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"Integrated disease management is a holistic approach in modern agriculture"

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Abstract
Integrated disease management (IDM) is the combination of effective and necessary strategies used to manage plant disease below the economic threshold level. This strategy does not include routine chemical application to prevent disease but promotes cultural, physical, biological and mechanical control practices in a holistic way rather than using a single component strategy proved to be more effective and sustainable. Environmental safety, reduce the cost of cultivation, judicious and limited use of fungicide is the aim of IDM. Bio agents used in IDM strategy act as bio-fungicides as well as plant growth promoters. Prior to the concept of IDM the major thrust for disease management remained focused on near total dependence on the use of fungicides from initiation the green revolution.

Keywords: Integrated disease management, economic threshold level

Introduction
Agricultural chemicals have an important role in the efficient and economic production of wholesome food and fibre products. Agricultural chemicals are also known as pesticides include herbicides, insecticides, fungicides etc. (ACUM, 2005). Pesticide based strategies among the various strategies available for pest management has been so far dominating. Use of synthetic pesticides has led to the emergence of several problems (chemical hazard) like environmental pollution, residual effect in grain and killing of non-target organism(s). Development of resistant strains of plant pathogens are serious problem of ***pest*** management, increase due to the application of only pesticide strategies for ***pest*** management (Kumar, 2014) [18]. Hazard is the inherent property of a substance capable of causing harm *i.e.*, toxicity (Carson and Mumford, 2002) [5].

Plant protective tools play important role in healthy crop production. Modern agriculture mostly depend***s*** on chemicals *i.e.*, fertilizers and pesticides. Indiscriminate use of chemicals in agriculture is risky due to environmental pollution and health hazards to human beings, animals and beneficial microbes. For second green revolution, it is necessary assimilate alternative management strategies which are eco-friendly but sustainable for long duration. Eco-friendly strategies (Integrated Pests Management) *i.e.*, management of pests through bio agents, botanicals and agronomic practices play important role in sustainable agriculture.

Why need of bio agents?
Environmental safety is one of the leading drivers of bio agent usage because chemical pesticides also kill beneficial insects (bees, butterflies etc.) and microbes (*Rhizibium*, entomopathogenic fungus etc.). Non-toxic to non-target organisms, including beneficial insects and wildlife, many bio agents also are biodegradable. They decompose quickly and do not negatively impact surface water and groundwater. Bio agents typically are effective in small a quantity which eliminates pollution concerns sometimes associated with traditional chemicals. In addition, bio agents are manufactured from naturally occurring raw materials in an environmentally responsible and sustainable manner.

Integrated Disease Management (IDM)
The management of disease can be done through cultural *i.e.*, crop rotation (Rani and Sudini,

2013) [27], changing in sowing date (Singh and Singh, 2004, Singh *et al.,* 2008, Singh *et al.,* 2015) [30, 31], destruction of plant debris (Rani and Sudini, 2013) [27], soil solarization (Patel *et al.,* 2014) [25], use of resistant cultivars (Ramakant *et al.,* 2008) [26], chemical (Holi and Meena, 2015) [14], biological management (Bhoye *et al.,* 2011, Biswas *et al,* 2015) [2, 3]. Cultural and biological strategies are mostly effective at initial stage, specially at sowing time of crops and they can not manage the disease in standing crop and even after appearance of disease. Use of resistant cultivar is also reasonable and easy method for disease management but due to development of new strain among the pathogens, resistant may be break down to susceptible one.

Chemical strategy is very effective but also delicate to environmental pollution, residual effect in grain and killing the non-target organisms (Kumar and Singh, 2017) [19]. Development of fungicide resistance in plant pathogens is a major obstacle of chemical strategy when use continuous and separately (Patel *et al.,* 2014) [25]. Therefore, all the methods have some limitations and draw back and due to least efficiency of single strategy of disease management, integration of various strategy (Integrated Disease Management=IDM) is the foremost need for management of plant disease in near future of agriculture. IDM act as safeguarding against the longer term risks of environmental pollution, hazard to human health and reduced agricultural sustainability (Ciancio and Mukerji, 2007) [7].

Cultural practices

Field sanitation

Plant debris, self-sown crops, ratoon crops, collateral (wild hosts of same families) and alternative (Wild hosts of other families) hosts are reservoirs of many plant pathogens. So, sanitation of above materials is helpful in plant disease management. Self-sown rice plants harbour the pathogen (Rice tungro virus) as well as vector (*Nephottetix virescens*). Pathogen of sugarcane mosaic disease is harbor in ratoon crop.

The fungal pathogen for blast disease of rice (*Pyricularia grisea*, Teleomorph: *Magnaporthe grisea*) can infect the grass weeds like *Brachiaria mutica, Dinebra retroflexa, Leersia hexandra, Panicum repens* (collateral hosts) *etc.* and survive during off-season of rice crop.

Temperate regions the alternate host of *Puccinia graminis tritici* (black or stem rust pathogen of wheat), the barberry bush (*Berberis vulgaris*) grows side by side with the cultivated host. In such areas this wild host belonging to a different family is important for survival of the fungus.

Deep summer ploughing

Ploughing the soil during summer months expose soil to hot weather which will eradicate heat sensitive soil borne pathogens. If sunny weather continues for several days or weeks, inactivates or kills many soilborne pathogens such as fungi, nematodes, and bacteria near the soil surface, thereby reducing the inoculum and the potential for disease (Rani and Sudini, 2013) [27]. Soil solarization has been demonstrated to manage soil borne diseases caused by such type pathogens *Rhizoctonia solani, Fusarium* spp., *Pythium* spp., *Phytophthora* spp., *Verticillium* spp., *Bipolaris sorokiniana, Plasmodiophora brassicae, Sclerotium rolfsii* etc. in many crops. Soil solarization has also been shown to significantly decrease the population of disease causing soil borne bacteria. Many nematode diseases caused by *Meloidogyne* spp., *Heterodera* spp. etc.have been successfully controlled by soil solarization (Kumar *et al.,* 2017) [17].

Crop rotation

Pathogens are able to infect susceptible plants by only under certain congenial environmental conditions. A slight change in sowing dates might be escape to this congenial environmental (Singh *et al.,* 2015) [31]. Continuous cultivation of the same crop in the same field helps in the perpetuation of the pathogen in the soil. Soils which are saturated by the pathogen are often referred as sick soils. To reduce the incidence and severity of many soil borne diseases, crop rotation is adopted. Crop rotation is applicable to only root inhabitants and facultative saprophytes, and may not work with soil inhabitants *e.g*., Panama wilt of banana (long crop rotation), wheat soil borne mosaic (6 yrs) and club root of cabbage (6-10 yrs), etc.

Use of resistant variety

Using disease resistance varieties is one of the best disease management practices. With a highly resistant variety, a plant disease can be managed with no added cost and no health risks to the farmer, farm workers or environment. Resistance may be complete on or incomplete. Incomplete resistance is most effective when used in combination with other control methods. Economic and environment safety point of view, use of resistant variety is a cheapest and best method of disease control (Kumar and Tripathi, 2018) [20].

Mixed cropping

Cultivation of multiple crops in the same field at the same time is called as mixed cropping. Mixed cropping is practiced to optimize nutrient uptake, control soil erosion, suppress the epidemic spread of airborne pathogens, and improve crop yields per unit of area (Hiddink *et al.,* 2010) [12]. Root rot of cotton (*Phymatotrichum omnivorum*) is reduced when cotton is grown along with sorghum. Intercropping sorghum in cluster bean reduces the incidence of root rot and wilt (*Rhizoctonia solani*).

Date of showing

Pathogens are able to infect susceptible plants under certain environmental conditions. Alternation in date of sowing can help avoidance of favourable conditions for the pathogens. Rice blast can be managed by changing planting season from June to September/October. Infection of black stem rust of wheat (*Puccinia graminis tritici*) is more in late sowing, hence, early sowing helps in reduction of stem rust incidence.

Seed treatment

Seed treatment is a process like vaccination applied in animal as well as human. Seed treatments, in broad terms, are the application of biological, physical and chemical agents and techniques to seed that provide protection to seeds and plants and improve the establishment of healthy crops.

Fungal bio agents

Trichoderma spp. is an antagonistic cellulolytic fungi has been found effective against aerial, root and soil pathogens (Elad, 2000; Chaube *et al*., 2002; Harman *et al*., 2004) [11, 6, 13]. *Trichoderma* spp *i.e., T. harzianum, T. viride* and *T. virens etc*, isolates from rhizosphere were found to have good antagonistic potential against many soil born fungi, such as *Fusarium oxysporum, Sclerotium rolfsii, Rizoctonia solani*.

Trichoderma spp. produce antibiotics and antifungal toxic metabolites *viz., Trichodermin, viridin etc.* and also inhibit pathogens by secreting enzymes like glucanase, cellulase, chitinase, protease *etc*, which disintegrate the cell wall of pathogen and act as a competetor for mineral nutrients.

Bacterial bio agents

Various species of the genus *Pasteuria* can be used to control nematodes, microscopic worms that feed on plant roots. The species of bacteria is specific to the species of nematode to be controlled. The spores of the bacteria germinate in the nematode, reproducing and causing death. Bio agents are considered important biological weapons of sustainable agricultural in recent years for managing of many soil-borne plant pathogens, which considers an environmentally friendly and sustainable alternative approach for disease management. The obtained results give a potential of the combination of *B. subtilis* and *P. fluorescens* with compost as efficient protection agents against Fusarium wilt of eggplant (Khairy Abdel-Maksoud Abada *et al.*, 2018) [16].

Viral bio agents

A bacteriophage is a virus that infects bacterial cell walls. If the virus attacks bacteria that cause plant disease, it can be used as a pesticide. One example is a product made by Omnilitics to kill *Xanthamonus* (Braverman, 2008). It can replace conventional products include copper or antibiotics such as streptomycin, a commonly used as plant antibiotic. As with bacteria that cause disease in humans, plant pathogenic bacteria develop resistance to antibiotics, and can contribute to the evolution of highly resistant bacterial strains (super bugs) and the cost to develop more potent antibiotics to control them.

Botanicals

Bio pesticides from various plants have a long history. Even in Neolithic period (7000 BC) farmers in their own way prepared pesticides from various plant extracts. It is reported more than 600 plant species in the world can control harmful pests.

Leaf and fruit extract of bael used against pests in certain region of India. Leaf extract of black mustard (*Brassica nigra*) is also considered as pesticide for jute when leaf extract of brown mustard (*B. juncea*) is an important pesticide for paddy burn spot.

Antifungal properties of leaf extracts of *Lawsonia inermis, Erythrinachi apasana, Carissa carandas,Ficus benghalensis, Catharanthus roseus, Nerium oleander, Zingiber officinale, Z. cumini, Ricinus communis* and *Aloe vera)* and *bulb, Allium sativum* extracts at 2 and 5% concentration were evaluate against *A. brassicae.* Maximum inhibition of mycelia growth of the pathogen was found from extract of *A. sativum* at both concentrations, followed by the extracts of *L.inermis* (30.0%), *E. chiapasana* (25.5%), *R. communis* (16.8%) and *Z.officinale* (16.3%) at 5% each (Meena and Sharma, 2012) [23].

References

1. Agricultural chemical user's manual. Queensland Government, Department of Primary Industries and Fisheries (ISBN:0734503210), 2005.
2. Bhoye BB, Raut SA, Pawar NB, Mondhe MK. Evaluation of culture filtrates of non-pathogenic isolates on mycelial growth and sporulation on pathogenic isolates of *Alternaria lini*. Asian Journal of Bio Science. 2011; 6(2):159-164.
3. Biswas SK, Shanker U, Kumar S, Kumar A, Kumar V, Lal K. Impact of bio-fertilizers for management of spot bloch disease and growth and yield contributing parameter of wheat. Journal of Pure and Applied Microbiology. 2015; 9(4):3025-3030.
4. Bryan MK. Studies on bacterial canker of tomato. J Agric. Res. 1930; 41:825.
5. Carson P, Mumford C. Hazardous Chemicals Handbook. Butterworth-Heinemann, Oxford, 2002.
6. Chaube HS, Mishra DS, Varshney S, Singh US. Biological control of plant pathogens by fungal antagonistic: Historical background, present status and future prospects. Annu. Rev. Plant Pathol. 2002; 2:1-42.
7. Ciancio A, Mukerji KG. eds., General Concepts in Integrated Pest and Disease Management. Springer, Netherland. 2007, XV.
8. Dhaliwal GS, Arora R. Integrated pest management. Kalayani publishers, 2006.
9. Dhawan AK. Major insect pests of cotton and their integrated management. In: R. K. Upadhyay, K. G. Mukerji and O. P. Dubey (eds.) IPM System in Agriculture. Cash Crops. Aditya Books Pvt. Ltd., New Delhi. 1999; 6:165-225.
10. Dunleavy J. Stunt disease of soybean caused by *Corynebacterium* sp. Phytopathology. 1962; 52:730.
11. Elad Y. Biological control foliar pathogens by means of Trichoderma harzianum and potential modes of action. Crop Protect. 2000; 19:709-714.
12. Gerbert A, Hiddink, Aad J. Termorshuizen, and Ariena H.C. van Bruggen. Mixed Cropping and Suppression of Soilborne Diseases. *In:* Genetic Engineering, Biofertilisation, Soil Quality and Organic Farming, Sustainable Agriculture Reviews 4(Lichtfouse, E., ed.). Springer, 2010, 119-146.
13. Harman GE, Howell CR, Viterbo A, Chet I, Lorito M. *Trichoderma* species opportunistic, avirulent plant symbionts. Nature Reviews. 2004; 2:43-56.
14. Holi SK, Meena S. Management of Alternaria blight of linseed (*Linum usitatissimum*) caused by *Alternaria lini*. Journal of plant science research. 2015; 31(1):47-50.
15. Hosford R. M., Jr. White blotch incited in wheat by *Bacillus megaterium* pv. *cerealis.* Phytopathology. 1982; 72:1453.
16. Khairy Abdel-Maksoud Abada, Amany Mohamed Farouk Attia, Ibrahim Abdel-Moneim El-Fiki. Bacterial Bioagents and Compost as Two Tools for Management of Eggplant Fusarium Wilt. Frontiers in Environmental Microbiology. 2018; 4(1):1-10.
17. Kumar A, Azad CS, Kumar R, Kumar R, Imran M. Soil Solarization: An eco-friendly and effective disease management approach for soil borne diseases. Journal of Pharmacognosy and Phytochemistry. 2017; SP1:513-515.
18. Kumar N. Studies on compatibility and sensitivity of *Trichoderma viride* against common pesticides. M.Sc. (Ag) Thesis, 2014, 4.
19. Kumar N, Singh SK. Screening of tolerance and compatibility of *Trichoderma viride* against common fertilizers and fungicides. International Journal of Chemical Studies. 2017; 5(4):1871-1874.
20. Kumar N, Tripathi UK. Screening of linseed germplasm for resistance against *Alternaria* spp. cause blight disease in linseed (*Linum usitatissimum* L.). Journal of Pharmacognosy and Phytochemistry. 2018; 7(1):1389-

1392.
21. Larson RH. The ringrot bacterium in relation to tomato and eggplant. J Agric. Res. 1944; 69:309.
22. Mathur RS, Ahmad ZU. Longevity of *Corynebacterium tritici* causing tundu disease of wheat. Proc. Natl. Acad. Sci. India Sect. B. 1964; 34:335.
23. Meena PD, Sharma P. Antifungal activity of plant extracts against *Alternaria brassicae* causing blight of *Brassica* spp. Annals of Plant Protection Sciences, 2012; 20(1):256-257.
24. Pape H. *Krankheiten und Schadlinge der Zierpflanzen und ihre Bekampfung*, 5th ed., Paul Parey, Berlin, 1964, 625.
25. Patel N, Desai P, Patel N, Jha A, Gautam HK. Agronanotechnology for Plant Fungal Disease Management: A Review, International Journal of Current Microbiology and Applied Sciences. 2014; 3(10):71-84.
26. Ramakant, Chauhan MP, Singh RB. Screening of linseed genotypes against Alternaria blight and bud fly. Crop Res. 2008; 35(1&2):124-127.
27. Rani VD, Sudini H. Management of soilborne diseases in crop plants: An overview. International Journal of Plant, Animal and Environmental Sciences. 2013; 3(4):156-164.
28. Scharif G. *Corynebacterium iranicum* sp. nov. on wheat (*Triticum vulgare* L.) in Iran and a comparative study of it with *C. tritici* and *C. rathayi. Entomol.* Phytopathol. Appl. Teharan. 1961; 19:1.
29. Schuster ML, Hoff B, Mandel M, Lazar I. Leaf freckles and wilt, a new corn disease. *Proc. Annu. Corn Sorghum Res. Conf.* (Chicago). 1963; 27:176.
30. Singh N, Plat R, Dabbas MR, Chandra DR. Effect of date of sowing on yield and disease intensity of Alternaria blight in linseed. International Journal of Plant Protection. 2008; 1(2):38-39.
31. Singh RB, Singh RN. Occurrence and management of Alternaria blight of linseed in eastern India. Pl. Dis. Res. 2004; 19:120-124.
32. Singh V, Lal M, Kumar S, Ali M, Singh J. Management of Alternaria blight of linseed with sowing dates and host resistance. Universe of Emerging Technologies and Science. 2015; 2(5):1-4.