applied 45 days after planting
T_{24}	Sandoz insecticide 6626 - 5% granules	@ 16 kg.a.i/ha applied at pre-planting and 45 days after planting.

T_0 Control, with nematocides.

Note: Pre-planting application was made on the same day of transplantation.

Collection of soil samples:

For the assessment of pre-treatment nematode population, three soil samples representing the entire experimental plots were collected prior to the application of chemicals.

Subsequent to the treatment, samples were collected at monthly intervals. From each plot soil was taken from 4 places from the root zone of the plants and upto a depth of 10 inches. Samples thus taken from all the three replications of each treatment were mixed thoroughly and 500 cc of it was packed in a polythene bag for further processing. Thus 25 soil samples were collected for each observation.

Washing the soil samples:

The soil samples were processed by the method adopted by Christie and Perry (1951).

Each sample in the polythene bags was transferred to a basin and mixed thoroughly with 1500 cc of water. Coarse particles etc., were allowed to settle. Then it was passed through 60 mesh sieve and the materials collected in the sieve and the sediments in the trough were discarded. The filtrate was allowed to stand for a few minutes and then decanted. It was then passed through 200 mesh sieve of 325 mesh sieve. The fine silt and nematodes collected in these sieves were washed down into a beaker, using a wash bottle, with minimum quantity of water.

Isolating nematodes by Baermann funnel:

The nematode suspension obtained from the soil sample was poured gently into a tissue paper kept in position in the Baermann funnel with the help of a wire gauze. The funnel was filled with water upto a level just touching the tissue paper. The funnel was kept undisturbed and at the end of 24 hours, about 10 cc of water was drawn out into a specimen tube by loosening the pinch cock. Then the water level in the funnel was restored as before for the second and the last drawing at the end of 48 and 72 hours respectively.

Fixing and Preserving the nematodes:

The nematode suspension collected from the Baermann funnel was allowed to settle and the volume was reduced to about 15 cc by pippetting out water from the top. To this an equal quantity of boiling 10% formalin was added to kill the nematodes. A drop of the suspension was examined to ascertain that the nematodes were properly killed.

Counting the nematodes:

The preserved suspension of nematodes was reduced to 10 cc by pippetting out liquid from the top. Then it was shaken well and 1 cc was transferred to a counting slide.

Meloidogyne sp., other parasitic forms and saprophytic forms were counted separately and recorded. Ten times of this count gave the population in 500 cc of soil processed.

The effects of the different nematocidal treatments on the plants were assessed as follows:

Effect on yield:

Plot wise yield of brinjal was recorded fortnightly till the end of the experiment. The total yield from the different treatments was analysed at the end.

Effect on height of plants:

Height of all the plants recorded when they were six months old. The maximum height from the ground level to the tip of the longest branch was measured using a meter scale and the data were statistically analysed.

Effect on leaf size:

The product of the maximum length and maximum width was taken as the size of the leaf. Two plants were selected from each plot and five fully formed leaves from the top were measured. The leaf size was determined when the plants were 6 months old. Mean leaf size was used for analysis.

Effect on root length:

At the end of the experiment plants were lifted with their roots in tact. The length of secondary, tertiary and tap root was measured and recorded. The roots of three plants in each treatment, one selected from each replicated plot, were measured and the mean values were analysed.

Effect on gall formation:

At the end of the experiment the plant were lifted with their roots in tact. Three plants were selected from each treatment (at the rate of one from each replication) and a sample of ten grams of the rootlets were taken at random, the number of galls counted and the mean values were analysed.

RESULTS

DETAILS OF THE EXPERIMENT AND RESULTS

An elaborate field experiment was carried out with the object of ascertaining the effect of some insecticidal and nematicidal chemicals in controlling nematode attack on brinjal plants.

Details of the experiment and results are presented below:

Experimental details

A randomized block design was adopted for the conduct of the experiment. There were 25 treatments including a control, each with three replications. The brinjal plants were planted in rows with a spacing of 90 cms. Each plot had four plants surrounded by bunds, 30 cms broad.

The treatments were as detailed under " Methods ".

Date of sowing	..	27-10-1969
Date and time of pre-planting application of the toxicants.	..	27-11-1969 Forenoon
Date of transplantation of the seedlings	..	27-11-1969 Afternoon
Date and time of post-planting application of the toxicants	..	15-1-1970 Afternoon

Dates on which soil samples were collected for nematode population estimation	X * X *	..	27-12-1969, 25-1-1970 25--2-1970, 26-3-1970 25-4-1970 & 31-5-1970
Dates on which fruits were harvested	X X	..	Harvest on every fortnight from the first month of planting Total : 12 harvests.
Date of measuring plant height and leaf area	X * X	..	30-4-1970
Date of lifting the plants for root length and root-gall estimation	X * X *	..	31-5-1970

Effect of nematicidal applications on the population of root-knot nematodes

The population of *Meloidogyne* sp. observed at different occasions under different treatments are presented in Fig. 1 to 3. Table 1 gives the population of the namatode parasite in the plots receiving pre-planting application of the toxicants and Fig. 1 is the graphical representation of the same data. It was observed that during the first month, following the application of the chemicals and the planting of the seedlings, there was a slight increase in the population of the parasite. Subsequently the parasite population showed a decrease. The decrease was seen even in the untreated plots. But the decrease was far more higher in the plots receiving the chemicals than in the untreated ones. From the third month onwards i.e. from February 1970 the population of the nematode once again increased in all the plots; the magnitude of increase however varied under different treatments.

The initial suppression of the nematode population by the different chemicals was seen from the counts made in the second and third months after the application of the materials. It was observed that all the chemicals were effective in suppressing the initial population and toxicants like endrin, nemafos, diazinon, solvirex, dasanit and thimet gave substantial reduction as compared with the rest and control.

The two materials which gave long standing effect in suppressing the nematode populations were nemafos and thimet while in all others the build up of the population was very high and higher than even control.

Population fluctuations of root-knot nematodes in plots receiving the nematicide application 45 days after planting are shown in Table 2 and Fig.2. A drastic

Table 1

Population fluctuation of *Meloidogyne* sp. in Pre-planting treated plots

Chemical	27-12-69 (December)	25-1-'70 (January)	25-2-'70 (February)	26-3-'70 (March)	26-4-'70 (April)	31-5-'70 (May)
Endrin	380	30	250	320	430	1520
Diazinon	400	80	140	560	510	700
Lindane	220	150	400	760	450	680
Solvirex	560	90	40	940	850	800
Nemafos	390	50	70	320	420	400
Dasanit	170	100	140	620	740	1400
Thimet	140	140	120	280	300	400
Sandoz 662	270	190	130	320	880	220
Control	350	220	240	390	460	480

POPULATION FLUCTUATION OF *Meloidogyne* Sp IN PRE-PLANTING TREATED PLOTS

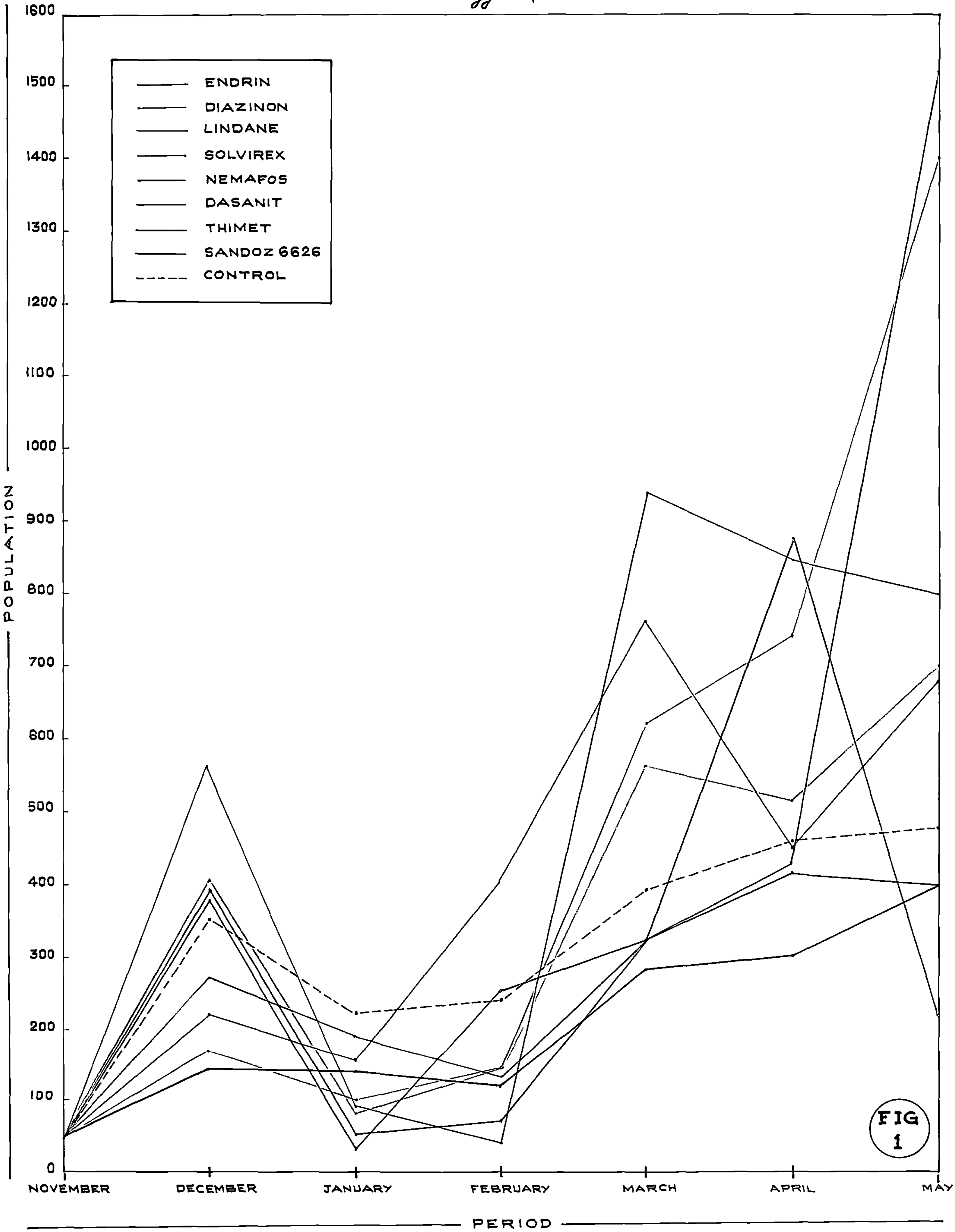


FIG 1

Table 2

Population fluctuation of *Meloidogyne* sp. in

Post-planting treated plots

Chemical	27-12-'69 (December)	25-1-'70 (January)	25-2-'70 (February)	26-3-'70 (March)	26-4-'70 (April)	31-5-'70 (May)
Endrin	720	100	60	130	400	140
Diazinon	280	80	240	160	410	520
Lindane	550	140	250	640	270	480
Solvirex	390	150	170	540	370	520
Nemafos	830	100	40	920	340	500
Dasanit	290	90	70	260	550	960
Thimet	160	90	90	380	610	260
Sandoz 6626	200	130	60	580	1470	640
Control	350	220	240	390	460	480

POPULATION FLUCTUATION OF *Meloidogyne* sp IN POST-PLANTING TREATED PLOTS

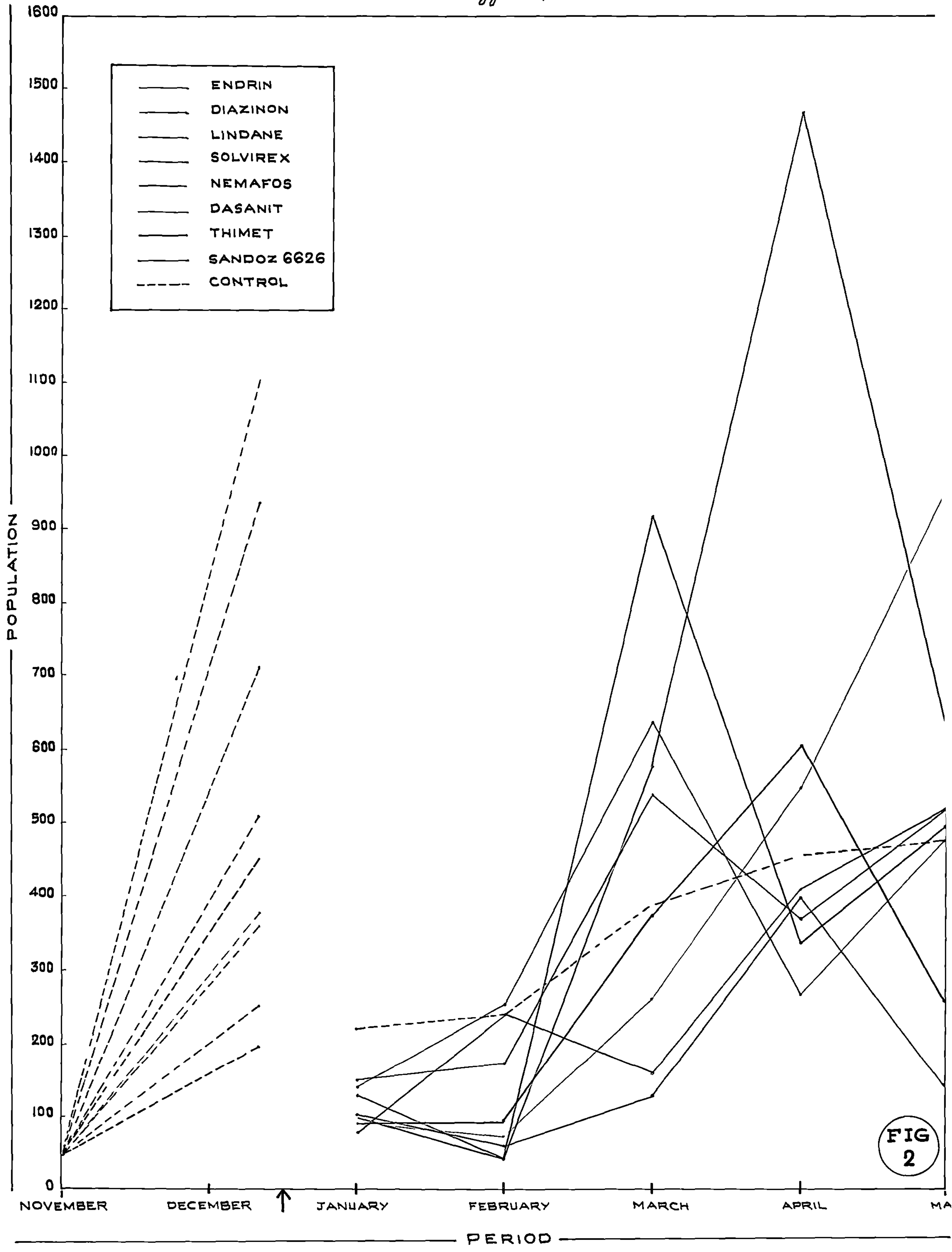


FIG 2

Table 3

Population fluctuation of *Meloidogyne* sp. in Pre-planting & post-planting treated plots

Chemical	27-12-'69 (December)	25-1-'70 (January)	25-2-'70 (February)	26-3-'70 (March)	26-4-'70 (April)	31-5-'70 (May)
Endrin	130	190	100	1060	1330	1100
Diazinon	390	170	220	260	980	1240
Lindane	390	120	310	640	1560	240
Solvirex	580	100	40	120	180	650
Nemafos	360	90	240	480	960	940
Dasanit	360	90	210	440	1060	1530
Thimet	210	90	160	980	320	1340
Sandoz 6626	180	200	220	1140	1240	360
Control	350	220	240	390	460	480

POPULATION FLUCTUATION OF *Meloidogyne* Sp IN PRE-PLANTING AND POST-PLANTING TREATED PLO

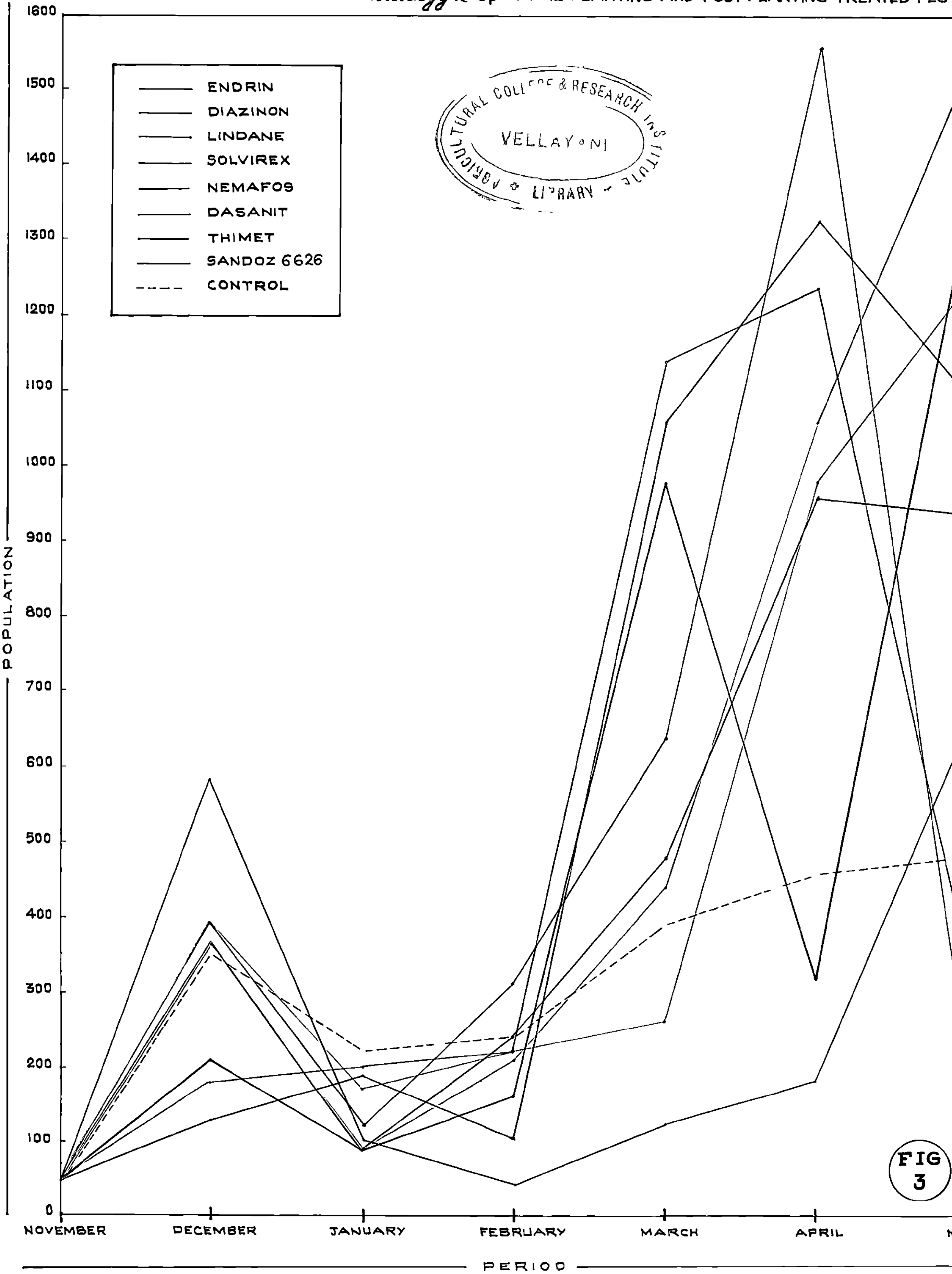


FIG 3

reduction in the population of the nematode was observed in treated plots. The subsequent build up of the population was seen to be less in plots receiving endrin, diazinon, dasanit and thimet than in plots receiving the other chemicals.

Table 3 and Fig.3 represent the effect of toxicants applied at the time of planting and 45 days after planting. The maximum suppression of root-knot nematode population was observed in the second month of planting. During the subsequent months a build up of the population was evidenced and this was relatively less in plots receiving solvirex and diazinon.

Table 4 gives the results of the statistical analysis relating to the effect of pre-planting application on root-knot nematodes. The reduction in nematode population caused by the different treatments is not statistically significant. However a comparison of the mean population shows that thimet reduces the population by 60%, sandoz insecticide 6626 by 48% and endrin by 39%. The others give only small reductions.

Mean tables relating to the population of root-knot nematodes under the different treatments observed on

Table 4

Analysis of variance table relating to the effect of pre-planting application of nematicides on root-knot nematode (27-12-1969)

Source	S.S.	d.f.	Variance	F. ratio
Total	777200.00	24		
Treatments	272961.11	8	34120.14	1.071
Error	504238.89	16	31514.93	

$F_{8,16}$ (05) = 2.59

Chemical	Mean population of *Meloidogyne* sp.
Thimet	175
Sandoz insecticide 6626	225
Endrin	255
Dasanit	265
Lindane	305
Nemafos	375
Diazinon	395
Control (without chemical)	419
Solvirex	570

different occasions are presented in Tables 5 to 9. It may be seen from these tables that pre-planting application of endrin and diazinon remained effective upto 55th day of planting and that post-planting application (on 45th day of planting) upto 70 days following application. The combination of pre-planting and post-planting applications did not appear to give better results. The effect of lindane application on the nematode population under all the three levels did not appear to persist beyond 55th day of planting. Application of solvirex at the time of planting and on the 45th day gave substantial reduction of the nematode population upto 85th day of planting; the combined treatment however persisted upto 145 days. The effect of nemafos in reducing the nematode population persisted upto 85 days when applied at the time of planting or 45 days after planting. The combined treatment did not give any better results. Dasanit reduced the nematode population substantially only upto 55 days when applied at planting and upto 85 days when applied to the 45th day of planting; combination of the two treatments did not give any added advantage. Thimet as pre-planting and post-planting treatments gave effective

Table 5

Mean population of *Meloidogyne* sp. on 25-1-1970 under different treatments

	Endrin			Diazinon			Lindane			Solvirex		
	o	a	Mean	o	a	Mean	o	a	Mean	o	a	Mean
o	220	30	125	220	80	150	220	150	185	220	90	155
b	100	190	145	80	170	125	140	120	130	150	100	125
Mean	160	110		150	125		180	135		135	95	

	Nemafos			Dasanit			Thimet			Sandoz 6626		
	o	a	Mean	o	a	Mean	o	a	Mean	o	a	Mean
o	220	50	135	220	100	160	220	140	180	220	190	205
b	100	90	95	90	90	90	90	90	90	130	200	165
Mean	160	70		155	95		155	115		175	195	

o .. .. Control without nematicidal application
a .. .. Pre-planting application
b .. .. Post-planting application (45 days after planting)
ab .. .. Pre-planting and post-planting.

Table 6

Mean population of *Meloidogyne* sp. on 25-2-1970 under different treatments.

Endrin			
	o	a	Mean
o	240	250	245
b	60	100	80
Mean	150	175	

Diazinon			
	o	a	Mean
o	240	140	190
b	240	220	230
Mean	240	180	

Lindane			
	o	a	Mean
o	240	400	320
b	250	310	280
Mean	245	355	

Solvirex			
	o	a	Mean
o	240	40	140
b	170	40	105
Mean	205	40	

Nemafos			
	o	a	Mean
o	240	70	155
b	40	240	140
Mean	140	155	

Dasanit			
	o	a	Mean
o	240	140	190
b	70	210	140
Mean	155	175	

Thimet			
	o	a	Mean
o	240	120	180
b	90	160	125
Mean	165	140	

Sandoz 6626			
	o	a	Mean
o	240	130	185
b	60	220	140
Mean	150	175	

o .. .. Control without nematicidal application.
a .. .. Pre-planting application
b .. .. Post-planting application (45 days after planting)
ab .. .. Pre-planting and post-planting.

Table 7

Mean population of *Meloidogyne* sp. on 26-3-'70 under different treatments

Endrin				Diazinon				Lindane				Solvirex			
	o	a	Mean		o	a	Mean		o	a	Mean		o	a	Mean
o	390	320	355	o	390	560	475	o	390	760	575	o	390	940	665
b	130	1060	595	b	160	260	210	b	640	640	640	b	540	120	330
Mean	260	690		Mean	225	410		Mean	515	700		Mean	465	530	

Nemafos				Dasanit				Thimet				Sandoz 6626			
	o	a	Mean		o	a	Mean		o	a	Mean		o	a	Mean
a	390	320	355	o	390	620	505	o	390	280	335	o	390	320	355
b	920	480	700	b	260	440	350	b	380	980	685	b	580	1140	760
Mean	655	400		Mean	325	530		Mean	385	630		Mean	485	730	

o .. .. Control without nematicidal application
a .. .. Pre-planting application.
b .. .. Post-planting application (45 days after planting)
ab .. .. Pre-planting and post-planting.

Table 8

Mean population of *Meloidogyne* sp. on 26-4-1970 under different treatments

	Endrin			Diazinon			Lindane			Solvirex		
	o	a	Mean	o	a	Mean	o	a	Mean	o	a	Mean
o	460	430	445	460	510	485	460	450	455	460	850	655
b	400	1330	865	410	980	695	270	1560	915	370	180	275
Mean	430	880		435	745		365	1005		415	515	

	Nemafos			Dasanit			Thimet			Sandoz 6626		
	o	a	Mean	o	a	Mean	o	a	Mean	o	a	Mean
o	460	420	440	460	740	600	460	300	380	460	880	670
b	340	960	1150	550	1060	805	610	320	465	1470	1240	1355
Mean	400	690		505	900		535	310		965	1060	

o .. .. Control without nematicidal application
a .. .. Pre-planting application
b .. .. Post-planting application (45 days after planting)
ab .. .. Pre-planting and post planting

Table 9

Mean population of *Meloidogyne* sp. on 31-5-1970 under different treatments

Endrin				Diazinon				Lindane				Solvirex			
	o	a	Mean		o	a	Mean		o	a	Mean		o	a	Mean
o	480	1520	1000	o	480	700	590	o	480	680	580	o	480	800	640
b	140	1100	620	b	520	1240	880	b	480	240	355	b	520	650	585
Mean	310	1310		Mean	500	970		Mean	480	460		Mean	500	725	

Nemafos				Dasanit				Thimet				Sandoz 6626			
	o	a	Mean		o	a	Mean		o	a	Mean		o	a	Mean
o	480	400	440	o	480	1400	940	o	480	400	440	o	480	220	350
b	500	940	720	b	960	1530	1245	b	260	1340	800	b	640	360	500
Mean	490	670		Mean	720	1465		Mean	370	870		Mean	560	290	

o .. .. Control without nematicidal application.
a .. .. Pre-planting application
b .. .. Post-planting application (45 days after planting)
ab .. .. Pre-planting and post planting.

control for the nematode upto 85 days and there was no better control by combining the two treatments. In the case of Sandoz insecticide 6626 post-planting treatment alone was found to have appreciable effect there being very high reduction of the population upto the 85th day.

Effect of nematicidal applications on the population of parasitic nematodes other than root-knot nematodes

Table 10 and Fig.4 represent the effect of the pre-planting treatments. Reduction of population of the soil living parasites caused by different toxicants was seen even after two months of their application. The toxicants giving substantial reductions are sandoz insecticide 6626, nemafos, endrin, solvirex and diazinon. As regards the subsequent build up of the population, materials like endrin, thimet, sandoz insecticide 6626 and nemafos were found effective in keeping the population down.

The effect of the application of the chemicals on the 45th day after planting is represented in Table 11 and Fig. 5. Chemicals like solvirex, dasanit, endrin, nemafos, thimet, diazinon and sandoz insecticide 6626 suppressed the nematode population considerably following their application. Materials like thimet, lindane and nemafos

Table 10

Population fluctuation of parasitic nematodes other than *Meloidogyne* sp. in pre-planting treated plots

Chemical	27-12-'69 (December)	25-1-'70 (January)	25-2-'70 (Febuary)	26-3-'70 (March)	26-4-'70 (April)	31-5-'70 (May)
Endrin	240	130	130	110	70	240
Diazinon	310	240	290	220	320	780
Lindane	420	560	280	320	1460	190
Solvirex	290	180	80	120	320	480
Nemafos	490	80	220	180	160	260
Dasanit	150	210	170	280	1340	1520
Thimet	90	360	130	180	100	340
Sandoz 6626	370	50	90	180	130	240
Control	250	480	140	270	170	1120

POPULATION FLUCTUATION OF PARASITIC NEMATODES OTHER THAN *Meloidogyne* Sp IN PRE-PLANTING TREATED PLOTS

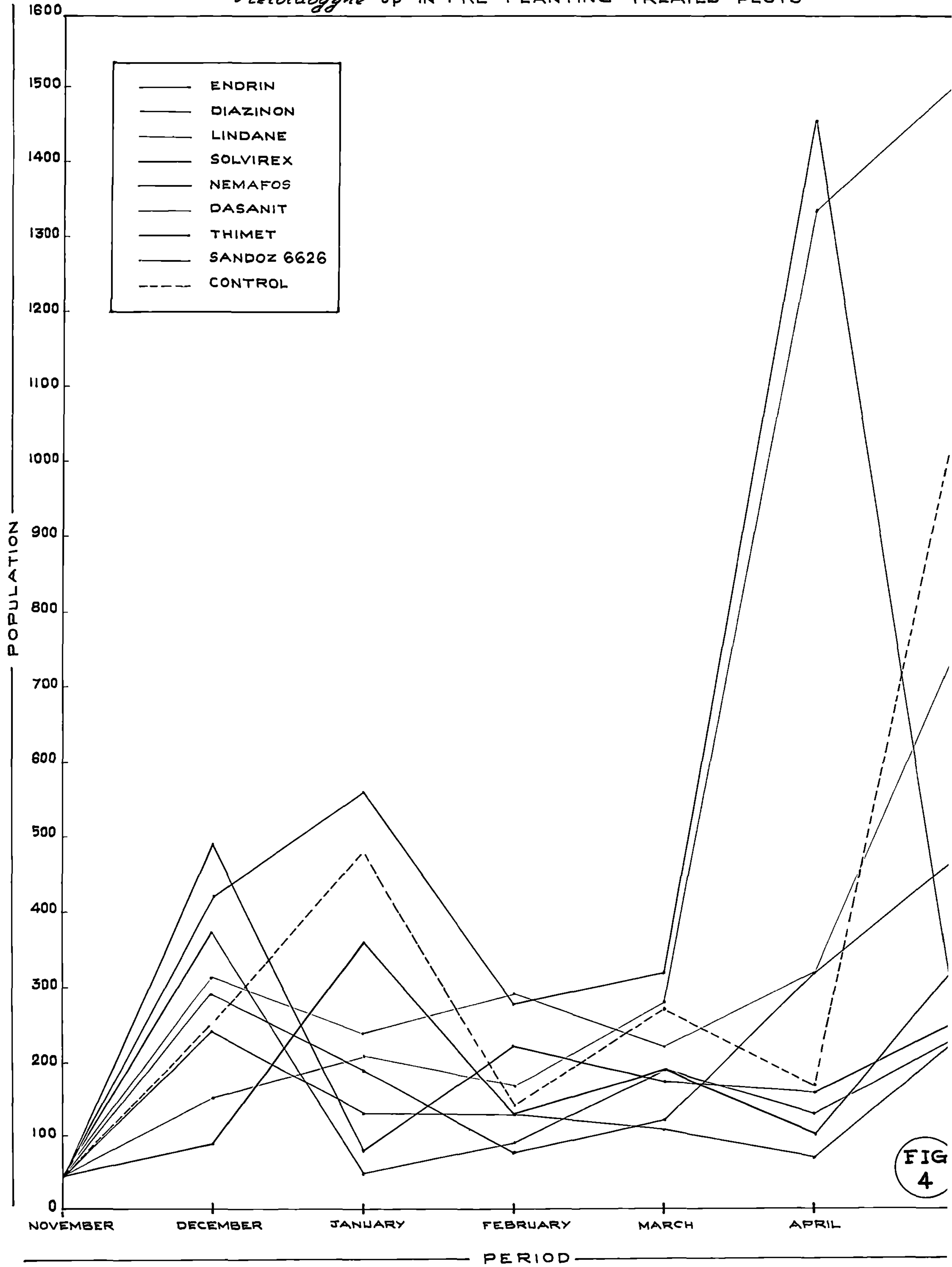


FIG 4

Table 11

Population fluctuation of parasitic nematodes other than *Meloidogyne* sp. in post-planting treated plots

Chemical	27 -12-'69 (December	25-1-'70 (January)	25-2-'70 (Feburary)	26-3-'70 (March)	26-4-'70 (April)	31-5-'70 (May)
Endrin	840	540	190	720	650	440
Diazinon	190	200	180	140	600	1280
Lindane	620	100	320	120	310	120
Solvirex	300	50	310	120	1600	1300
Nemafos	400	140	60	320	240	280
Dasanit	220	80	130	400	370	1410
Thimet	480	180	110	140	210	170
Sandoz 6626	580	290	130	1250	360	1400
Control	250	490	140	270	170	1120

POPULATION FLUCTUATION OF PARASITIC NEMATODES OTHER THAN *Meloidogyne* Sp IN POST-PLANTING TREATED PLOTS

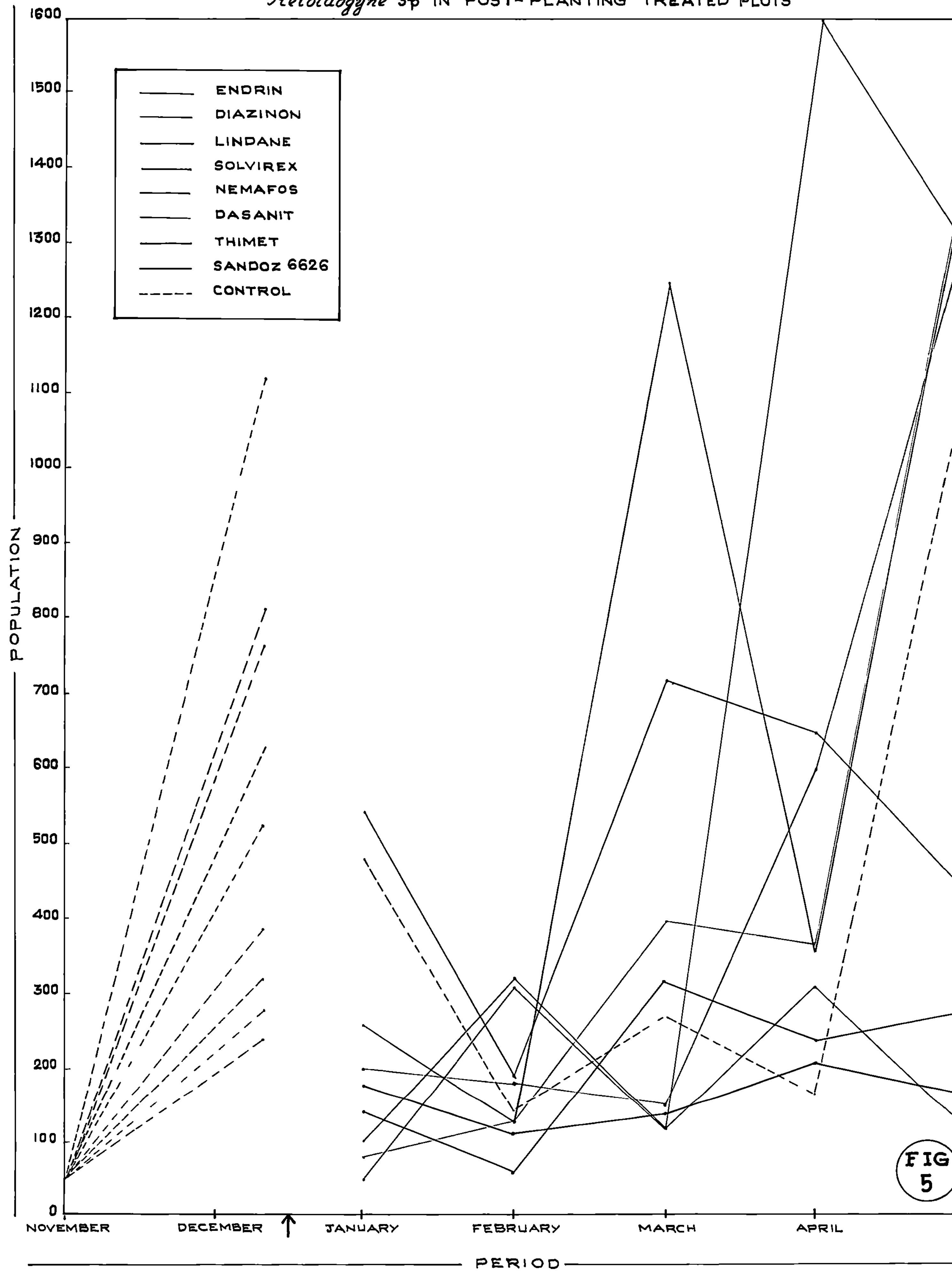


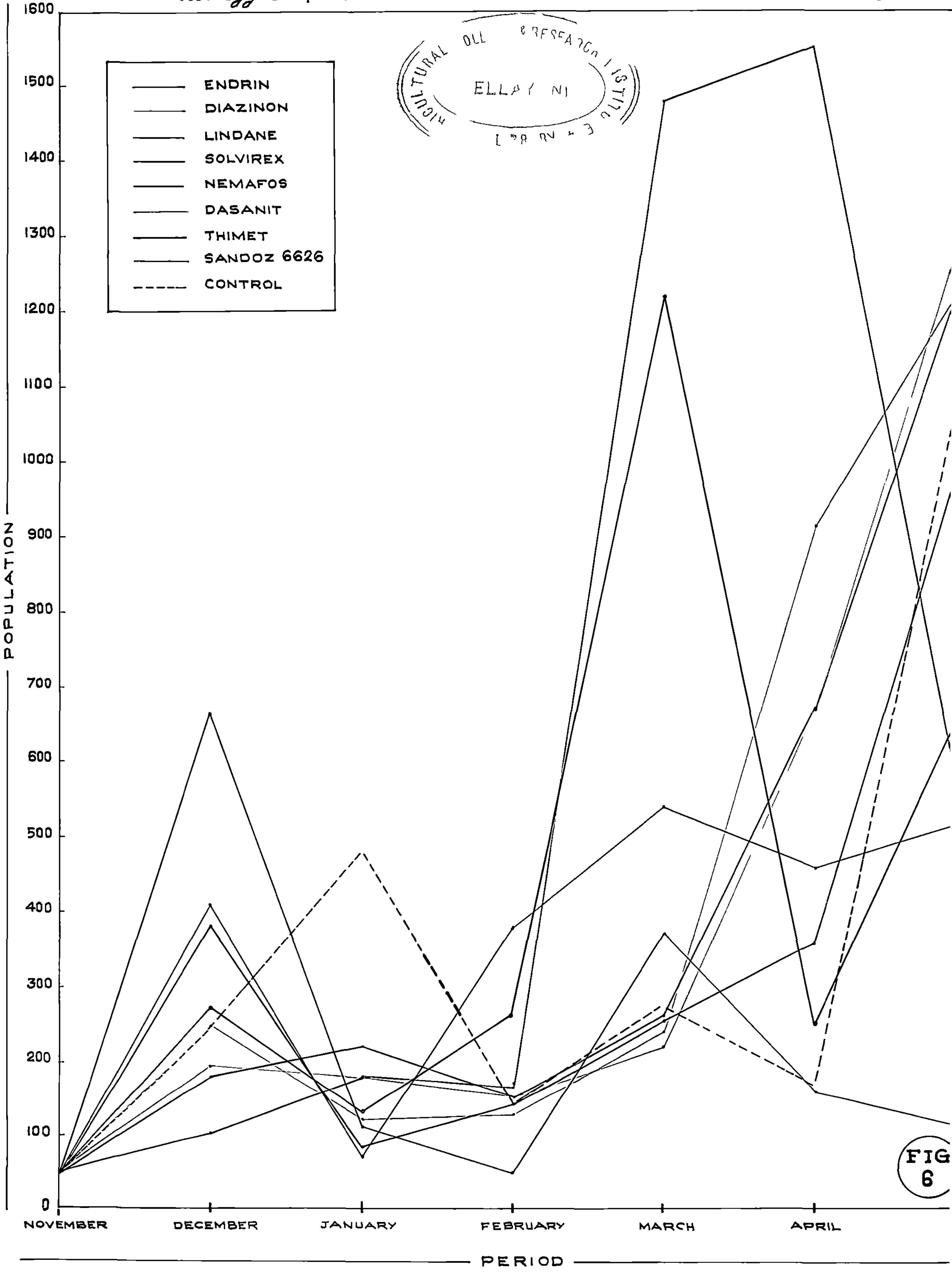
FIG 5

Table 12

Population fluctuation of parasitic nematodes other than *Meloidogyne* sp. in pre-planting and post-planting treated plots

Chemical	27-12-'69 (December)	25-1-'70 (January)	25-2-'70 (February)	26-3-'70 (March)	26-4-'70 (April)	31-5--'70 (May)
Endrin	180	220	150	260	670	1250
Diazinon	190	180	150	220	670	1310
Lindane	410	70	380	540	460	520
Solvirex	660	110	50	370	160	110
Nemafos	380	80	140	260	360	1020
Dasanit	250	120	130	240	910	1240
Thimet	270	130	260	1220	250	680
Sandoz 6626	100	180	160	1480	1550	520
Control	250	480	140	270	170	1120

POPULATION FLUCTUATION OF PARASITIC NEMATODES OTHER THAN *Meloidogyne* Sp IN PRE-PLANTING AND POST-PLANTING TREATED PLOTS



prevented the subsequent build up of the populations.

In Table 12 and Fig. 5 are given the effect of the application of the chemicals at the time of planting and 45 days thereafter. The maximum suppression of the soil parasites was evidenced during the second and third months of planting. All the toxicants gave effective reduction of the nematodes but were seen to be not of much value in preventing the subsequent build up of the populations.

Effect of nematicides on the yield of fruits

Data on the total yield (mean) of fruits harvested from the different treatments are given in Table 18. The analysis of variance of this data is given in Table 13. The order of efficacy of different chemicals in increasing the yield was found to be thimet > dasanit > sandoz insecticide 6626 > nemafos > lindane > endrin > solvirex > diazinon. The increase in yield brought about by all the chemicals is significant over control.

Effect of nematicides on the height of brinjal plants

The height of all the plants in each plot was measured and recorded when the plants were six months old. The mean height is presented in Table 18. The mean height

Table 13

Analysis of variance of yield of brinjal fruits under different nematicidal treatments

Source	S.S.	d.f.	Variance	F. ratio
Total	6463584.00	74		
Block	1078997.00	2	539498.50	12.32 **
Treatments	3243414.66	24	135142.28	3.03 **
Error	2141172.34	48	44607.75	

* significant at 0.05 level
** significant at 0.01 level   CD(05) = 347.2

$T_{21}T_{18}T_{19}T_{22}T_{24}T_{16}T_{15}T_{7}T_{6}T_{2}T_{13}T_{10}T_{12}T_{20}T_{9}T_{17}T_{3}T_{14}T_{23}T_{11}T_{4}T_{8}T_{1}T_{5}T_{0}$

	Chemical	Mean yield	
G	Thimet	7436.66	$\overline{T_{21}T_{19}}T_{20}T_{0}$
F	Dasanit	7153.33	$T_{18}T_{16}T_{17}T_{0}$
H	Sandoz insecticide 6626	6861.11	$\overline{T_{22}T_{24}T_{23}}T_{0}$
E	Nemafos	5459.99	$T_{15}T_{13}T_{14}T_{0}$
C	Lindane	4989.99	$T_{7}T_{9}T_{8}T_{0}$
A	Endrin	4502.22	$T_{2}T_{3}T_{1}T_{0}$
D	Solvirex	4436.66	$T_{10}T_{12}T_{11}T_{0}$
B	Diazinon	4345.55	$T_{6}T_{4}T_{5}T_{0}$
To	Control	1796.66	

$\overline{G\ F}\ H\ E\ C\ \overline{A\ D\ B}\ T_{0}$

for each treatment was analysed. The analysis of variance table and the ranking of treatments are given in Table 14. All the chemicals increased the plant height significantly over control. The order of efficacy observed was thimet > sandoz insecticide 6626 > dasanit > endrin > solvirex > nemafos > lindane > diazinon. Thimet significantly increased the plant height over all other chemicals except that of Sandoz insecticide 6626 and dasanit. It was observed that the increased plant height was accompanied by profuse branching and high yield.

Effect of nematicides on the leaf size of brinjal plants

The mean leaf sizes calculated, as described under methods are presented in Table 18.

Significant increase in leaf size was not observed in any of the treatments. The leaf size in plots treated with lindane and nemafos was smaller than that in control. The leaf size in nemafos treated plots was significantly smaller than in others including control.

The order of efficacy observed was thimet = sandoz insecticide 6626 > endrin > dasanit > solvirex > diazinon.

The analysis of variance table and the ranking of treatments are given in Table 15.

Table 14

Analysis of variance table : Height of plants under different nematicidal treatments

Source	S.S.	d.f.	Variance	F. ratio
Total	15374.32	74		
Block	823.07	2	411.54	4.39 *
Treatments	10055.65	24	418.99	4.47 **
Error	4495.60	48	93.65	

* significant at 0.05 level
** significant at 0.01 level

C.D. (0.05) = 15.91

$T_{19} T_{21} T_{16} T_{22} T_{20} T_{18} T_{15} T_{24} T_{3} T_{10} T_{9} T_{1} T_{23} T_{11} T_{12} T_{2} T_{7} T_{6} T_{17} T_{4} T_{14} T_{5} T_{13} T_{8} T_{0}$

	Chemical	Mean plant height	
G	Thimet	114.85	$T_{19} T_{21} T_{20} T_{0}$
H	Sandoz insecticide 6626	103.34	$T_{24} T_{22} T_{23} T_{0}$
F	Dasanit	102.79	$T_{16} T_{18} T_{17} T_{0}$
A	Endrin	98.39	$T_{3} T_{1} T_{2} T_{0}$
D	Solvirex	96.59	$T_{10} T_{11} T_{12} T_{0}$
E	Nemafos	92.77	$T_{15} T_{14} T_{13} T_{0}$
C	Lindane	91.03	$T_{9} T_{7} T_{8} T_{0}$
B	Diazinon	90.98	$T_{6} T_{4} T_{5} T_{0}$
T_0	Control	64.16	

G H F A D E C B T_0

Table 15

Analysis of variance Table : size of brinjal leaves under different nematicidal treatments

Source	S.S.	d.f.	Variance	F. ratio
Total	62039.41	74		
Block	5491.81	2	2745.90	4.901 *
Treatments	29654.42	24	1235.60	2.206 *
Error	26893.18	48	560.27	

* significant at 0.05 level C.D (05) = 38.90

$T_{22}\,T_{1}\,T_{12}\,T_{20}\,T_{19}\,T_{2}\,T_{6}\,T_{18}\,T_{23}\,T_{21}\,T_{24}\,T_{17}\,T_{8}\,T_{3}\,T_{5}\,T_{11}\,T_{0}\,T_{16}\,T_{4\&3}\,T_{9}\,T_{15}\,T_{7}\,T_{10}\,T_{14}$

	Chemical	Mean leaf size	
G	Thimet and X *	175.00	$T_{20}\,T_{19}\,T_{21}\,T_{0}$
H	Sandoz insecticide X 6626 *		$T_{22}\,T_{23}\,T_{24}\,T_{0}$
A	Endrin	171.86	$T_{1}\,T_{2}\,T_{3}\,T_{0}$
F	Dasanit	158.60	$T_{18}\,T_{17}\,T_{0}\,T_{16}$
D	Solvirex	155.53	$T_{12}\,T_{11}\,T_{0}\,T_{10}$
B	Diazinon	154.56	$T_{6}\,T_{5}\,T_{0}\,T_{4}$
T_0	Control	151.10	
C	Lindane	143.73	$T_{8}\,T_{0}\,T_{9}\,T_{7}$
E	Nemafos	126.03	$T_{0}\,T_{13}\,T_{15}\,T_{14}$

G H A F D B T_0 C E

Effect on nematicides on the root length of brinjal plants

The data on the mean root length are presented in Table 13.

Significant increase in root length could be observed only in treatments with sandoz insecticide 6626, nemafos and thimet. Post-planting treatment with dasanit was inferior even to control. In all the other levels it proved better than control. The order of efficacy observed was sandoz insecticide 6626 > nemafos > thimet > solvirex > endrin > dasanit > lindane > diazinon. The analysis of variance table and the ranking of each chemical are given in Table 16. Plates1to 8 show the comparative root development under the different nematicidal treatments. The roots of plants in control plots appeared hairy and rot early. Rotting of roots was observed in plots receiving endrin diazinon and lindane also.

Effect of nematicides on gall formation

The mean numbers of galls in the different treatments are presented in Table 18.

Gall formation was observed in all the treatments at varying levels. Significant reduction in gall formation

Table 16

Analysis of variance table of root length of brinjal plants under different nematicidal treatments

Source	S.S.	d.f.	Variance	F. ratio
Total	2837656.19	74		
Block	60971.71	2	30485.85	2.896
Treatments	2271423.52	24	94642.64	8.989 **
Error	505260.96	48	10526.27	

** significant at 0.01 level C.D (05) = 168.60

$T_{24}T_{21}T_{15}T_{14}T_{22}T_{23}T_{2}T_{10}T_{18}T_{13}T_{12}T_{16}T_{19}T_{11}T_{9}T_{8}T_{4}T_{6}T_{7}T_{1}T_{5}T_{3}T_{20}T_{0}T_{17}$

	Chemical	Mean root length	
H	Sandoz insecticide 6626	698.66	$T_{24}T_{22}T_{23}T_{0}$
E	Nemafos	568.33	$T_{15}T_{14}T_{13}T_{0}$
G	Thimet	466.77	$T_{21}T_{19}T_{20}T_{0}$
D	Solvirex	410.55	$T_{10}T_{12}T_{11}T_{0}$
A	Endrin	379.33	$T_{2}T_{1}T_{3}T_{0}$
F	Dasanit	350.77	$T_{18}T_{16}T_{0}T_{17}$
C	Lindane	321.88	$T_{9}T_{8}T_{7}T_{0}$
B	Diazinon	297.33	$T_{4}T_{5}T_{6}T_{0}$
T_0	Control	259.33	

H E G D A F C B T_0

was brought about by all the chemicals at all levels. On detailed examination of the roots of treated plants it was found that galls were present only on rootlets and lateral roots formed at a later stage of plant growth. It could be clearly seen that all the chemicals were efficient in arresting gall formation for variable periods of time after application. The order of efficacy observed was sandoz insecticide 6626 > dasanit > nemafos > diazinon > thimet > lindane > solvirex > endrin.

The analysis of variance table and the ranking of treatments are given in table 17.

Table 17

Analysis of variance table: gall formation on roots of brinjal under different nematicide treatments

Source	S.S.	d.f.	Variance	F. ratio
Total	823871.67	74		
Block	29698.67	2	14849.33	1.802
Treatments	398790.00	24	16616.25	2.017 *
Error	395383.00	48	8237.14	

* significant at 0.05 level C.D(05) = 143.9

$T_{19} T_{24} T_{23} T_{7} T_{17} T_{15} T_{5} T_{11} T_{6} T_{22} T_{16} T_{14} T_{18} T_{13} T_{9} T_{2} T_{20} T_{12} T_{3} T_{1} T_{8} T_{4} T_{10} T_{22} T_{0}$

	Chemical	Mean gall count	
H	Sandoz insecticide 6626	221.00	$T_{24} T_{23} T_{22} T_{0}$
F	Dasanit	277.30	$T_{17} T_{16} T_{18} T_{0}$
E	Nemafos	284.44	$T_{15} T_{14} T_{13} T_{0}$
B	Diazinon	294.44	$T_{5} T_{6} T_{4} T_{0}$
G	Thimet	295.30	$T_{19} T_{20} T_{21} T_{0}$
C	Lindane	306.22	$T_{7} T_{9} T_{8} T_{0}$
D	Solvirex	322.56	$T_{11} T_{12} T_{10} T_{0}$
A	Endrin	341.60	$T_{2} T_{3} T_{1} T_{0}$
T_0	Control	522.67	

H F E B G C D A T_0

Table 18

Effect of nematicidal treatments on gall count, yield and plant characters of brinjal

Treatments	Mean yield of fruits (in gms.)	Mean height of plants (in cms.)	Mean leaf size (sq.cms.)	Mean root length (cms.)	Meangall count (nos.)
T_1	3556.66	96.76	186.4	296.00	353.00
T_2	5726.66	93.60	173.9	571.66	330.00
T_3	4223.33	104.83	155.3	270.33	342.00
T_4	3656.66	91.60	143.0	311.66	366.67
T_5	3233.33	89.10	153.4	274.66	255.00
T_6	6246.66	92.26	167.3	305.66	261.67
T_7	6796.66	92.76	129.7	304.00	223.67
T_8	3580.00	81.23	158.9	317.66	366.00
T_9	4593.33	99.10	142.6	344.00	329.00
T_{10}	4846.66	101.16	129.6	475.33	369.67
T_{11}	3696.66	94.60	152.9	349.33	259.33
T_{12}	4766.66	94.03	184.1	407.00	338.67
T_{13}	4980.00	83.60	143.0	416.00	317.33
T_{14}	4076.66	89.63	109.5	632.00	381.67
T_{15}	7323.33	105.10	135.6	657.00	254.33
T_{16}	9253.33	111.10	147.0	371.66	281.33
T_{17}	4280.00	92.26	161.7	211.00	235.00
T_{18}	8926.66	105.03	167.1	469.66	315.67
T_{19}	8653.33	118.36	179.7	371.33	179.00
T_{20}	4690.00	109.60	180.7	264.66	334.33
T_{21}	8966.66	116.60	164.6	764.33	372.67
T_{22}	8543.33	109.13	195.0	611.00	270.33
T_{23}	3716.66	95.96	166.0	586.33	197.67
T_{24}	8323.33	104.93	164.0	898.66	195.00
T_0	1796.66	64.16	151.1	259.33	522.67

DISCUSSION

DISCUSSION

In the studies presented above an effort has been made to compare the nematicidal effect of six insecticides and two nematicides when used in the granular form. The results have been assessed in terms of the effect of the nematode control on the height, leaf size and root length of plants and fruit yield. Gall formation on the root-system and the population of the nematode in the soil were the two direct effects assessed as results.

The results presented will show that in all cases an increase in the population of nematodes in soil is evidenced upto two months following planting. The suppression of the nematode population due to the various toxicants is evident only from the second month of planting even when the chemicals were applied at the time of planting. This is evidently because the toxicants do not have any effect on the eggs. The eggs may hatch only when the hatching stimulus is received from the root exudates and the toxic action of the chemicals may take place only when the larvae become active.

Almost all the toxicants under study suppresses the initial population of the nematode. They do not however appear to have sustained action as it was seen from the subsequent build up of the population.

A scrutiny of the results will show that the different chemicals influence the different criteria of effects such as yield, plant height, leaf area, root length, gall formation and reduction in nematode population differently. An attempt was hence made to have an overall idea about the relative efficacy of the different compounds as nematicides. In table 19 is represented the ranking of the different materials with reference to the different characters influenced by them. The rankings were tested for concordance by using the coefficient of concordance due to Kendall (Johnson 1961) defined as:-

$$W = \frac{12\,S}{m^2 N\,(N^2 - 1)}$$

where 'm' is the number of characters

'N' is the number of chemicals

'S' is the sum of squares of deviations
of the sum of ranks around their mean

'W' has been found to be 0.681

On testing this coefficient of corcordance using chi-square it has been found to be significant showing that there is agreement between the rankings. Hence a combined ranking is justified. The ranking is as follows (vide col.9 of table 19)

1. Sandoz insecticide 6626
2. Thimet
3. Dasanit
4. Endrin
5. Nemafos
6. Lindane
   Solvirex
7. Diazinon
8. Control

Thus it was observed that sandoz insecticide 6626 ranks the top most in its overall effects on nematode control as well as its beneficial effects on yield and plant characters. This is immediately followed by thimet and dasanit. The fourth rank is occupied by endrin; the 5th, 6th, 7th and 8th being occupied by nemafos, solvirex, lindane and diazinon respectively. The two insecticides sandoz insecticide 6626 and thimet are thus found to be superior to the nematicides dasanit and nemafos in the control of nematodes.

On account of the insecticidal properties of the former two compounds they may control some of the insect pest too and this additional attribute also renders them superior to other chemicals used. Further, being granules they can easily be applied without any special equipment and without involving much hazards.

Table 19

Ranking of the nematicides with reference to their effect on different plant characters, nematode infestation and yield

Toxicant	Nematode count one month after planting Effect of pre-planting appln:	Effect on increasing fruit yield.	Effect on plant height	Effect on root length	Effect on leaf size	Effect on gall formation.	Total ranks	Combined ranking
Sandoz insecticide 6626	2	3	2	1	1.5	1	10.5	1
Thimet	1	1	1	3	1.5	5	12.5	2
Dasanit	4	2	3	6	4	2	21.0	3
Endrin	3	6	4	5	3	8	29.0	4
Nemafos	6	4	6	2	9	3	30.0	5
Solvirex	9	7	5	4	5	7	37.0 *	6
Lindane	5	5	7	7	7	6	37.0	
Diazinon	7	8	8	8	6	4	41.0	7
Control	8	9	9	9	8	9	52.0	8

SUMMARY AND CONCLUSIONS

SUMMARY

An elaborate field experiment to evaluate the effect of granular formulations of six insecticides and two nematicides on the control of nematode parasites affecting brinjal was undertaken.

All the toxicants under study were effective in suppressing the initial population of both the root-knot nematode and other nematode parasites. Thimet gave the maximum suppression followed in the descending order by sandoz insecticides 6626, endrin, dasanit, lindane, nemafos, diazinon and solvirex.

None of the chemicals were effective in preventing subsequent build up of the nematode population to any appreciable extent.

The height of the plants were maximum in plots receiving thimet followed by sandoz insecticide 6626 dasanit, endrin, solvirex, nemafos, lindane and diazinon in the same order.

The leaves of the plants attained the maximum size in plots receiving thimet and sandoz insecticide 6626

followed in the descending order by endrin, dasanit, solvirex, diazinon, lindane and nemafos.

The greatest root development was observed in plots receiving sandoz insecticide 6626, followed in the descending order by nemafos, thimet, solvirex, endrin, dasanit, lindane and diazinon.

The greatest reduction in gall formation on the roots was caused by sandoz insecticide 6626 followed by dasanit, nemafos, diazinon, thimet, lindane, solvirex and endrin in that order.

The yield of fruits was maximum in plots treated with thimet followed in the descending order by plots receiving dasanit, sandoz insecticide 6626, nemafos, lindane, endrin, solvirex and diazinon.

An estimation of the overall beneficial effects of the different toxicants based on the coefficient of concordance due to Kendall showed that the different chemicals can be ranked as - sandoz insecticide 6626 > thimet > dasanit > endrin > nemafos > solvirex = lindane > diazinon.

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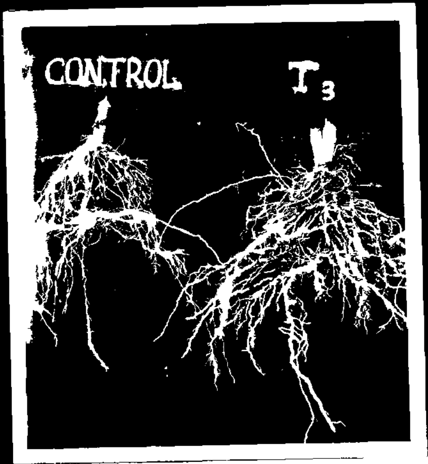

Plate 1

Root development in plots treated with endrin - 2G applied at pre-planting and 45 days after planting and in control plot.

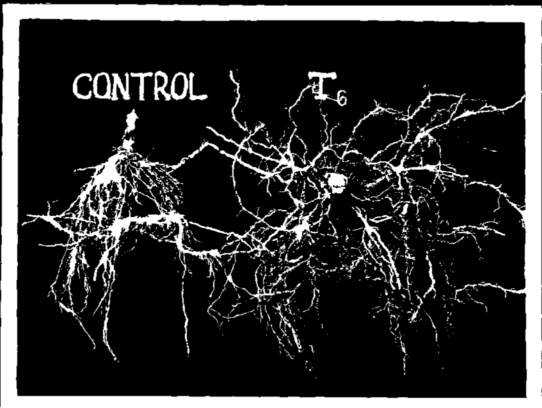

Plate 2

Root development in plots, treated with diazinon - 5G applied at pre-planting and 45 days after planting and in control plot.

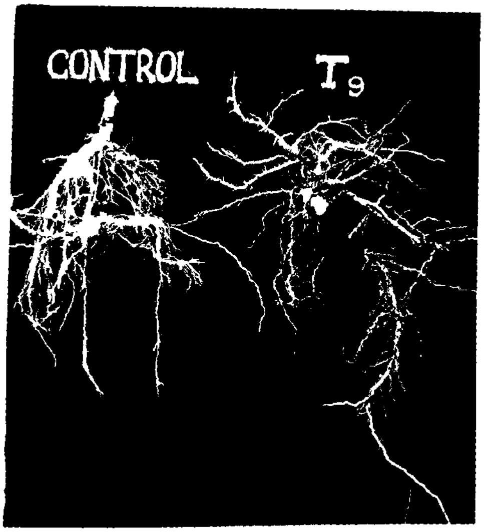

Plate 3

Root development in plots treated with lindane - 10G applied at pre-planting and 45 days after planting and in control plot

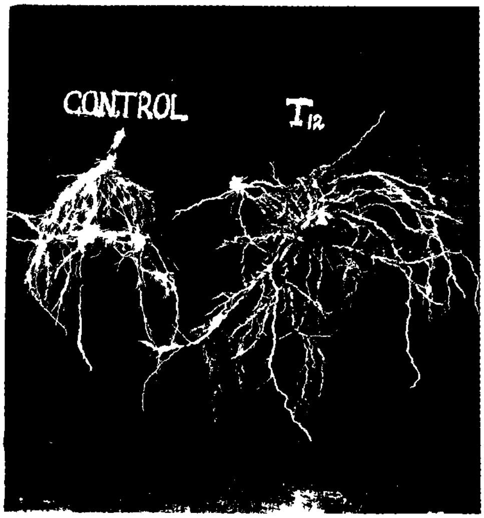

Plate 4

Root development in plots treated with solvirex - 5G applied at pre-planting and [illegible] after planting and

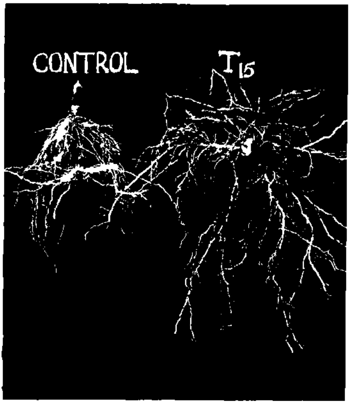

Plate 5

Root development in plot
treated with nemafos - 1
applied at pre-planting
45 days after planting a
in control plot.

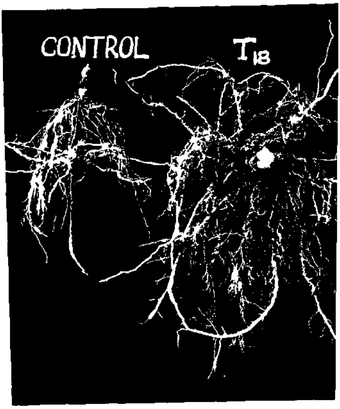

Plate 6

Root development in plo
treated with dasanit -
applied at pre-planting
45 days after planting
in control plot.

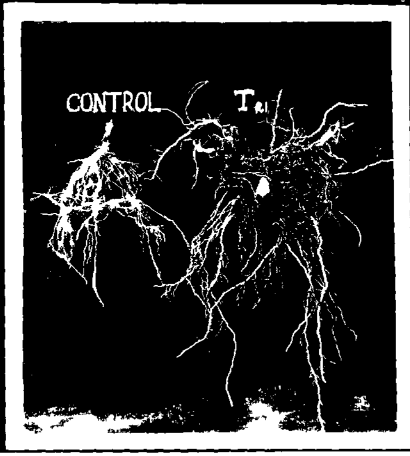

Plate 7

Root development in plots treated with thimet - 10G applied at pre-planting and 45 days after planting and in control plot.

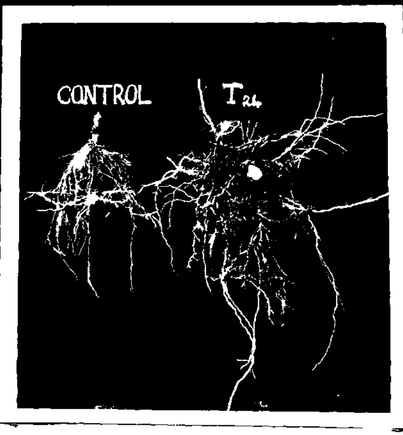

Plate 8

Root development in plots treated with sandoz insecticide 6626 applied at pre-planting and 45 days after planting and in control plot.