

Control of the Potato Golden Nematode (*Heterodera rostochiensis* Woll): Campaign on the Nilgiris

by

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Introduction : Discovered in 1961 on the Nilgiris for the first time in India. *Heterodera rostochiensis* has been a very serious pest, known popularly as "Golden Nematode of potatoes". Repeated surveys were made to locate and keep track of the spread of this infection in the potato fields and the current estimate of the affected area is 3050 acres which is approximately 15% of the total area cultivated under potato in the Nilgiris.

On the Nilgiris the Golden Nematode appears to have been introduced along with seed imports in the past (Seshadri and Sivakumar 1962). Its multiplication and spread is found encouraged by the prevalence of mono-cropping of potatoes year after year and the conducive climate. Infestation at the level of 50 Cysts per 100 mille-litre of soil has been known to affect crop performance and reduce yields. Infection at higher than 300 cysts per 100 mille-litre is observed to very severely affect the yield. Often at this level of infestation, farmers fail to harvest a crop. Symptoms of nematode infestation include an unthrifty stand, (in the initial stage), yellowing in patches, similar to N deficiencies, and dying out of whole plants. Symptoms may manifest on an entire field, or in parts of it, depending upon the distribution of the nematode population in the area.

Control measures include use of nematocides and crop rotations. The disease is best controlled by abandoning cultivation of the host plant in an affected area. When, for other reasons, it is not possible, long term rotations in which the host crop appears in a cycle but once every four or five years would be only recourse. Even for this biological control measure, the initial population level in an infected field would have to be brought down considerably in order that crop rotation may effectively keep the population at levels which would permit the cultivation of the host plant successfully in the cycle. Therefore when a total prevention of the cultivation of the host plant is not possible, chemical treatment of the soil followed by crop rotations is the only effective way for controlling the menace.

The project since its inception has been evaluating the known nematocides in the market and has found that Fensulfothion (Benjamin *et. al.*, 1959) marketed in India under the name "Dasanit" and, in Europe, under the name "Terracur-P", used as a 10% granulated formulation is the most affective. The

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Project invited the expert opinion of leading Nematologists of the world, of the Indian Agricultural Scientists of repute and of the Plant Quarantine experts of the Government of India and came to the conclusion that the total prevention of potato cultivation on the Nilgiris District is not at present a feasible solution. The only desirable control measure according to those experts is the use of Fensulfothion on every known infested field for a minimum of three seasons, consecutively, and follow up with a rotation of crops in which potato would appear only once every year or two. The Nematode control campaign starts from this advice of the special international committee constituted by the Government of India and the Government of the Federal Republic of Germany, a year ago, in 1970.

The Campaign: The object of the campaign is to treat and protect 3050 acres known to be infested with the Golden Nematode with Fensulfothion and arrest further spread of the disease. It involves the application of 120 kgs of Dasanit (10% Fensulfothion granules) per acre (300 kg/hect) as a first application in 1970-71, followed by two subsequent applications in 1971-72 and 1972-73, the latter applications being at the reduced level of 60 kg/acre (150 kgs/hect).

This paper is a report on the plan and progress of the first phase of this campaign.

Discussion: The campaign can be considered under: (i) use of the highly poisonous chemical in a safe and effective manner; (ii) treating each and every infected field without any exception and (iii) making satisfactory financial arrangements to meet the cost of the Campaign.

The chemical 0,0 - diethyl (-0-(4-methyl sulfinyl - phenyl) - mono thio-phosphate, called Fensulfothion, ($L_{50} = 2$ mg/kg) (Anon. 1971 a) has been known to cause serious depression of choline esterase activity and also reduce longevity in male rats on intake even at 5 ppm. (Doull *et al.* 1971). The use, therefore, of this chemical has to be done under strict technical supervision and the handling of the chemical should be strictly under protected conditions such as with gloves, masks etc. (Fig. 1).

The chemical, therefore, could not be distributed to the farmers as such for handling and had to be applied under departmental supervision to avoid accidents. The men engaged for application had also to be properly clothed and protected from coming into physical contact with the chemical. They had to be provided with masks to prevent inhalation of the fumes as it has been known that even inhalation of contaminated air is likely to cause poisonous effects.

To avoid prolonged exposures, the batches of men engaged in this programme were rotated and given intervening periods of rest to permit recovery from their lowered choline esterase activity. In order that the men used in the

campaign may have absolutely normal health they were specially fed daily during the campaign with adequate nutritious food, as a precaution against any loss of vitality among them causing accidents.



FIG. 1. A person engaged in the field application of the chemical with protection from contacting the chemical

Detailed instructions had to be given to each working group applying Dasanit on First Aid action in the event of accidental poisoning and every unit carried an injection syringe, ampules of Toxogonin, tablets of atropine sulphate, etc. In order that victims needing medical attention may be properly taken care of medical men in the district were given special training to handle Dasanit poisoning cases. Instructions on the treatment of different levels of poisoning were freely made available in every dispensary and medical aid centre and adequate stocks of oxygen cylinders (25) were specially provided through the courtesy of the Director of Medical services, Madras at the district Head-quarters Hospital for cases needing administration of oxygen for recovery. Large supplies of Atropine sulphate tablets and Toxogonin ampules were specially imported for the use of Dasanit victims and issued free through the hospitals.

Nature of poisoning and its cure: Poisoning occurs usually through inhalation of vapours, by swallowing or through slow absorption by the skin and results mainly in a variable inhibition of the enzyme, Acetyl Cholin esterase (Elr/Wi, 1969). It is likely, other enzymes and nerve substance may also be toxically affected.

Symptoms of poisoning include, frequently, headache, nausea, sweating, vomiting, narrowing of pupils, low blood pressure and slow pulse. The chemical often causes psychogenic reactions with symptoms characteristic of Organophosphorus poisoning and only the lowering of blood Choline-esterase activity gives conclusive evidence of real poisoning. Efforts, therefore, had to be taken to develop capabilities for determining the level of choline esterase activity in blood samples of persons engaged in the campaign. This could not be done easily as no medical institution in the State had a reliable, efficient and satisfactory method for carrying out repeatedly large numbers of this test rapidly. It was more than necessary that the lowering of Choline esterase activity in the blood of persons exposed to Dasanit be detected sufficiently early, before even the other symptoms became manifest, as otherwise, poisoning cases, even the few which occurred, scare away farmers and labourers. As one stage, the project had to requisition for the assistance of 300 army personnel for the campaign as labourers were afraid of being poisoned and refused to come for work.

Finally, a choline esterase Test kit (Anon. 1971) was obtained specially from the manufacturers of this chemical and the Pathologists of the District Head-quarters Hospital and other officers in the Project involved in the campaign were thoroughly trained in the use of the kit and periodical choline esterase activity was depressed below 87.5% of the normal blood level, the individual was given a rest period with immediate effect for recovery and taken back on work only when he recovered and reached a 100% level. In a few cases when the esterase activity dropped below 62½%, the individual was permanently debarred from any association with the campaign.

In spite of every precaution taken 64 persons had to be hospitalised and treated before they recovered from the symptoms. An interesting observation made during the campaign indicated the great need for strict vigilance in the use of this chemical. Poisoning cases usually occurred on the afternoons prior to holidays, such as Saturday afternoons, when both the workers and Supervisors tend to slacken their attention on protective measures. They were also noticed to crop up whenever the officers supervising the application were temporarily absent. Except in a couple of cases, no poisoning was noticed among the lay public. Even in these two cases, the poisoning occurred due to drinking of water which was specifically prohibited. It is noteworthy, that not even a single fatal case was reported in this campaign which distributed over one thickly populated valley a chemical in quantities which could have killed people by the millions.

The All India Radio maintained a constant support for the campaign through its broadcasts for the farmers warning people of the dangers.

Lest, the above should deter future use of this chemical by the farmer it should also be stated that occasional short time handling of this chemical with

normal care offers absolutely no problem and several earlier applications in restricted areas had already been done perfectly without any disturbing events. The problem arises only when large quantities are handled and then too when persons continue to handle the chemical for three or more days consecutively. Therefore, use of this chemical, especially the 5% formulation available in our country, should be adequately safe.

Treating of every infected field: The topography of the district is very undulating and fields are located on steep hills and deep valleys. Most of the fields are included under one single survey number and fragmented holdings do not have separate identity in the revenue records. Location of the field, therefore, which is infected is possible only by on-the-spot identification either by farmers or the special staff who were responsible for the survey for the presence of the Golden Nematode. In many instances the chemical packed in 25 kg steel drums had to be manually carried distances up-to even 3 kms and heights one thousand feet in elevation.

The application of the chemical is to be done not earlier than a week to ten day before planting time but preferably at the time of planting. Most of the area under potatoes in a season happen to be planted almost simultaneously within a period of one month. A large number of fields had to be individually attended to and application of the chemical made with out exception what-so-ever, and also as close to planting time as possible in advance of the actual planting of the tubers. To achieve this job a fleet of vehicles available in the project was pressed into service to cover a travel of 41,877 kms and a labour force of 5962 persons was employed. (Table 1)

TABLE 1. *Monthly distribution of vehicles used*

Month	Truck		Unimogs		Hafflinger Jeeps		Volkswagon Variant		Volkswagon Transporter	
	No. of days	K.M. covered	No. of days	K.M. covered	No. of days	K.M. covered	No. of days	K.M. covered	No. of days	K.M. covered
November	11	134	20	225	12	526	—	—	21	1636
December	6	84	17	343	33	1914	6	253	26	1394
January	1	18	21	732	29	1596	1	63	36	1705
February	36	1186	44	1469	5	351	1	66	155	7765
March	30	797	48	1380	24	1141	21	1293	209	9354
April	—	—	12	343	10	572	20	902	95	4635
Total	84	2219	162	4492	113	6100	49	2577	542	26489

Note: The figures under "number of days" indicates the "number of vehicles days" i.e. if 4 vehicles are used for only 10 days in a month, the figure shown would be "40" for the month.

Periodical meetings were conducted in the villages with the infested fields announcing the campaign and explaining to the farmers precautions and actions to be taken by them. The farmers were further reached through letters written individually to each of the infected farmers. A loud Speaker Van specially built out of one Volkswagen transporter was sent around announcing the campaign to all villages, well in advance of the campaign, again two to three days before the campaign and during the actual application time. Detailed broadcasts by the All India Radio were maintained informing the concerned farmers about the programme of application in their fields a day or two in advance of the actual date of application in their fields. A series of Radio talks were arranged and experts in the Project described the campaign and the need for it and the ways farmers can co-operate in the control of the Golden Nematode in Tamil.

The actual programme of application was accomplished by organising different groups of officers with specific responsibilities in the campaign such as the planting group, the pegging group, the application group and the accounting group. The planting group had the responsibility for collecting data on the fields to be treated, farmers concerned, days of planting of crops, quantity of material required for treatment day-wise. Also this group was responsible for arranging the training of labours and staff used in the campaign. They also provided everyone with protective clothing such as gloves, face masks, overhalls, gum-boots etc. and the equipments such as field trays, screens for protecting streams, wells and water sources.

The pegging group was responsible for inspecting the field to be treated in advance by about a fortnight of planting have the field identified and properly demarcated with special red painted pegs. They had the responsibility also for acquainting the farmer with the details of precautions etc., to be taken and supply of requisites such as labour etc. The pegging group consisted also of a District Agricultural Officer with the special responsibility of checking that this pegging has actually been done well in advance of the actual date of application, so that the men and material on moving to the site for application do not find either the field un-demarcated or the farmers' absent.

The application group consisting of an experienced group leader and trained labourers, totalling four to nine persons, spread the chemical on the demarcated fields in the presence of the farmers. The leader of this group is responsible for the distribution of the requisite quantities of chemical to each of the labourers and also for ensuring the uniform spread of the granules on the ground.

The accounting group consisting of an Extension officer and Gram Sevaks maintained on the spot records of areas treated, quantity of chemical used, signatures of the farmers concerned and collected the token payment of Rs. 100/-

per acre each which every farmer whose field has been treated with Dasanit was expected to pay. The total amount so collected in this campaign without any separate staff assigned for recovery of this revenue to the State is over Rs. 3 lakhs. This collection of revenue is itself an achievement worth special mention because in no known earlier instance in the annals of this department did one see such a large amount collected with absolutely no special staff provided for it and in so short a time.

Making satisfactory financial arrangements: The cost of the campaign on each acre works out to approximately to Rs. 4,000/- and the total cost of the campaign is therefore Rs. 120 lakhs.

The chemical "Dasanit" costing Rs. 70 lakhs was donated entirely free of cost by the Government of Federal Republic of Germany C.I.F. Cochin. The Government of Tamil Nadu has had to advance a total of Rs. 32 lakhs as customs duty on this chemical so far and other payments are expected to follow. As the farmer cannot be expected to meet the cost of this programme entirely by himself and also because the control of the Golden Nematode is a national necessity in view of the fact that if this control is not immediately taken up vast areas under tomato and brinjal in the rest of the country would be threatened with extinction, the Government of Tamil Nadu took a very large hearted and national decision in ordering that only Rs. 100/- be collected from the farmers for each acre of area treated.

Results: The campaign is an outstanding one in several respects and has been a significant success as can be seen from the yield increases obtained.

TABLE 2. Number of golden nematode cysts observed in treated fields
(Root examination)

	No. of fields examined	No. of fields with		
		White Females - Nil (indicates complete control)	1 to 10 white females per plant	More than 10 white females per plant
Irrigated crop	68	40	27	1
Rainfed crop	75	52	21	2
Total	143	92	48	3

Note: Yield is adversely affected when the cyst count is usually more than 10 per plant or 50 cysts per 100 ml of soil.

1. In the field of nematode control no parallel exists where such a large quantity of nematocide was used in one single campaign. (*vide* Histogram next page). 2. The precise planning and execution of the campaign and the mobilisation of so many resources for publicity, transport medical aid and conduct of the campaign is itself an important feature. The results on the control of the nematode and the range in increase in yield of potato following the chemical treatment are given in Tables 2 and 3.

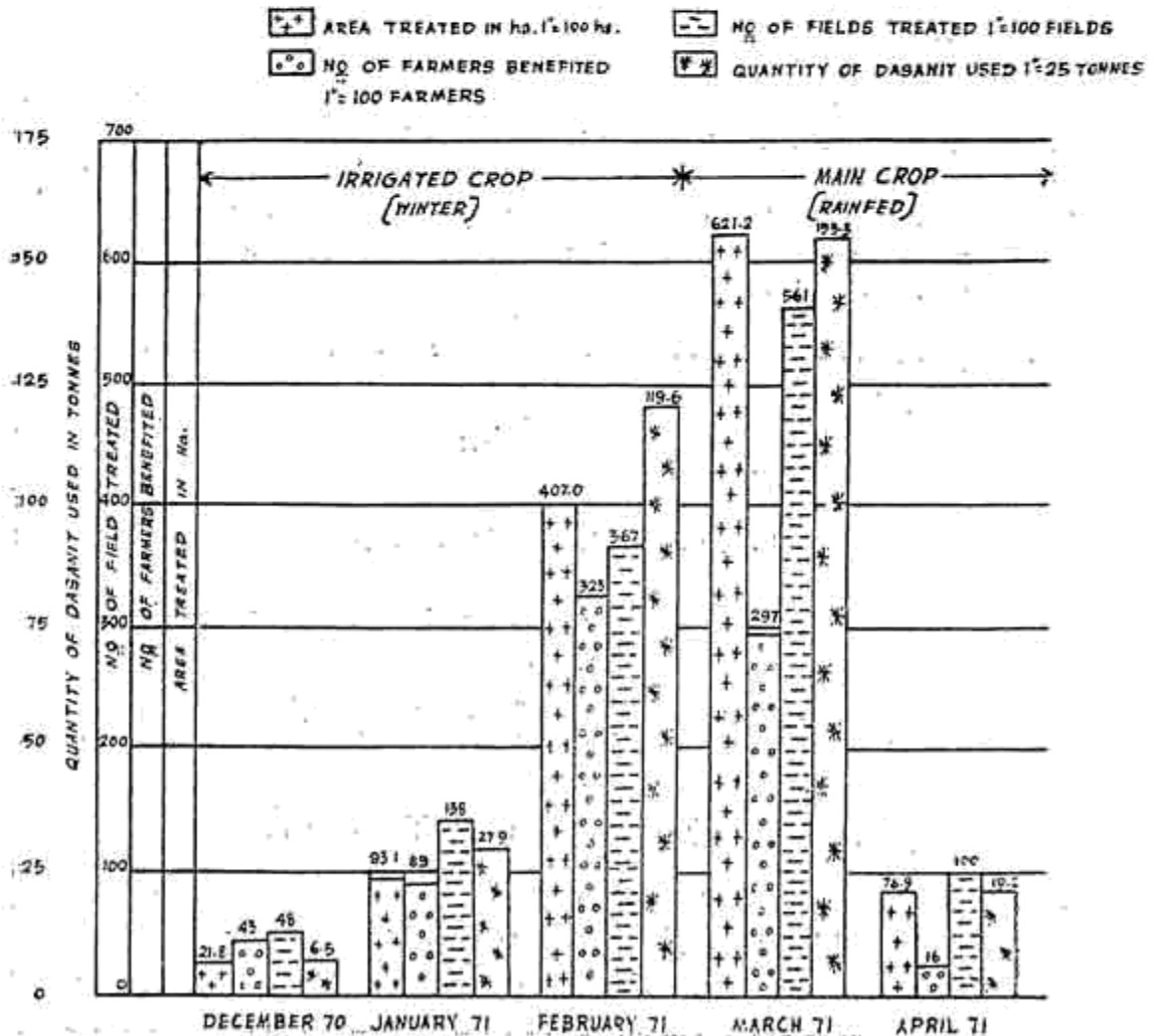
TABLE 3: Yield data in kg/ha of potato from fields treated with Dasanit

	Average yield before treatment 1970	Average yield after treatment	Percentage increase in yield due to treatment	No. of fields sampled at random
Irrigated crop	13395	18685	39.5% (20 to 166)	25
Rainfed crop	9670	12845	32.8% (20 to 85)	10

Note: The figures in brackets indicate the range of increase in yield

Today the farmers are solidly behind the campaign and the Project is confident that the second and the third phases of the campaign would also be completed successfully in due course and this campaign would stand out as a great example for many more plant protection activities.

HISTOGRAMS SHOWING THE MONTHWISE PROGRESS OF GOLDEN NEMATODE CONTROL PROGRAMME 1970-71



Acknowledgment: The campaign represents the labour of many individuals, everyone deeply devoted to the cause, and any attempt to acknowledge the debt due to them in fully would be futile. Mention may, however, be made of Mr. Ahluwalia, and Mr. Shivakumar, District Collectors, Dr. K. J. Varghese, District Medical Officer, Ootacamund and his excellent band of doctors, Messrs. Bayer (India) Limited, farm Radio officer, Tiruchy and the farmers themselves.

To Thiru N. Hari Bhaskar, the Director of Agriculture, Madras, is due special mention for the several orders relating to the campaign, many of them issued in anticipation of Government sanctions involving huge sums of money, without which the completion of the campaign in time would have been impossible. Last but not the least, the spontaneous unsparing cooperation and involvement of each and every member in the Project is acknowledged.

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