
CORRESPONDENCE

1. Comments on the paper 'Association of nematodes in Bunchy Top of Banana' by R. Nayar, published in *Current Science*, June 5, 1984, No. 11, p. 595.

We have the following comments to offer:

The occurrence of the bunchy top disease of banana has been reported from different parts of the world. Magee¹⁻⁴ studied the external and internal symptoms of bunchy top disease of banana and he observed the conspicuous and interrupted dark green streaks along the secondary veins of the lamina or along the midrib or petiole of banana, bunching of leaves, brittleness of the leaves etc. It was further reported that bunchy top virus was responsible for the characteristic, disorganisation of the phloem tissues of the vascular strands. In advanced stages of bunchy top the root system presented a decayed appearance.

In 1927, Magee reported that an ultramicroscopic agent, a virus, transmitted from plant to plant by the banana aphid *Pentalonia nigronervosa* was responsible for the bunchy top disease.

In 1923, Darnell-Smith⁵ reported that contact between roots of infected and healthy plants and grafting for disease transmission were not successful.

Magee¹ reported that both alate and apterous adults and all the four nymphal stages of the aphid *P. nigronervosa* coq. transmitted the bunchy top virus. According to him the bunchy top virus was transmitted by infective aphids in 1½ to 2 hr and longer periods of inoculation feeding on susceptible plants and the minimum acquisition feeding period was 17 hr. Rajagopalan⁶ in his detailed study of the disease has confirmed all the above findings. Under the above circumstances the following points may arise which necessitate clarification.

1. Whether the pathogenicity of Bunchy top disease of banana with nematodes has been proved following stipulated procedure.
2. Is there any nematode diseases of crop plants transmitted by aphid vectors?
3. If the bunchy top disease is due to nematodes, can it be transmitted to healthy plants either by root grafting or by core grafting?
4. Nothing is mentioned about the number of plants in each plot, variety used, the design used etc in the studies of the control of the disease and also from where she has taken the healthy plants.

Similarly nothing is mentioned about the suckers used in the experiment for the control of the disease (i.e. whether it is diseased or not) by hot water treatment at 70°C for 120 min. Ramaswamy⁷ treated diseased banana suckers at 45-65°C for 30 min to eliminate the virus from the diseased suckers. According to him the virus was not eliminated by the above method, but the suckers treated above 60°C have not germinated.

If hot water treatment is successful, is it possible to get a bunchy top free banana plant from a bunchy top affected sucker after hot water treatment at 70°C for 2 hr? In that case we can give wide publicity among the farmers of Kerala for successful control of the disease where bunchy top is a limiting factor in banana cultivation.

5. It is stated that when pits and suckers were treated with insecticide Ekalux before planting and after that soil treatment with it at 3 months interval there was 80% control of the disease. This point is not clear. Has she taken the nematode population count before and after treatment?

By Ekalux treatment the aphid vector *P. nigronervosa* present on the rhizome and near, might have been controlled, thus causing reduction in the bunchy top disease incidence and not in the number of the nematodes.

Banana bunchy top is a severe problem in Kerala. Hence I request these clarifications and further information on the nematode etiology of the disease so that we can modify our recommendation to the farmers of Kerala.

19 July 1984

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1. Magee, C. J. P., *Bull. Coun. Sci. Ind. Res. Aust.*, 1927, 30, 64.
 2. Magee, C. J. P., *J. Aust. Agric. Sci.*, 1936, 41, 13.
 3. Magee, C. J. P., *J. Aust. Inst. Agric. Sci.*, 1940, 6, 109.
 4. Magee, C. J. P., *J. Proc. R. Soc. N.S.W.*, 1953, 87, 1.
 5. Darnell-Smith, G. P., *Agric. Gaz. N.S.W.*, 1923, 34, 846.
 6. Rajagopalan, B., *Studies on bunchy top disease of*

banana, Ph.D. thesis, Tamil Nadu Agric. Univ., Coimbatore, 1981.

7. Ramaswamy, S., *Studies on bunchy top disease of banana*, M.Sc. (Ag.) Thesis, University of Madras, 1967.

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2. We have a few comments to offer on the note "Association of nematodes in bunchy top of banana" published in *Current Science* dated June 5, 1984, Vol. 53, No. 11, p. 595.

We have been studying the damage caused by both *Helicotylenchus multicinctus* (Cobb, 1893) Golden, 1956 and *Radopholus similis* (Cobb, 1893) Thorne, 1949 for a period of six years. A monoculture of *R. similis* has been maintained at this Research Station on banana for over a year now and in the field here both *R. similis* and *H. multicinctus* are found associated with about six varieties of banana for over four years. In none of the plants in monoculture plot or in the field have we observed bunchy top till now.

1. In the note only association of the nematodes with the disease has been claimed without proof on the symptom production due to the causal agent.
2. Magee¹ and Sun² have proved that bunchy top is caused by a virus through insect vector, *Pentalonia nigronervosa* (Caladii) Coquillett.
3. *R. similis* and *H. multicinctus* do not penetrate stele and well developed endodermis³.
4. The two nematodes belonging to the group *Tylenchids* are not known to be vectors of viruses.
5. Earlier work and our investigations here clearly indicate that these nematodes cause root lesions which are invaded by wound parasites leading to root rot and subsequent "tip over"⁴. Tip over is common and is not associated with bunchy top.
6. We have examined many specimens from different parts of the country and all plants with these nematodes as pathogens of root rot of banana have not shown bunchy top disease.
7. How is the author sure that quinalphos which controlled the bunchy top did so by controlling

any viruliferous vector as these insecticides can be taken up by the plant when applied to the soil or stool depending on various physio-chemical properties of the soil and the pesticide(s).

In view of the various points above, we feel that the author's statement 'Bunchy top of banana is caused by a nematode' lacks experimental proof as per 'Koch's postulates' and the conclusions drawn are premature, unscientific and hence unwarranted.

26 July 1984

1. Magee, C. J. P., *J. Aust. Inst. Agric. Sci.*, 1940, **6**, 109.
2. Sun, S. K., *Special Publ. Coll. Agric. Taiwan Univ.*, 1961, **10**, 82.
3. Blake, C. D., *Nematologica*, 1966, **12**, 129.
4. Stover, R. H., *Banana, plantain and Abaca diseases*, CMI, England, 1972.

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Since the Rallis and the Vellayani group of scientists have the same type of comments to offer on my note, I am giving a common reply to both.

1. Nematodes were observed in the phloem elements, pericycle and stele in a number of thin sections from diseased spindles of banana affected with bunchy top disease. Hence the contention of the Rallis group that *R. similis* and *H. multicinctus* do not penetrate the stele and well developed endodermis is not correct. Further when there is extensive damage and disorganisation of cells by the infecting nematodes, there is no question of any confining tissue preventing the entry, at all. The proof on the symptom production is the decrease in the symptom expression of the banana plants by the application of nematicides, Solvex and Ekalux. No other nematicide was readily available in the market for trials; even Solvex was not available later.
2. No nematode has been reported to be transmitted by an aphid. I have not conducted any transmission experiment with nematodes combining aphids. I am therefore not in a position to give experimental data for the nematode-aphid transmission.

3. Root or core grafting with diseased material to healthy bananas can certainly transmit disease if at the time of grafting, living nematodes are present in the internal tissues of the grafted diseased material. This has been confirmed with electron microscopic evidence.

4. I have not stated that nematodes are the vectors of the viruses. In fact I have pointed out that in the absence of electron microscopic evidence of virus particles in the infected *Pentalonia* and diseased tissues of banana, during my electron microscopic investigations, and in the absence of any authentic electron micrographs either from the aphid or the banana, reported by any scientist working on bunchy top in the past or the present to date, in or outside India, the virus etiology of the disease is not proved. On the other hand I have found nematodes in the spindles and stunted leaves and core from bunchy top affected banana. As such I have no reason for confusing the 'bunchy top' with 'tip over'.

5. I have examined the stunted shoots of bunchy top affected banana and found nematodes in many samples. As such, even though I do not deny the existence of nematodes in the soils of bananas affected with root rot, I cannot agree, in the face of scientific evidence of the presence of the organism, with the Rallis group that "these nematodes as pathogens of root rot of banana have not shown bunchy top disease".

6. I have used the 'Nendran' variety for all the trials; 100 plants were used for each treatment and 25 plants were replicated 4 times for each treatment in a randomised fashion. Hundred plants which were fully diseased were retained as controls without any treatment and 100 healthy plants were given identical treatment for comparison. Decreases in disease symptoms were noticed only with ekalux and solvex.

7. It is a matter of common sense that heat affects the rhizomes only in the external tissues; the water as it permeates the internal tissues gets cooled and the efficacy of the hot water treatment is significant only when intermittent doses are given, unless ofcourse the banana suckers are kept in a thermostatically controlled water bath at 70°C. The germination per cent

goes down even with cold water steeping of plants for long periods. If dry heat without affecting the suckers, can be given, then the treatment would be wholly successful.

8. The nematode count was taken before and after the treatments; sections of the treated and untreated plants were examined under the electron microscope. There was a definite decrease in levels of the nematodes.

9. I regret to state that in spite of my repeated requests, no worker has sent me an electron micrograph of virus particles from bunchy top affected banana. Koch's postulates have not been proved for the viral etiology, by any worker, as transmission by *Pentalonia nigronervosa* is not the final proof of the causal organism being a virus. Virus has to be isolated in sufficient numbers in the vectors and the diseased host banana; this has to be purified and inoculated on healthy bananas and aphids, after which the banana should produce bunchy top symptoms; *Pentalonia* after acquisition feeding of virus should produce symptoms on healthy banana on which the insects are fed under insect proof conditions. Virus should be reisolated from the artificially infected bananas and aphids. All these experiments have not been conducted to satisfaction with evidence of data and until these are completed bunchy top is not scientifically proved to be a virus disease. It remains a disease of unknown etiology even after 6 decades.

10. My electron micrographs are as much evidence for nematode etiology of bunchy top as the *Pentalonia* transmission is to virus etiology; in fact electron microscope is a less speculative evidence than transmission. Without the proof of Koch's postulates in the identification of the causal organism and characterisation of the same, the dogma that bunchy top is a virus disease is unscientific, without complete experimental proof and hence unwarranted.

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(Note. The topic is treated as closed and no further correspondence will be entertained in the matter.)

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