Experiences with Effective Microorganisms in Disease and Pest Control in Farms and Gardens in India

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Abstract *: AuroAnnam at Auroville has used EM-fermented plant extract (EM-FPE) from locally available plants, some of which are known to have pest controlling properties - for pest management. In exchange with various parties in India, experience with this method has been gathered. It seems that the pest controlling properties of many plants can be enhanced if fermented with EM. Neem tree leaves form the base of all EM-FPEs. Methodology does not satisfy scientific parameters, but seems to be useful for farmers and gardeners and is encouraging everybody to create one's own preparations. This method of pest control is effective and affordable and based on easily available materials.*

Introduction

Indian Scenario

With 329 million ha, India is the seventh largest country of the world. However, measured in terms of cultivable area, India is the richest country in the world. India's cultivable area measures 190 million ha, while USA has 177, Russia has 126, China 124, West Europe as a whole 77 million ha. With 59 million ha of irrigated area, India also has the largest irrigated area - China having 53 million ha and USA 21 million ha - and enough irrigation potential to double it (Bajaj and Srinivas, 2001).

As of 2000 India had a population of 1,094 million people and is the second populous country of the globe. Table 1 compares population in absolute and percentage figures, food grain production in total and per hectare, and volume of food grain available per person, of India, China and USA.

Table 1. Population and Food Grains of India, China and USA

	India	China	USA	Year
Population (in millions)	1,014	1,285	278	2000
% of world population	16.7	21.2	4.6	2000
Food grains (million tons)	197	397	348	1998
Food grains (kg ha?)	1,600	4,100	5,600	1998
Food grains (kg per capita)	201	314	1272	1998

Source : Bajaj & Srinivas (2001)

It has been estimated that agricultural yields in India have over the last seven hundred years decreased. Annual yields of paddy per hectare are estimated to have been 15 to 18 tons between AD 900 and 1200, 20 tons around 1325, 9 tons in 1770, 7.5 tons in 1803, and 5.5 tons in 1993 (Bajaj and Srinivas, 2001). Yield increase from 1950 till today - during the years of the "Green Revolution" - is negligible in comparison to older yield figures.

Indian crops are affected by over 200 major pests, 100 plant diseases, hundreds of weeds, by nematodes, birds, rodents and other animals. Approximately, 30% of the Indian crop yield potential is being lost due to insects, diseases and weeds which in terms of quantity would mean 60 million tons of food grain. The value of the total loss represents about 20% of the gross national agricultural production. Losses of food grains are due to weeds 28%, diseases 25%, insects 23%, during storage 10%, due to rats 8% and 6% due to other reasons (CPCB, 1986).
In 1991 India used 82 thousands tons of pesticides. In regard to pesticide use per acre India is the sixth biggest consumer in the world. The largest use of pesticides is on a non-food crop i.e. cotton (45%), and the second largest is on paddy (30%). Among South Asian and African countries, India is at present the largest manufacturer of basic pesticide chemicals. Insecticides and fungicides account for 92% of the installed pesticide manufacturing capacity, and the scope for growth of the industry is regarded as large (CPCB, 1986).

Auroville

Auroville was founded in 1968 near Pondicherry on the Coromandel Coast of Tamilnadu, India, as an international town dedicated to human unity. It presently has a population of 1,600 people from about thirty nations. Auroville is experimenting many areas, for example, in appropriate building technologies, sustainable energy, in communal economics and education. It has developed a renowned afforestation programme which has turned barren and eroded land into a forest of increasing diversity of fauna and flora. Auroville cannot claim outstanding achievements, but is appreciated for its courage to experiment with innovate approaches in many fields of life.

In the field of farming and gardening, Auroville is following ecological principles, often at the costs of economic viability. AuroAnnam farm has been started to develop and demonstrate exemplary organic cashew nut cultivation as cashew is the prevailing cash crop of the region on which chemical pesticides are being used indiscriminately.

Plants Traditionally used for Pest Control

Indian farmers have been using plant extracts in pest control for centuries. This method of pest control provides an ideal source of low-cost, safe and effective preparations. However, the use of plant products for pest control seems not to be very widespread. Farmers exposed to university-based science and to government-organized advice services have switched over to chemical pesticides. These chemicals cause severe problems to their human users, to beneficial insects and microbes, and to the biosphere at large. And, in spite of them, pests are not being increasingly controlled, but become increasingly more difficult to control (Vijayalakshmi et al. 1999). Amongst the traditional sources for plant-based pesticides are, for example, onion, garlic, and tobacco. Some of the plants, for example *Euphorbia tirucalli*, are typically used as fence plants as they are not eaten by stray animals and cattle.

Various plant parts and extracts of the neem tree (*Azadirachta indica*) belong to the most widely used and the most powerful pest controlling agencies. Neem extracts can influence nearly 200 species of insects some of which are pests resistant to chemical pesticides or extremely difficult to control with them. Neem products do not necessarily kill insects and pests - they are not always biocides or pesticides -, but incapacitate them in several other ways, for example by interfering with development and growth of insects, by deterring them to feed on the host plant, or by deterring them from depositing their eggs. Often, the precise effect is unknown (Vijayalakshmi et al. 1995).

Material and Methods

As Prof. Teruo Higa has pointed out repeatedly, there is a big discrepancy between the complexity of academic research and its usefulness in practical application, in agriculture as well as in science in general. He wrote: "Anything that was valid, anything that was authentic would not need to be presented in a complex manner, but could be written in clear, lucid and precise terms." (Higa, 1996; Higa, 1998) This was the idea behind the work done and its presentation.

The work with EM-FPE was done on farms and in gardens in Auroville and in several other places in India, in part by academically untrained farmers and gardeners, in part under scientific observation, some by NGOs and some by governmental authorities. Experience was gained and immediately passed on. There was no effort to build in controls or to quantify results with scientifically accepted tools of entomology or agriculture.

In response to suggestions of the biodynamic farming method, in particular of Ehrenfried E. Pfeiffer (Pfeiffer, 1970), plant material for the FPEs was also taken from weeds.

In principle, EM was used to ferment locally growing plant material that was known for its medicinal value and for its pest repelling or pest controlling properties, such as neem and *Calotropis gigantea.* Locally available neem oil is of dubious origin and obtained through questionable processing procedures (Vijayalakshmi et al. 1995), therefore only freshly plucked neem leaves and flowers - but no kernels and no oil - were used. All plant material was chopped, immersed with the help of a stone weight in EM solution undergoing extension, and let ferment for about five days under anaerobic conditions. For the production of approximately 20 liters of FPE, the following ingredients were used: 15 liters of water, 3 kg of neem leaves (and flowers), 250 g of each plant material indicated as per table 2, 450 ml of EM stock solution and 450 g of cane jaggery which could be replaced by molasses. Afterwards it was filtered and stored away for use, at least for 90 days.

If, for example, you encounter aphids, mites and stem borer as pests on your crop, you will have to use all the plants mentioned in table 2 which are indicated by "+" under the pest names. If a plant source appears indicated more than once, it is enough to use it once only in the FPE. If the pest is present, sprays should be applied three times per week; subsequently one application is enough as a prophylactic measure.

Results and Discussion

Table 2 gives an overview over controlled pests and used plant material. The following pests and diseases were observed to decrease or be repelled or controlled under use of EM-FPE: In bananas, “black Sigatoka”; in coconut, Eriophyd mite and Rhinozeros beetle; in cashew nut, tea mosquito bug, nut borer, leaf miner, leaf webber, leaf folder, and flower thrips; in vegetables, caterpillars and bugs; in guavas, some fungus - in combination with cow urine; in mangoes, some fungus - in combination with fish meal; in tomatoes and brinjal, bacterial wilt; in orchids, viral, bacterial and fungal diseases; in citrus, gummosis (*Diplodia natalensis*) - in combination with copper sulphate, full recovery; in various fruit trees, *Phytophthora nicotianae* and *Anthracnosis* (*Colletotrichum gloeosporioides*). in a rose garden, termites - in combination with ashes and mulching.

From a cardamom plantation in Kerala it has been reported that thrips and shoot borer incidence went down from 80 - 90% to 30% and 10% respectively, and that capsule rot incidence was less than 1%. It appeared that natural pest enemies were encouraged and helped to control the pests.
EM-fermented FPEs from fruits, weeds and plants with known pest repellent properties have been observed to enhance the efficacy of pest control. It seems that EM is capable of extracting the active ingredients from plants and making them available as pest control agents. It would require controlled testing of EM-FPEs versus plant extracts without EM to determine the percentage of altered or improved efficacy.

The obvious advantages of this method for pest control are as follows: The preparations are biodegradable and ecologically sound. They are effective as a pest control measure and combine this with the additional benefits of EM. Wherever EM is made available at affordable rates, this method will be affordable too. It uses plant resources that are locally available.

Another advantage is that, while plant extracts usually have a very short life span, EM-FPEs keep a pleasant smell and their efficacy for several months. Further, while ordinary extracts are required in big quantities, EM-FPEs are effective in comparatively small quantities. Again, the assessment of quantities and quantity differences will necessitate controlled studies.

Conclusions

In the preparation of EM-FPE using locally available plants with known pest controlling properties, an easily available, effective and affordable pest control method is being found that can be taught to any farmer and gardener. In order to quantify its effect and compare it with other pest control measures and to assess and quantify its cost-effectiveness, controlled studies will be required.

Table 2. EM Fermented Plant Extract (EM-FPE) for Pest Control

Range of Pests Controlled		Host plants	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Common name	**Scientific name**															
America boll worm	*Heliothi Helicoverpa armigera*	Maize, cotton, tobacco, tomatoes, legumes, vegetables		+	+				+			+	+			
Army worm	*Spodoptera litura*	Maize, rice, citrus, vegetables, legumes, crucifers	+	+		+			+			+	+	+	+	
Aphids	All species	Legumes, cucurbits, citrus, etc.	+	+	+		+		+		+	+	+	+	+	
Bacterial diseases									+			+	+			
Black bugs	*Scotinophara spp.*	Cultivated rice, wild rice							+	+						
Brown leaf spot of rice	*Helminthosporium oryzae*	Cultivated rice, wild rice		+		+			+			+				
Bruchids	Stored pulses								+							+
Castor caterpillar	*Achaea janatha*	Castor, rose, pomegranate						+	+							
Caterpillars				+			+		+			+				+
Cockroach	*Periplaneta Americana*													+		
Citrus leaf miner	*Phyllocnistis citrella*	Citrus							+				+		+	
Colorado beetle	*Leptinotarsa decemlineata*								+			+				
Coffee green scale	*Coccus viridis*	Coffee						+	+						+	
Cotton boll worms	*Pectinophora gossypiella*	Cotton							+							
Cotton semi-looper	*Anomis flava*	Cotton	+						+							
Cotton stainer	*Dysdercus cingulatus*	Cotton					+		+			+		+		
Desert locust	*Schistocera gregaria*	Beans, general							+							
Diamond backmoth		*Plutella xylostella*					+	+	+							
False codling moth	*Cryptophlebia leucotreta*								+			+				
Fruit flies	Cucurbits, mango, guava, loquot, etc.								+						+	
Fungal diseases									+	+			+			
Grasshopper surface	*Chrotogonus spp*	Cotton, pulses, millets, etc.					+		+							
Green bugs							+		+							
Green leaf hopper	*Nephotettix virescens*	Rice, wild grasses	+				+		+					+		
Hairy caterpillar	*Amsacta moorei/Euproctis lunata*							+	+							
House fly	*Musca domestica*						+		+			+				
Khapra beetle	*Trogoderma granarium*	Storage cereals and peanuts						+				+			+	
Leaf curl virus	*Viral disease*	Vegetables			+				+				+			
Lesser grain borer	*Rhizophertha dominica*	Storage grains & cassava, flour, meal products	+					+	+						+	

		Host Plants	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Maize stem borer	*Chilo partellus*	Maize							+						+	+
Mango anthracnose	*Colletotrichum gloeoporioides*	Mango		+					+							
Mites	*Tetranychus sp.*	Citrus, tomato, rice, sugarcane, brinjal, papaya, jasmine	+						+			+		+		
Moles									+							+
Mosquito	*Anopheles culicifacies*								+			+		+		
Pest of fruits								+	+	+		+				
Pod borers	*Heliothis armigera*	Pulses							+							+
Potato tuber moth	*Phthorimaea operculella*	Potato							+			+			+	
Powdery mildew disease	*Fungal pathogen*	Cucurbits, chilli, bhendi, others vegetables	+						+							
Pulse beetle	*Callasobruchus chinensis*	Stored pulses such as: cowpea, soyabean, red gram	+	+			+	+	+			+			+	
Red ant	*Oecophylla smaragdina*								+						+	
Red flour beetle	*Tribolium castaneum*	Grains, vegetable powders, oilcakes and nuts	+						+						+	
Red pumpkin beetle	*Aulacophora foveicollis*	Pumpkin					+		+							
Rice weevil	*Sitophilus oryzae*	Storage paddy and rice, wheat, barley, maize	+					+	+						+	+
Rice blast fungi	*Pyricularia oryzae*	Cultivated rice, wild rice							+			+				
Rice brown plant hopper	*Nilaparvata lugens*	Cultivated rice, wild rice			+		+		+						+	
Rice earhead bug	*Leptocorisa acuta*	Cultivated rice, wild rice			+				+							
Rice grasshoppers	*Hieroglyphus banian*	Cultivated rice, wild rice							+	+						
Rice stem borer	*Sciropophaga incertulus*	Rice, maize, sugarcane, millet, wild grasses	+		+			+	+							
Rice leaf roller	*Cnaphalocrosis medinalis*	Cultivated rice, wild rice	+						+							
Root knot nematode	*Meloidogyne javanica spp*	Cotton, sugarcane, chillies, wheat, barley, tea		+	+	+			+	+		+		+	+	
Slugs									+							+
Snails	*Melania scabra*								+							+
Sugarcane shoot borer	*Chilo infuscatellus*	Sugarcane							+		+	+				
Termites (white ant)	*Coptotermes formasanus*								+	+						
Thrips	*Thrips tabaci*	This species infests a whole range of vegetables.		+	+				+			+				
Ticks									+		+	+		+		
Tobacco *mosaic virus*	Marmor tabaci	Chilly							+		+					
White fly	*Bemisia tabaci*	Tobacco, beans, cucurbits, potato, sunflowers, cotton		+	+				+		+	+	+		+	

1. Turmeric (*Curcuma longa*) 2. Ginger (*Zingiber officinale*) 3.Tobacco (*Nicotiana tabacum*) 4. Papaya (*Carica papaya*) 5. Custard Apple (*Annona squamosa*) 6. Vitex (*Vitex negundo*) 7. Neem (*Azadirachta indica*) 8.Calotropis (*Calotropis gigantean*) 9.Onion (*Allium cepa*) 10. Garlic (*Allium sativum*) 11. Aloe (*Aloe barbedensis*) 12.Tulasi (*Ocimum sp.*) 13.Pongam (*Pongamia pinnata*) 14.Euphorbia (*Euphorbia tirucalli*)

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