Village level mass multiplication of biopesticides and their delivery: A review

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Abstract: *Despite using plant protection strategies, one third of crop yield destroyed by pests and diseases annually. Chemical use greatly increased the food production but raised a number of ecological problems and increase resistance in pathogens. Scientist's diversion towards exploring the potential of beneficial microbes for plant protection will be a best solution over it. However only few numbers of biopesticides viz., Trichoderma viride, T. harzianum and Pseudomonas. fluorescens registered against plant diseases as compared to chemical pesticides. Annual availability of these biopesticides is too much low as that of actual requirement. In spite of their high efficacy under lab condition, their performance at farmer's field is not consistent and need support even after their application to get established in targeted niche to give same results as that of chemical pesticides. To overcome problems of availability and proper establishment, an appropriate technology not only for quick multiplication but also for a proper delivery system is necessary at farmer's field. Present article contains the original reviews of this study which is too much important not only for researchers but also for farmers.*

Key words: *Chemical, Diseases, biopesticides, biocontrol agents, antifungal.*

1. INTRODUCTION:

The discovery and use of synthetic chemicals from last three decades has greatly increased the food production but raised a number of ecological problems such as soil, water and environmental pollution (Nakeeran *et. al*., 2005). Non judicious use of chemicals leads to increase in pathogen resistance. Due to all such problems in several cases, the chemicals that were registered for their use in agriculture may not be available and registrations are being lost due to pressure and concerns in general public. Despite the use of available means of plant protection one third of crops produced are destroyed by pests and diseases. In the recent years scientists have diverted their attention toward exploring the potential of beneficial microbes for plant protection measures. Out of 12 biopesticides registered in 2009 under Insecticide Act, 1968, only *Trichoderma viride*, *T. harzianum* and *P. fluorescens* registered against plant diseases in all 221 pesticides. Annual availability of *Trichoderma* sp. is only 500 tonns/yr in India (Kalra & Khanuja 2007) as against 357500 tonns/yr requirement for net cropped area of 143 Mha at general dose of 2.5 kg/ha as soil application. *Trichoderma* sp., *Pseudomonas* sp., and etc are most widely used biocontrol agents since they are reported to have antifungal, anti-nematode, plant growth promoting and plant inducing activities (Zaidi and Singh, 2004).

2. NECESSITY OF EDUCATION AND AWARENESS IN FARMERS:

New strains of pathogens are reported in different parts of the world every year. (Khaskheli *et. al*., 2008; Garibaldi *et. al*., 2009). Chemical pesticides are widely used throughout the world to control theses pathogens. These chemicals mostly prove to be effective and take less time to show results. On the contrary, biopesticides take time to establish themselves in free soil, rhizosphere and rhizoplane and show effect after a complex interaction with the pathogen and the plant (Chakraborty and Chatterjee, 2007) but if these once get established in a proper niche of a crop, shows a long lasting effect not only disease resistance in particular crop but also increasing fertility status of soil. The use of chemical pesticides can not be abruptly stopped but a gradual decrease is necessary. To minimize the ill effects of chemicals, popularization of biological control methods is required. An approach to use chemicals and biological agents in synergism has also been studied. (Mathre *et al*., 1995). Scientists and research organizations throughout the world have made immense advances in agricultural research. It is necessary to communicate these advances to the farmers in the developing and underdeveloped nations through awareness

Let us see the general factors affecting restricted growth of biopesticides and scope of biopesticides for future:

Factors affecting restricted growth of biopesticides	Scope of biopesticides
Erratic availability.	Highly specific
Strong market of chemical pesticides.	Harmless
Slow in action compared to chemicals.	Eco-friendly
Shorter shelf life.	Easy biodegradability
Low reliability because of slow stability in effect.	Pollution free

	Improve soil and plant health Induce resistance Degrade organic matter Make availability of nutrients. Cost effective Persistant effect Component of IPM, NF, SA and OF.

3. MASS MULTIPLICATION:

In fact, by giving little attention towards our ITK (Indigenous Technological Knowledge) the manipulation of microbial inoculums to minimize disease intensity in crop production is not a new strategy. Some of the techniques like, composting, green manuring, crop rotation and intercropping are long established agriculture practices. Among them composting is the natural process of rotting or decomposition of organic matter by microbes under controlled conditions. Raw organic materials such as crop residues, animal wastes, food garbage, some municipal wastes, and suitable industrial wastes enhance their suitability for application to the soil as a fertilizing resource after having undergone composting. Composting was done generally by heap, pit methods from ancient times by the farmers. By taking the idea from ITK recently the scientists in the field of Plant Pathology gave very good innovative technologies for the mass multiplication of already commercialized biopesticides by utilizing very inexpensive and easily available sources such as agricultural waste and organic manures with a commercially available biopesticides culture in the market on farmers own fields.

4. METHODS OF MASS MULTIPLICATION:

***In vitro*/in lab/ commercial level:** 1) Solid state and 2) liquid state fermentation**.**

At village level: 1) Heap method 2) Pit method 3) Bed method 4) Biobin composting.

Delivery systems: 1) seed treatment 2) soil application 3) foliar spray 4)multiple delivery system 5)through drip.

What is the importance of mass multiplication and understanding the use of delivery system is necessary:

- To improve the biopesticides performance.
- To get establishment of biopesticides in targeted niche.
- To understand the efficacy of various delivery system.
- To do effective use of biopesticides.
- Permanent establishment biopesticides in targeted niche.
- Increasing shelf life.
- To overcome problem of erratic availability.
- Increase reliability and acquiring high stability.
- Avoidance of ecological problems.
- Minimize the cost of production
- Achieving high crop yield as that of chemical use.
- Decrease use of chemical pesticides.

5. INEXPENSIVE SUBSTRATES UTILIZED IN THE MASS MULTIPLICATION OF BIOPESTICIDES:

Waste is any substance, solution, mixture or article for which no direct use is envisaged but which is transported for reprocessing, dumping, elimination by incineration or other methods of disposal (Yakowitz, 1988). Substantial amounts of wastes that are generated from various sources including domestic establishments accumulated in natural environment provide an excellent site for colonization and multiplication of microorganisms including fungi. (Mishra *et. al.*, 1996).

Agricultural wastes: Sugarcane bagasse, Sugarcane trash, Groundnut trash, Rice straw, Rice husk, Wheat bran, Wheat husk, Bajra husk, Dry weed, Banana pseudo stem, Dried banana leaves, Dried mango leaves, Chickpea husk.

Organic amendments/ matters are excellent sources of nutrition which favors native antagonist to proliferate and suppress the soil borne diseases (Mukhopadhyay, 1994).

Organic matter: Well decomposed FYM, Seasoned press mud, Poultry manure, Neem cake, Mustard cake, Groundnut cake, Caster cake, Fresh cow dung, Vermicompost, etc.

Press mud

Sugarcane press mud and FYM have been widely utilized for mass multiplication and delivery of the *Trichoderma* biopesticide in soil. Press mud is good substrate and its composition suits well for developing good compost by *Trichoderma*. Press mud helps in establishment of *Trichoderma* in soil and provides protection against different diseases. *T. harzianum* is reported to multiply well on press mud under laboratory and compost pits at farmer

fields. Press mud maximizes the survival of *Azospirillum* spp than lignite, which is predominantly used as a carrier material in India (Muthukumarasamy *et. al*., 1997). Sabalpara (2005) gave an innovative technique for the mass multiplication of *T. viride* along with seasoned press mud (2 lit/120 kg) under shade condition where as pit method using press mud (1ton) + urea (15kg) + cow dung (15kg) in altenate layers was given by (Anon., 2005) and Singh and Joshi (2007) suggested that multiplication of *T.harzianum* is sufficiently rapid in sterilized as well as unsterilized press mud in 21 days of incubation at 30% moisture by heap method with delivery systems by various workers for the farmers.

FYM/Compost

Locke *et. al.* (1984) reported that *Trichoderma* species were excellent biocontrol agents when applied to sterile soil or soilless mix in the green house in chrysanthemum, but not when applied to natural soil. Organic manures such as FYM and Poultry manure were found suitable for the proliferation of *T harzianum* due to the low population of other microflora at all the moisture levels. Singh (2003) recommended multiplication of *T. harzianum* in moist FYM /compost in a farm shade at 25 to 30^0C for 15 days of incubation and can be mixed with more FYM for further multiplication. Mishra (2004) suggested bed method for multiplication of *Aspergillus niger* in moist FYM under shade at normal temperature for 20-25 days of incubation.

Wheat bran and FYM

Wheat bran substrate has been used for multiplication of antagonists by several workers (Henis *et. al*., 1978; Sivan *et. al*., 1984; Singh, 1991). Hadar *et. al.,* (1979) observed that *T. harzianum* in the form of wheat bran culture reduced the damping off of bean, tomato and brinjal caused due to *Rhizoctonia solani.* Application of wheat bran preparation of *T. harzianum* brought out an excellent control of damping-off of tomato and egg plant and wilt and root rot of lentil (Elad *et. al*., 1980). *Trichoderma* spp. have been grown on wide range of grains *viz.,* maize, sorghum, pearl millet, wheat, Jhangora weed (*Echinocloa frumantacea*), wheat bran, wheat straw, waste tea leaves, banana fruit bark, coffee husk, paddy-straw, earth granule impregnated with molasses (Lewis and Papawizas, 1984). Several agricultural wastes / by-products such as tapioca rind and farmyard manure were found to be suitable media for mass culturing of *Trichoderma* (Kousalya and Jayarajan, 1990). Baby and Manibhushanrao (1993) used wheat bran, saw dust substrate for the mass production of *Trichoderma.* Kapoor (2008) recommended wheat bran alone or in combination with FYM (1:1) for the multiplication of *T. harzianum*. He also obtained better results in shelled maize cob powder, maize bran and FYM. Biocontrol agents are formulated in the form of powder using talc as carrier medium by commercial firms.

Cow dung, organic cakes, vermicompost, leaf manure, compost and other organic matters

Pan and Das (2009) found that cow dung with mustard cake followed by groundnut and neem cake were suitable at 10, 20 and 40% concentration while cow dung with vermicompost and leaf manure up to 50% concentration also proved suitable for multiplication of *T. harzianum*. Bora *et. al* (2010) noticed that optimal compost and vermicompost singly or in mixed form supported excellent multiplication of both *T. harzianum* and *T. viride* up to 45 days after inoculation.

Coco-peat

Addition of neem cake in coirpith had been found to be beneficial to *Trichoderma* and could help in reducing infection by *Phytopthora* spp. (Sarma, 2006). Sriram *et. al.* (2010) found that multiplication of *T. harzianum* was sufficiently rapid in sterilized and unsterilized coco-peat in 21 days of incubation at 28^0C temperature. The use of cocopeat enriched with *Trichoderma Harzianum* can be adopted by commercial nurseries for better plant growth and reduced incidence of tomato wilt and chilli root rot while raising disease free and healthy seedlings.

Farm wastes and organic matters

Sibi *et. al.* (2008) found that sorghum seeds, neem cake, decomposed coir pith and FYM increased the population of introduced *T. harzianum* and other fungi within 15 days when used as carrier media. Pandya (2010) found well decomposed FYM and wheat bran were superior for mass multiplication of *T. harzianum*.

Composting of coir pith, weeds, banana sheath and cotton stubbles

Gaur *et al* (1982) have reported the use of microbes in the plant residue compost, due to inoculation, the period of composting was reduced by one-two months and the quality of compost improve similar trends in the banana sheath compostitig were recorded. Balasubramanian *et. al.* (2008) found that triple inoculation of *Bacillus polymyxa*, *Pleurotus sajor-caju* and *T. viride* reduced composting time of Banana sheath by two months with quality compost by increasing the availability of macro and micronutrients. Inoculation of *Trichoderma* sp. reduced composting time of shredded coir pith and weeds by 3-7 weeks in IBS rapid method while inoculation of EM (effective microbes) reduced composting by 4-5 weeks giving good quality compost with full load of effective microbes (Anon., 2003). Instead of burning of Cotton stalks as fuel after picking, it can be utilized effectively with farm wastes from other crops and weeds for preparing quality compost, by using beneficial fungi like *T. viride*. (Anon., 2008a).

6. VILLAGE / URBAN HOME WASTE:

Biobin composting using home waste + biopesticides results in getting rich organic manure (Anon., 2008b).

7. DELIVERY SYSTEMS:

Gohil (1993) advised soil application of *T. viride* multiplied in press mud @ 9 tonns/ha to control sugarcane wilt. Vidhyasekharan and Muthamilan (1995) stated that soil application of peat based formulation of *P.fluorescens* (Pf1) at the rate of 2.5 kg of well decomposed FYM in combination with seed treatment increased rhizosphere colonization of Pf1 and suppressed chickpea wilt caused by Fusarium oxysporum f.sp.ciceris. Zaidi and Singh (2004) suggested application of TH and PsF to soil through FYM @12tonns/ha as most effective for higher plant stand in sugarcane. Gaur *et al* (2005) Found that pre-incubating *T.harzianum* in FYM for 10-15 days before soil application proved better than application of *T.harzianum* alone or a direct application of a mixture of bioagent and FYM to the soil without any pre-incubation. Singh *et. al.* (2008) recommended *Trichoderma* multiplied culture (TMC) in FYM @ 20 kg/ha as soil application to control the red rot of sugarcane. Singh *et. al.* (2010) suggested that application of *T. harzianum Trichoderma* multiplied culture (TMC) in press mud @ 20 kg/ha on the stubbles at the ratoon initiation stage increased the availability of major and micronutrients and led to a considerable increase in organic carbon (55%) with concomitant decrease in soil pH (6%). The level of protection against red rot increased up to 78% in combination with TMC + salicylic acid (SA) and 86% with metabolites + SA where as the protection was 60 and 71%, respectively with TMC and metabolites. Mishra (2004) recommended the application of *A. niger* enriched FYM @ 5 kg and 10 kg / pit before planting and in old plantation of guava, respectively. Kapoor (2008) reported that wheat bran multiplied culture @ 2 g/kg soil was the best in controlling root rot of pea and collar rot of tomato. Sangeetha and Usharani (2010) suggested that combine application of TV3 and TV4 on fruits for 2h @1ml/fruit treatment before pathogen infection for the control of crown rot of banana. Singh (2003) advised seed biopriming with suspension of 10g TH + 10g FYM + 5g gum arabica in 50 ml water for 1 kg seed for 24 hrs + 10gm Psf for rapid and uniform seedling emergence, better growth and protection against seed and soil borne diseases.

8. CONCLUSION:

Farmers can definitely multiply biopesticides like *T.viride*, *T. harzianum*, *P. fluorescens*, *A.niger* etc on their own farm by utilizing very inexpensive sources such as farm and domestic wastes in natural condition within 3 to 4 weeks by adopting indigenous heap, pit or bed methods.

Delivery technologies such as seed biopriming, application of biopesticides based multiplied enriched culture at specific time by suitable method gives rise to proper establishment of bioagent in targeted niche to control plant diseases with increasing availability of macro and micronutrients.

Biobin composting at village and urban home save the pollution in society with getting rich organic manure to the home garden.

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