Plant Protection Practices in India Based on Indigenous Knowledge

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This paper is a revised version of paper presented at the symposium on "Indigenous knowledge systems' at the 13th International Plant Protection Congress, 2-7 July, 1995, The Hague, The Netherlands.

Indigenous knowledge is the "...largest single knowledge resource not yet mobilized in the development enterprise..."[1] India has a treasure of indigenous knowledge concerning plant health developed and documented several centuries ago. The three major ancient texts inter alia are:

(1) Varahamihira, 505 AD, Brihat Samhitha, Vriksshayurveda Part I, Chapter 55 (edited by M. Ramakrishna Bhat, Motilal Banarasidass, Bangalore, India, 1981).
(2) Chavundaraya, 1025 AD, Lokopakara, Chapter 6 Vriksshayurveda (edited by H. Shesha Iyenger, Governmental Central Manuscripts Library, Madras, India, 1950).
(3) Sarangadhara, 1363 AD, Vriksshayurveda, (edited by S.K. Ramachandra Rao, Kalpatharu Research Academy, PO Box 1857, Bangalore, 1993, India).

The most detailed of all the Vriksshayurveda works, seems to be that of Chavundaraya, 1025 AD. It is however to be noted with caution that the development of this body of knowledge need to be viewed in the pest-disease scenario prevalent 10 to 15 centuries ago, during which many of the current pests and diseases may not have existed. Nevertheless, these methods have common characteristics such as (1) multi-pronged attack on the pest and disease, (2) improving the plant health thereby increasing the resistance capability, (3) enriching soil with nutrients and increasing useful microbial activity, and (4) broad-spectrum effect on pests and diseases, which are desirable.

The caution by Bentley[2] not to overemphasize the role of indigenous knowledge, is crucial for exploration of the complementary interactions for mutually beneficial exchanges between the indigenous and international knowledge systems.

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[1]. *John Madeley, quoted in the synopsis of the workshop on 'Indigenous knowledge systems' by H.De. Kruijf, University of Utrecht, and G.V. Libenstein, CIRAN, Co-convener, 6 Feb 1995.*

[2]. *J.W. Bentley, referred in the synopsis of the workshop on 'Indigenous knowledge systems', XIII International Plant Protection Congress, The Hague, July 2 to 7, 1995, by H.De. Kruijf, University of Utrecht, and G.V. Libenstein, CIRAN, Co-convener, 6 Feb 1995*.

In this paper we present: 1) a few indigenous methods of plant protection as outlined in ancient texts, 2) the documentation of research endeavors in a few indigenous plant protection practices in the University of Agricultural Sciences, Bangalore, India, 3). the documentation of indigenous methods of plant protection as practiced by a few farmers, and 4) policy implications.

1. A few Indigenous methods of plant protection as outlined in ancient texts

Esteemed authors of the ancient texts, make a mention of the painstaking efforts they have taken while observing and researching on the indigenous methods they have documented. In this paper mainly the methods of disease and pest control are highlighted.

The following methods are drawn from *Lokopakara,* Chapter 6- Vriksshayurveda.

(i) ***Seed treatment:*** (6th and 7th stanza)

Such of those seeds from fruit bearing trees, which have fallen on their own need to be considered for planting. The treatment is in the following steps: (1) seeds are mixed with cow dung and dried for five days (2) such seeds are dipped with milk for five days (3) these seeds are dipped in water for five days (4) the seeds are treated with the mixture of tender coconut water and the fruit juice of egg plant (Gulla)[*Solanum ferox* L (fam: Solanaceae)] (5) seeds are then treated with the incense of the cow ghee + *Embelia ribes* Burm (Vayuvilanga) (fam: Myrsinaceae), and (6) Finally thus treated seeds are sprinkled with fresh water before sowing. These steps will promote good germination and sprouting in seeds.

1.1 Pest Avoidance (11th stanza)

A mixture of *Ferula asafoetida* (Ingu) (fam: Apiaceae), *Acorus calamus* (Baje = Athibaje) (Fam: Araceae), *Piper nigrum* (Menasu) (fam: Piperaceae), *Embelia ribes* Burm (Vayuvilanga) (fam: Myrsinaceae), seeds of *Anacardium occidentale* (Gerbeeja) (fam: Anacardiaceae), *Barleria busivolia* (gubbi balli ?) (fam: Acanthaceae) or *Chelianthes farinosa* (gubbi balli ?) (fam: Polypodiaceae), *Brassica nigra* (sasuve) (fam: Brassicaceae) and the cow horn creeper (?) with cow's urine applied to the plant roots will provide comprehensive avoidance of pests.

1.2 Disease Avoidance **(as in 12th stanza)**

The incense of *Embelia ribes* Burm (Vayuvilanga) (fam: Myrsinaceae), *Commiphora wightii* (Mahishakshi) (fam: Burseraceae), fish meat, *Curcuma longa* (arisina) (fam: Zingiberaceae), *Brassica nigra* (sasuve) (fam: Brassicaceae), flowers of *Terminalia tomentosa* (mathi) (fam: Combretaceae), will provide resistance to plants against diseases.

If the growing tips of plants dry up or get broken or get whitened, such plants are inferred to have been affected by disease. In the affected part, warm ghee has to be smeared and black soil applied to enable plant to combat the disease.

The following methods are drawn from Brihat Samhitha, Part I, Chapter 55 -Vrikshayurveda:

1.3 Seed Treatment

The seeds need to be soaked in cow milk for ten days. Every day they have to be taken out with palms greased with cow ghee. Later they are rolled in cow dung mixed with flesh of deer and hog. Later on they are treated with the flesh and marrow of hog. Thus treated seeds are planted in the soil treated with sesamum. The sown seeds are to be sprinkled with milk and water.

1.4 Disease Treatment

The ulcers in the affected trees be removed with knife. A paste made using *Embelia ribes* Burm (Vayuvilanga) (fam: Myrsinaceae), cow's ghee, and silt be applied to the affected parts and later be sprinkled with water and milk.

According to Sarangadhara (Stanza 175, 180, 181), the pathological conditions of wind (vata) , bile (pitta) and phlegm (kapha) which are responsible for diseases in human beings are also the causes of diseases in plants also. When trees are affected by pests, the affected parts should be removed. The disease due to vata (wind) are overcome with the application of clarified butter and flesh juice, that due to bile is overcome with the application of substances that are cold mixed with water, and that due to kapha (phelgm) are overcome with the application of substances which are acidic mixed with hot water or substances which are pungent and bitter. In addition, plants which have tubercles all over the body due to windy factors (Vata), can be treated with the application of *Symplocos racemosa* (lodhra) (fam: Symplocaceae) flower, cow dung, fats and *kunapa* water. The *kunapa* water (*Kunapajala*) is prepared by boiling flesh, fat and marrow of deer, pig, fish, sheep, goat and rhinoceros in water. The boiled water is mixed with milk and powders of sesamum, oil cake, and pulses boiled in honey, the pulse decoction, clarified butter and hot water all in an earthen pot. The earthen pot is then kept in warm place for a fortnight (for fermentation) and the resultant compound is kunapa water.

Plants attacked by pests are to be treated with a mixture of fresh cow urine, clarified butter, *Embelia ribes* Burm (Vayuvilanga) (fam: Myrsinaceae), mustard and sesame, applied to the trunk, and then are to be watered with milk and water (stanza 181).

Trees which are attacked by any type of pests, are to be treated with the paste made from bark of *Pongamia glabra* (Honge) (fam: Fabaceae), *Cassia fistula* (Kakkegida) (fam: Caesalpiniaceae), *Sapindus laurifolius* (arishta) (fam: Sapindaceae), *Alstonia scholaris* (Saptaparni) (fam: Apocynaceae), *Embelia ribes* Burm (Vayuvilanga) (fam: Myrsinaceae) and *Cyperus esculentus* (tungamuste), (fam: Cyperaceae) in cow's urine (stanza 184).

Exudation from trees can be stopped with the application of the bark paste of *Setaria italica* (priyangu / navane), (fam: Poaceae) and *Terminalia arjuna* (arjuna), (fam: Combretaceae) in boiled milk (stanza 194).

2. Documentation of research endeavors in indigenous plant protection practices in the University of Agricultural Sciences, Bangalore (UASB), India

In general, it is difficult to manage soil borne diseases by any means, including cultural control. In particular it is difficult to control *Fusarium* pathogen in the soil, since it can remain viable in soil for almost 50 years, once it enters the soil. The cow milk, curd, ghee, cow dung and cow urine have been individually used as plant protection protocols as prescribed in ancient 'vrikssayurveda' texts (concerning health of plants/trees). It is known that cow ghee and curd can be toxic to pests, and in addition curd is acidic. The 'Panchagavya' - a mixture of five products of cow (milk, curd, ghee, dung and urine) is to be consumed in a little quantity by persons who need to get purified before performing certain rites. In 'Ayurveda', '*panchagavya ghritha*' (panchagavya ghee) is recommended as a cure to epilepsy, jaundice and fever. Plant pathologists at UASB, Ramachandra Reddy and Siddaramaiah[3], ventured to use different combinations of 'Panchagavya' - for control

[3]. *The innovation of using 'Panchagavya' hitherto used for human ailments, in plants was first developed by Professor H. Ramachandra Reddy, Professor of Plant Pathology (Retired), UASB. He derived the cue from an article by T. Curtis, 1992, Jim Martin's living water, Span, Feb, pp. 29-37. Upon retirement, he is continuing to serve cause of plant pathology using indigenous methods. Professor Reddy can be contatced at 162/10, 3rd main road, Ganganagar, Bangalore, India (Phone: 91-80-3339039) and from*

of seedling disease and wilt in Tomato caused by the fungus *Fusarium oxysporum f. sp. lycopersici* and for the control of Panama disease of Banana caused by the soil borne fungus *Fusarium oxysporum f.sp. cubense* . This is the first time that such an innovation has been attempted and found successful, cost effective and environment friendly. The details of the experimental results on Tomato and Banana are given below.

2.1. 'Panchagavya' to control seedling diseases and wilt in tomato caused by soil borne fungus Fusarium oxysporum f. sp. lycopersici

The Fusarium wilt organism invades the roots of tomato. The symptoms could be seen within 48 hours of the entry of the pathogen. The leaf veins become translucent, later leaves turn yellow with discoloration of vascular tissue. Old leaves, young petioles, stem and the whole plant wilt resulting in withering and death. The present investigation was conducted in laboratory, glass house, net house and at field level during 1992-93 at the University of Agricultural Sciences (UAS), GKVK, Bangalore, India.

Cultivar Pusa Ruby of tomato was used as test plant. The seedlings were raised in cement pots (60 X 30 X 45 cm) filled with wilt-sick soil. For preventing the attack by insects and viral diseases, the pots were kept in nylon net house. The traditional *Panchagavya* was modified by adding yeast and common salt and three formulations of were tested (Table 1). The components of modified Panchagavya were fermented for seven to ten days in closed plastic container and stirred every day for 10 minutes. The addition of salt is to reflect Jim Martin's living water concept promoting microbial activity which is further augmented with the addition of yeast.

Table 1: Composition of Modified Panchagavya to control Fusarium wilt in tomato

Composition of Panchagavya	Modified Panchagavya - 3 (MPG-3) (Per cent)	pH level
Ghee	2	6.9
Curd	5	5.1
Milk	5	7
Fresh dung	48	7.2
Urine	40	8.2
Common salt	0.25g	7.5
Yeast	0.25g	

The fermented preparation was diluted ten times with water and filtered through two layers of muslin cloth to obtain a clear filtrate. The filtrate was used for dipping seedlings for 30 minutes and for drenching the sick soil pre-infected by the pathogen in the experiments. Three MPG combinations (MPG-1, MPG-2 and MPG-3) were tried of which the third formulation MPG-3 was the most effective in reducing disease at seedling stage and under field conditions.

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the following theses:

1. Bhaskara Padmodaya, 1994, Biological control of seedling disease and wilt in Tomato (Lycopersicon esculentum Mill.) caused by Fusarium oxysporum Schl. f. sp. lycopersici (Sacc.) Snyder and Hansen, Ph.D thesis (unpublished), Department of Plant Pathology, University of Agricultural Sciences, Bangalore, India.

2. Shamarao Jahagirdar, 1995, Studies on Panama disease of Banana (Musa spp.) caused by *Fusarium oxysporum* Schl. f. sp. *cubense* (E.f. Smith) Snyd. and Hans. with *special reference to biological control, M.Sc(Agri) thesis (unpublished), Department of Plant Pathology, University of Agricultural Sciences, Bangalore, India.*

Further, four dilutions of MPG-3 (0, 10, 100, 1000 parts of water for one part of MPG-3) were tried. The lowest percentage disease incidence was in zero dilution. There was delayed appearance of wilt symptoms by 2 to 10 days in all the treatments over control.

A field experiment in RCBD was laid with neem cake (0.1 per cent), MPG-3 (10 dilution, as above), Carbendazim (0.1 %) (trade name Bavistin), inoculated control, un-inoclulated control and other combinations (Table 2).

Table - 2: *Fusarium* wilt control under different combination treatments in tomato

Treatment	Disease Incidence (%)	Mean shoot length (Cm)	Mean root length (Cm	Shoot dry weight grams	Root dry weight grams	Total dry weight grams	Fruit yield tonnes/ hectare	Cost benefit ratio
Uninoculated control	-	104	26.2	38.4	2.6	41.1	14.1	-
Carbendazim*	34.4	94	23.7	31.4	2.2	33.6	10.3	1:4
NeemCake	25	95	25.5	35.4	2.6	37.9	11.6	1:1.1
NC**	20.3	97.9	25.3	33.8	2.4	36.2	12.3	1:21.3
MPG-3 ***	7.8	105	29.9	38.3	3.1	41.4	16.7	1:2.4
NC+MPG-3								
Inoculated control	55.7	63.2	16.5	17.5	1.1	18.5	7.7	-

Note: * - Carbendazim at 5 per cent; ** - neem cake @ 2.5 t per hectare; *** - MPG3 at 10 dilution.

The MPG-3 and neem cake+MPG-3 treatment had maximum disease reduction under both pot culture and field conditions. Neem cake + MPG-3 gave the highest fruit yield compared to MPG-3 and Carbendazim alone. The cost benefit ratio was most favorable with MPG-3. Further, MPG-3 and neem cake + MPG-3, induced high total microflora which resulted in reduced inoculum density of the fungus. When assayed for efficiency, the MPG-3 gave better results; and dilution up to 10 times was as effective as zero dilution in significantly reducing seedling and wilt disease over the control. By using MPG-3, conidial germination of F. oxysporum was reduced by 63 per cent.

It is important to note that the each single component of *Panchagavya* when applied to the sick soil individually was not effective against *Fusarium*. For instance, the fresh liquified dung + urine when sprayed without dilution had phytotoxic effect, but when all the five components of MPG-3 were combined and fermented for 10 to 14 days, no phytotoxic effect on tomato foliage was observed.

2.2. '*Panchagavya*' to control Panama wilt of Banana (*Musa* spp.) caused by *Fusarium oxysporum f. sp. cubense*

In Banana, the panama disease is one of the most catastrophic plant diseases in the world. In Karnataka State, India, all the farms growing local landrace 'Nanjanagudu Rasabale', once a very tasty and popular variety, has been totally wiped out due to this disease. *Fusarium* fungus enters the roots and spreads to corm where disease develops rapidly resulting in leaves turning yellow, split of pseudostem and rotting of roots. As a sequel to the successful control of Fusarium wilt in tomato using Panchagavya, experiments were conducted to explore the possibility in controlling the panama disease in banana caused by *Fusarium* on cultivar Nangangud Rasabale during 1992-94[4].

[4]. Shamarao Jahagirdar, Op cit.,

As outlined earlier, the MPG-3 was prepared and the filtrate was used as seedling dip and soil drenching with three replications. Carbendazim was applied @ 1 gram per liter for 1 hour as seedling dip and 0.1 per cent as soil drench on the day of planting. Healthy banana suckers developed by tissue culture, were dipped in MPG-3 for two hours and planted in the sick soil. Observations on growing banana plants were recorded at 10 days interval to examine growth, vigor and other parameters.

The different treatments under pot culture studies were *Trichoderma viride* (0.25 per cent), *Pseudomonas fluorescens* (1 hour dip, 10^8 cells/ml), *Bacillus subtilis* (1 hour dip, 10^6 / ml), MPG-3 (2 hour dip, @10 dilution), Carbendazim (0.1 %) and inoculated control with *Fusarium* and uninoculated control.

Plant height (40 to 50 cms), number of leaves (7.66 per plant), number of damaged roots (5.42), number of healthy roots (27.35), maximum root length (31.69 cms), maximum pseudostem girth (22.18 cms), fresh weight of plantlets (320 grams) im MPG-3 treatment were comparable with carbendazim and biocontrol treatments. Thus, the MPG-3 provided encouraging results in pot culture on par with potential biocontrol and chemical control agents. Soil application of MPG-3 provided encouraging results compared with seedling dip. The population of *Fusarium f. sp. oxysporum cubense* declined significantly after 150 days of planting. These results indicate the promise of MPG-3 in eco-friendly and cost effective management of the *Fusarium* wilt. MPG-3 gave protection from *Fusarium* up to three months of planting. Further work is under progress to study effect of different regimes of disease incidence in the field under different environmental and soil conditions.

2.3 Studies on pest Control

The USDA Bureau of Chemistry and Soils published the list of plants found in India possessing insecticidal value in 1931. Puttarudriah & Lakshminarayana Bhatta[5], (during 1935-39) tested the insecticidal properties of 45 species of plants in Mysore (current Karnataka state, India) on 4 caterpillars (*Plutella maculipennis* Curt., *Euproctis fraterna* Moore., *Prodenia litura* Fab., *Crocidolomia binotalis* Zell; surface grasshopper *Epacromia tamulus* Fab; and soft scales (green bug) *Coccus viridis colemani* Kannan. They documented that seeds of *Tephrosia candida* (Papilionaceae) and *Annona squamosa*, stem bark of *Mundulea suberosa* (Papilionaceae) possessed high degree of insecticidal potency. For getting spray emulsions, the hot industrial alcohol extracts of *M. suberosa* bark and *T. candida* seeds have to be mixed with molasses and diluted with water.

3. The documentation of indigenous methods of plant protection as practiced by a few farmers

The leaves of *Lasiosiphon eriocephalus* (Mukudaka) (fam: Thymeleaceae), *Strychnos nuxvomica* (Kasarkayi) (fam: Loganiaceae), *Azadirachta indica* (Bevu) (fam: Miliaceae), *Agave americana* (Kattale) (fam: Amaryllidaceae) are in general used on any pest or disease affected plant. The preparation consists of 1 kg of any of the above leaves in a bucket to which 10 litres of boiling water be added and kept for 24 hours to ferment in sun. The solution is decanted and is ready for spray at 1:10 dilution. In order to control fungal and viral diseases, the leaves of *Acorus calamus* (Baje or Athibaje) (fam: Araceae) be used similarly as above. For the control of bacterial or viral attack of roots of coffee, cinnamon plants, the leaves of *Tragia involucrata* (Turachi balli) (fam: Euphorbiaceae) are similarly used. Farmers listed in addition, the leaves of *Anacardium occidentale* (Gerbeeja) (fam: Anacardiaceae), *Annona squamosa* (Seethaphala) (fam: Annonaceae), *Calotropis gigantea* (Bili ekka) (fam: Asclepiadaceae), *Pongamia glabra* (Honge) (fam: Fabaceae), Piper betle (Veelya dele) (fam: Piperaceae), Lantana tiliaefolia (Lantana) (fam: Verbenaceae), *Acorus calamus* (Baje or Athibaje) (fam:

[5]. M. Puttarudriah and K. Lakkshminarayana Bhatta, 1955, A preliminary note on studies of Mysore plants as sources of insecticides. The Indian Journal of Entomology, Vol.17, Part II, pp.165 to 174.

Araceae) and *Amorphophallus campanulatus* (Suvarna gedde) (fam: Araceae) can be similarly used for pest control. Largely these practices are followed by a group of innovative farmers lead by Sri Purushothama Rao, Progressive farmer, Thirthahalli, Karnataka,India who is advocating use of indigenous methods of agriculture. These practices however need to be subjected to experimentation before acceptance.

4. Implications

It is heartening to note that plant protection experts all over the world are beginning to evince keen interest in the indigenous methods of plant protection. With this knowledge being made available, research endeavors need to be oriented towards validation of the indigenous methods. This calls for funding support for research on the efficacy and complementarity between indigenous and modern methods of plant protection especially in tropical developing countries which are the store houses of indigenous knowledge systems.

SUMMARY

Ancient texts of India - 'Varahamihira Brihathsamhitha' (5th Century AD), 'Vriksha Ayurveda' of 'Lokopakara' (9th Century AD), and 'Vriksha Ayurveda' of 'Sarangadhara Samhitha' (13th Century AD), provide recommendations of the plant protection practices based on indigenous knowledge. They provide indications of an integrated approach to control crop pests and diseases through soil, seed, plant and environmental treatment. The seed treatment with cow dung, milk, juice of Solanum indicum L. (Gulla) (fam: Solanaceae), tender coconut water, Embelia ribes Burm (Vayuvilanga) (fam: Myrsinaceae) and cow ghee is prescribed. As prophylactic measure for disease control, the incense of Embelia ribes (Vayuvilanga), Commiphora wightii (Mahishakshi) (fam: Burseraceae), fish meat, turmeric, mustard, flowers of Terminalia tomentosa (Mathi) (fam: Combretaceae) are mentioned. The prophylactory pest control measure includes soil application of the mixture of Ferula foetida (Ingu) (fam: Apiaceae), Acorus calamus (Baje or Athibaje) (fam: Araceae), pepper, Embelia ribes (Vayuvilanga) (fam: Myrsinaceae), cashew seed, Barleria busivolia (gubbi balli ?) (fam: Acanthaceae) or Chelianthes farinosa (gubbi balli ?) (fam: Polypodiaceae), mustard, cow horn creeper (?) in cow urine.

It is difficult to manage soil borne diseases by any means. In particular it is difficult to control Fusarium pathogen in the soil, since it is soil inhabitant and can remain viable for 50 years, once it enters the soil. Hence it is difficult to control this pathogen by any method including cultural method. In Banana, the panama disease caused by Fusarium is one of the most catastrophic plant diseases in the world. In Karnataka State, India, all the farms growing the variety 'Nanjanagudu Rasabale', once a very tasty and popular variety, have been totally wiped out due to this disease. The ancient knowledge of 'Ayurveda' (Indian system of human medicine) prescribed 'Panchagavya gritha' - preparation from five products of cow viz urine, dung juice, milk, curd and ghee for curing epilepsy, jaundice and fever. Innovations in using 'Panchagavya' to control plant diseases were developed by a team of plant pathologists at UAS found that the fermented, diluted (10^1) filtrate formulation of ghee (2 %), Curds (5 %), Milk (5 %), fresh cowdung (48 %), cow urine (40 %), + common salt (0.25 grams), yeast (0.25 grams) to most effectively control the Fusarium wilt in tomato under pot culture and field conditions. This provided a benefit cost ratio of 21 : 1 compared with Carbendazim (50 %WP) which gave only 4 : 1. This modified 'Panchagavya' formulation effectively controlled the Panama disease of Banana caused by Fusarium oxysporum f. sp. cubens for the initial three months.

The USDA Bureau of Chemistry and Soils published the list of plants found in India possessing insecticidal value in 1931. The insecticidal properties of 45 species of plants in Mysore (southern India) have been tested on 4 caterpillars (Plutella maculipennis Curt., Euproctis fraterna Moore., Prodenia litura Fab., Crocidolomia binotalis Zell; surface grasshopper Epacromia tamulus Fab; and soft scales (green bug) Cocus viridis colemani Kannan. They documented that seeds of Tephrosia candida (Koggi gida) (fam: Papilionaceae) and Annona squamosa (Seethaphala) (fam:Annonaceae), stem bark of Mundulea suberosa (Meenumari) (fam: Papilionaceae) possessed high degree of insecticidal potency. For getting spray emulsions, the hot industrial

alcohol extracts of M. suberosa bark and T. candida seeds have to be mixed with molasses and diluted with water.

It is heartening to note that plant protection experts all over the world are beginning to evince keen interest in the indigenous methods of plant protection. With this knowledge being made available, research endeavors need to be oriented towards validation of the indigenous methods. This calls for funding support for research on the efficacy and complementarity between indigenous and modern methods of plant protection especially in tropical developing countries which are the store houses of indigenous knowledge systems.

Acknowledgements

We dedicate this paper to late Dr. M.N. Lakshmikantha Sastry, Associate Professor of Plant Pathology at UAS, Bangalore for his commitment to the research on indigenous systems of plant protection and for providing the contacts and references for this study on 24th Feb 1995 and passed away just two months later. We are grateful to Professors G.P. Channabasavanna, C.A. Virakthamath, N.G. Kumar, Puttaswamy, Akshay Kumar Chakrawarthy, Department of Entomology; V.S. Sheshadri, S.C.Chandrashekharaiah, Nanje Gowda, and V Muniyappa, Department of Plant Pathology; Ranganath Mangalvedkar, Department of Agricultural Extension, T.N. Prakash and Sri V.K. Arunakumara, Department of Agricultural Economics, Sri Ananda, Department of Soil Science, UAS, Bangalore, Sri Purushothama Rao, Progressive farmer, Kuruvalli, Thirthahalli, and Dr AS Kumaraswamy, Department of Agronomy, UAS, Shimoga for their help in this study.