Can organic farming be a game changer for management of soil borne pathogen?

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Abstract: To manage crops and animals, organic agricultural systems emphasize the use of naturally occurring ecological processes rather than external inputs. Insect, pest, and weed control are all emphasized in these agricultural systems. Biodiversity is a critical component of organic farming systems that ensures their effectiveness. Permaculture, Panchagavya farming, Rishi Krishi, Natueco farming, Zero budget natural farming, Biodynamic farming, and other organic farming systems are popular. There is a wealth of literature and supporting materials available to support the use of these agricultural systems to fight soil pollution caused by chemical use. When it comes to scientific explanation, however, the work is dispersed. Organic farming has been identified as an alternative soil borne pathogens. Organic farming (OF) has become more popular in recent decades. Disease control in OF is mainly based on maintaining biological diversity and soil health through balanced crop rotations, which include nitrogenfixing and cover crops, intercrops, manure and compost additions, and reduced soil tillage.

Introduction:

Organic farming (OF) is described as "an environmentally, economically, and socially responsible method of farming that provides a lasting supply of safe and balanced food and fibres with the least possible losses of nutrients and resources, and the least negative environmental impacts, as governed by certification agencies" (Finckh MR2015)(van Bruggen

AHC2015). Between the two World Wars, 'modern', chemical-intensive, technologically advanced agriculture faced a crisis in the form of land erosion, low food quality, and the decline of rural social life and customs. Organic farming proponents presented a compelling, sciencebased hypothesis as a solution to this problem in the 1920s and 1930s, which became a popular farming method in the 1930s and 1940s. Organic farming did not gain prominence in the broader realms of agriculture, society, and politics until the 1970s, when there was an increasing awareness of an environmental problem. A scientific philosophy of soil fertility, intensification of farming by biological and ecological advances, renunciation of chemical fertilizers and synthetic pesticides to increase food quality and the environment, and finally, principles of appropriate animal husbandry were among the leading methods suggested to achieve sustainable land use. Over the last 20 years, the consumer demand for organic products has grown dramatically, even in developed nations, and the global market for organic products was worth nearly $US72 billion in 2013 (Willer H and Lernoud 2015). Organic farming is based on the premise that all natural processes in an agroecosystem are interdependent, and that management should strive for and promote self-regulation by natural processes (Dubois D *et al.*, Birkhofer K 2008). This is detailed in the International Federation of Organic Agricultural Movements' (IFOAM) organic farming principles. The key purpose of an organic farming method is to efficiently use local and sustainable resources, to allow productive use of solar energy for processing, to increase the biological system's capacity, to improve soil fertility, to recycle plant nutrients and organic waste, to preserve sustainability in the production system and in the agricultural landscape, and to avoid using chemicals of any way. Crop rotations, crop residues, livestock manures, legumes, green manures, off-farm organic wastes, mechanical agriculture, minerals bearing rocks, and biological pest management are all used to sustain soil fertility and tilth, provide plant nutrients, and control mosquitoes, disease, and weeds to the fullest degree practicable in organic farming systems (Ram and Pathak, 2018). Modern methods such as the use of resistant host cultivars and synthetic fungicides are often unsuccessful in managing soilborne fungal and oomycete plant pathogens, which are among the major factors restricting agro-ecosystem productivity. The lacks of effective chemical controls, as well as the incidence of fungicide resistance in pathogens, are both factors to consider. As well as pathogen species breaking or circumventing host resistance (McDonald and Linde, 2002). In this sense, eco-sustainable modern agriculture faces a challenge in seeking solutions that are high-efficiency, low-cost, and have a low environmental impact.

Chemical modifications such as animal manure, green manure (the introduction of crop residues into the soil), composts, and peats have been suggested to increase soil composition and productivity of both traditional and biological agriculture systems (Magid *et al.*, 2001; Conklin et al. 2002; Cavigelli and Thien, 2003) and minimize disease caused by soilborne pathogens (Litterick *et al.*, 2004; Noble and Coventry, 2005). Conventional farming (CF) has encouraged outbreak growth of many plant diseases caused by fungi, bacteria, nematodes, and viruses because of monocropping of genetically uniform varieties and high external inputs (Berkelmans R *et al.*, 2003; Finckh MR and Wolfe MS, 2015; van Bruggen AHC and Termorshuizen AJ,2003; van Bruggen AHC and Semenov AM, 2015). The degradation of soil structure and soil content by lack of soil organic matter favors root diseases. Soil fumigation provides a biologically impoverished, substrate-rich ecosystem favouring the explosive growth of plant pathogens that happen to penetrate the fumigated soil. Furthermore, elevated nitrogen levels and nutritional imbalances make plants more susceptible to a number of root and foliar pathogens (Datnoff LE et al., 2007). We identify the different disease control options available in organic farming in this study, which may be helpful to other farmers and researchers pursuing greater ecological sustainability. We go through the methods used to control disease progression and make some recommendations for future studies on plant disease management in organic farming.

Types of organic forming

Permaculture, Rishi Krishi, Panchgavya, Natueco, Zero Budget, Natural Farming, and Biodynamic Farming are some of the organic farming systems used in different parts of the country and around the world.

Permaculture: is an agricultural technique that is based on the trends and features found in natural habitats. Permaculture was used to describe "permanent agriculture," but it has since been extended to include "permanent culture." (en.wikipedia.org/wiki/Permaculture).
Permaculture's three basic values are:

• A healthy world so that all living systems can continue to thrive and reproduce.

• All human beings should have access to natural resources.

• Recycling of agricultural waste

Panchagavya: is a mixture of five cow-derived ingredients, including dung, urine, milk, curd, and ghee, mixed thoroughly and fermented for seven days with occasional stirring (NCOF, Ghaziabad). Since the time of the Puranas (c. 200 BCE to c.750 CE), Hindus have known how to render and use fresh Panchagavya for house purification after deaths.

Panchagavya is generally prescribed for all crops as a 3 percent foliar spray (3 litres Panchagavya in 100 litres of water), in irrigation water (50 litres for one hectare), as dipping seed and planting products, or before seed storage. (Nene 2017).

Rishi Krishi: Farmers from Maharashtra and Madhya Pradesh established Rishi Krishi, a natural farming system. There are four activities that make up this system (rishikrishi.co.in).

1. Angara (banyan tree rhizosphere soil): Per acre of farmland receives fifteen kilograms of soil from the rhizosphere of the banyan tree.

2. Amritpani: To make Amritpani, combine 250 g of ghee from an indigenous breed cow, half a kilogram of honey, and ten kilograms of fresh cow dung from a desi cow in 200 liters of water. Sugarcane, turmeric, and ginger should be dipped in Amritpani before planting, and if seedlings are transplanted, the roots should be dipped in Amritpani before planting, according to the proponent of this agrisystem.

3. Beej sanskar (seed dressing): 1 kg banyan tree (Angara) pulp mixed with enough amritpani to produce a thick paste. Apply the paste to hard-coated seeds, dry them in the shade, and store and use them as required, while thin-coated seeds, such as hemp, cereals, moong, and groundnut paste, are sprinkled over the seeds and used right away.

4. Acchadana (Mulching): Mulching can be done in three ways:

I Soil mulch: Which is used to shield the surface soil from tillage. It increases soil aeration and water preservation.

(ii) Straw mulch: Straw mulch is usually dried biomass waste from previous crops.

(iii) Symbiotic intercrops and mixed crops are referred to as "live mulch." Multiple cropping patterns of monocots and dicots cultivated in the same area are recommended to provide all necessary nutritive elements to the soil and crops. (rishikrishi.co.in, Nene 2017).

Bijamrit: Seed dressing and root dipping are also performed with bijamrit. It's made according to the following procedure: 50 g cow dung, 50 ml cow urine, 50 ml fresh cow milk, 2 g lime mortar, and 2 g water (1 liter). In a plastic pot, all of the ingredients are carefully combined and left to ferment overnight. (http:ncof. dacnet.nic.in).

Application: It is used to handle every crop's seeds. Seeds are coated with bijamrit and allowed to dry after being thoroughly mixed by hand. Sowing was done with dried plants. It aids in the defense of young roots against fungi, as well as soil and seed-borne disease.

Jeevamrit: is a microbial culture that has been fermented. It is made by combining cow dung (5 kg), cow urine (5 litre), pulse flour (1 kg), fertile soil (1/2 kg), and water (50 litre) in a plastic drum and fermenting it for 5 to 7 days with regular stirring with a wooden stick (http:ncof.dacnet.nic.in). The aerobic and anaerobic bacteria found in cow dung and urine reproduce during the 48-hour fermentation period when they decompose the organic ingredients (like pulse flour). As natural microflora, a handful of virgin soil is also added. Jeevamrit also assists in the treatment of bacterial and fungal plant diseases. (Nene 2017).

Application : It is added to the crops twice a month in irrigation water or as a foliar spray at a concentration of 10%. It assists in the control of bacterial and fungal plant disease. One acre of land can be covered with 200 litres of jeevamrit**.**

Management of plant disease in organic agriculture:

In Organic farming, pest and disease management is largely dependent on maintaining soil productivity by balanced crop rotations that include nitrogen-fixing crops, winter cover crops, intercrops, manure and compost additions, and reduced soil tillage (Hasna MK *et al.*, 2007; van Bruggen AHC, (1995); Yogev A. *et al.*, 2009). When compared to traditional management, crop rotations are typically longer and geographical variation is greater under organic management (Leoni C, Rossing WAH and van Bruggen AHC, 2015). Crop sequences are tweaked to increase nutrient supply while reducing herb, disease, and insect threats (Finckh MR and Tamm L, 2015; Leoni C. et al., 2013). Genetically modified organisms (GMOs) are not used, partially due to worries about the uncertain consequences of gene editing, but also to prevent genetic uniformity, which would lead to insect and disease outbreaks (van Bruggen AHC and Finckh MR, 2015; Finckh MR and Wolfe MS, 2015). As a result, crop safety in Organic farming is focused on environmental conservation rather than direct pathogen control, allowing plants to survive future attacks (Letourneau D and van Bruggen AHC, 2006). Cultural plant defense is widely used by organic farmers (van Bruggen AHC and Termorshuizen AJ, 2003; Grünwald NJ, Hu S and van Bruggen AHC, 2000; Lithourgidis AS, *et al.*, 2011). The use of organic amendments and manure instead of conventional fertilizers would result in a microbially based environment and improvements in micronutrient supplies. This can have a big impact on plant resistance and the soil's pathogen-beneficial microbial equilibrium (Datnoff LE. *et al.*, 2007; Bonanomi G. *et al.*, 2007; Dordas C, 2008). There are some strategies to minimize disease effect as discussed below,

Strategies for before planting:

When soil-borne diseases and pests endanger plant establishment and survival, treatment and soil disinfestation may be used to try to eliminate the pathogens and pests. Soil disinfestation can alter the ecology of the soil, with the goal of eliminating fungi, bacteria, nematodes, and weeds. As long as artificial pesticides are not used, many methods of soil disinfestation can be used in Organic farming, including irrigation, soil steaming, solarization, biological soil disinfestation, and biofumigation. Due to a shortage of water in most regions, flooding is seldom used. Soil steaming is rarely used in organic greenhouse processing, but it goes against certain organic farmers' production values because it produces a biological void in the soil (van Bruggen AHC, 2015). Sanitation is an important preplant step in reducing the initial inoculum of plant pathogens. For eg, winter pruning or improving the breakdown of apple leaves after applying an N-rich organic fertilizer (such as a by-product of the sugar industry, vinasse) in the fall and winter minimize the initial inoculum of Venturia inaequalis, the causal agent of apple scab(Holb IJ, *et al.*, 2010). Crop residues with overwintering inoculum are usually extracted in organic greenhouse processing. The residues are regularly composted, and daily turning of the composting materials is needed to reach sufficiently high temperatures to destroy residual pathogens (van Bruggen AHC and Finckh MR, 2015). Crop stubble is prized in organic fields and can never be burnt to avoid the depletion of organic carbon in the form of CO2. Shallow incorporation of the debris to provide substrate for the soil food web or leave it on the surface for slower decomposition to avoid erosion are better alternatives to burning. Cull dumps of diseased plants, on the other hand, must be avoided. This is particularly true for potatoes infected with Phytophthora infestans, which causes late blight(Zwankhuizen MJ. *et al.*, 2000). Covering or removing cull piles, as well as removing volunteer potatoes and alternate hosts, is much more critical for organic farmers to manage late blight than it is for traditional farmers, since other management methods are restricted in Organic farming.

Soil solarization:

Soil solarization involves coating saturated soil with a sheet of translucent plastic and exposing it to sunshine for a few weeks during the summer. Stretched around the field are sheets of transparent, UV-stable polyethylene-based plastic that are stuck together at their joints (Gamliel A and Katan J, 2012). Temperatures of 45–50°C can be achieved to a depth of 10–15 cm under a single layer of plastic in the field, and temperatures of 40–45°C to a depth of 15– 30 cm under a double layer (in the open field) or a single layer within a closed greenhouse, but soil temperatures can be raised by an additional 5–8°C under a double plastic layer (in the open field) or a single layer inside a closed greenhouse (Gamliel A and Katan J, 2012). The process has also been applied to outdoor vegetable production in raised beds mulched with polyethylene, as well as greenhouse and perennial crop production (Butler DM, *et al.*, 2012; Chellemi DO, 2002; Chellemi DO, 2015; Vitale A. *et al.*, 2011). Soil solarization inhibits soilborne pathogens and pests both directly and indirectly by raising their susceptibility to antagonistic microorganisms and abiotic stresses by heat inactivation of cellular processes. It can also improve plant growth by increasing mineral nutrient supply and enhancing soil tilth. In the upper solarized soil layer, root-knot and cyst nematodes are vulnerable (killed at 45– 50°C). They can, however, withstand solarization in deeper soil layers (40 cm). But for heattolerant species (55–65°C), most plant-pathogenic fungi and bacteria are (45–55°C) very susceptible (Chellemi DO, 2015; Klein E, Katan J and Gamliel A, 2011; Yildiz A. *et al.*, 2010). Most plant viruses are inactivated in the range 55–70 ▫C, and most weed seeds are killed between 50 and 60 ▫C, but again there are some exceptions (Noble R. *et al.*, 2011). The implementation of solarization involves addressing aspects of soil planning, tarping and plastics technology, which are important for achieving efficient solarization. The need for implementation methodologies adapted to each solarization niche, such as open field, closed greenhouse, strip or bed solarization, has contributed to the development of advanced devices, such as soil heating plastic films (Gamliel A and Katan J. 2012; Gamliel A, 2015). Furthermore, by using specialized equipment, advanced glues, and other plastic welding techniques, the technologies for laying the plastic and anchoring it to the soil have greatly improved (Gamliel A and Katan J. 2012; Gamliel A, 2015).

Mitigation of pathogen entry in organic crops:

If certified organic suppliers are available, seeds and planting materials used in organic crop production must come from them (Lammerts van Bueren ET. *et al.*, 2003). Seeds from organically grown fruits must be harvested naturally, such as by fermentation. Alternative seed treatment methods have been studied since chemical seed treatment after extraction is banned (Kasselaki AM. *et al.*, 2011; Schmitt A. *et al.*, 2009). Physical processes, treatment with plant or microbial extracts, and seed coating with biological control agents are the three primary seed treatment methods for organically grown plants (Finckh MR *et al.*, 2015; Roberts DP. *et al.*, 2014). Hot water or steam treatment, accompanied by drying, may be used as physical processes (Finckh MR *et al.*, 2015). Furthermore, numerous seed sorting machines have been designed to eliminate immature or diseased seeds (Lammerts van Bueren ET. *et al.*, 2003). To protect organic seeds from fungal and bacterial contamination, a variety of biocontrol agents and plant extracts are commercially available (Caldwell B. *et al.*, 2013).

Spatial and Temporal Isolation:

Susceptible host plants may be isolated in time or space to create a shield against pathogen propugules aggregation.

Temporal Isolation:

Choosing early maturing cultivars or alternating with crops that aren't prone to the pathogen in question is two choices. Planting dates may be changed to prevent heavy aphid flights or cycles when other diseases are at their highest by planting at the right time of year or maintaining sufficient crop growth (Finckh MR *et al.*, 2015).

Crop rotation, the most popular method of temporal isolation, avoids inoculum buildup and enables different pathogens to naturally decline amongst host crops (Finckh MR *et al.*, 2015). A multiyear grass ley, grass-legume ley, or an alfalfa crop are often used in organic rotations, both of which contribute to the creation and preservation of a good soil (Finckh MR *et al.*, 2015; van Bruggen AHC, Termorshuizen AJ. 2003). Crop rotation, on the other hand, has a small impact on disease growth whether the pathogen is transported long distances by wind, has a wide host variety, or has extremely persistent resting structures.

To minimize the risk of disease outbreaks and nematode damage in the following cash crop, cover crops in the rotation that are used for nitrogen fixation or nitrate leaching must be carefully selected. Even if a cover crop is not susceptible to a pathogen in terms of symptom growth, the pathogen will replicate in the root cortex, increasing the initial inoculum for a subsequent susceptible host crop (Leoni C. *et al.*, 2013). Furthermore, cover crops, especially legumes, must be rotated. Any cover crops are used as nematode traps or allelopathic crops. Crotalaria spp., Mucuna spp., Tagetes spp., and some brassicas, for example, may be used for this (Finckh MR *et al.*, 2015; Matthiessen JN, Kirkegaard JA. 2006).

Spatial Isolation:

Tillage, planting barrier crops around fields, or planting nonsusceptible crops between susceptible ones will all help to separate the pathogen from a susceptible host plant. Separation can be achieved on a variety of scales, and the distance between susceptible patches or plants expected to delay disease transmission is determined by the inoculums travel distance (Thrall PH, Burdon JJ. 1999). In Organic farming, a mosaic of crops is commonly planted to satisfy multi-year crop rotations. Land separation by natural vegetation (to increase parasitoids and predators for insect vector control) is also normal, limiting the spread of epidemics (Finckh MR *et al.*, 2015; Letourneau D, van Bruggen AHC. 2006). Natural vegetation and weeds around cropping areas, on the other hand, can harbor pathogens and pests or create a diseasefriendly microclimate. Many organic farmers are aware of this possibility, and they selectively eradicate weeds inside and between crops, as well as manage hedges, to prevent pests and diseases from spreading into their crops. Spatial isolation may also be described as preventing viruliferous vectors from probing a possible host. This can be achieved by using aphidrepelling mulches such as straw or synthetic mulches, as well as aphid-repelling oils (Saucke H, Doring TF. 2004; Schuster DJ. *et al.*, 2009; Stapleton JJ, Summers CG. 2002). Artificial mulches that reflect light, like UV, are the most effective at confusing aphids and whiteflies (Polston JF, Lapidot M. 2007). The texture of straw, on the other hand, confuses the aphids' tactile senses (Saucke H, Doring TF. 2004). Whiteflies may be drawn to the hot film by reflective yellow mulch, resulting in death (Gamliel A, Katan J. 2012).

Host plant resistance:

For a number of factors, many organic farmers prefer open pollinated cultivars over hybrids (Lammerts van Bueren ET, Struik PC, Jacobsen E. 2003). When diseases threaten crop production, organic farmers try to use the most disease-resistant varieties available, such as potato cultivars that are more resistant to late blight (P. infestans) and grow earlier to prevent epidemics (Kuepper G, Sullivan P. 2004). Organic farmers favour cultivars with partial tolerance dependent on several genes, which can also be successful if pathogen burden is decreased. While a developing pathogen can often resolve dominant single-gene resistances, recessive qualitative resistances can be very robust (van Bruggen AHC. *et al.*, 2014). The resistance to barley mlo powdery mildew, which has not been solved since its arrival in 1976 (Finckh MR, Wolfe MS. 2006), the resistance to F. oxysporum f. sp. conglutinans in cabbage, which has been effective since the 1920s (Parlevliet JE. 2002), and the resistance to corky root of lettuce caused by R. suberifaciens, which has been effective since the 1980s (van Bruggen AHC. *et al.*, 2014), are all notable examples. There are no horticulturally suitable resistant cultivars for some of the most destructive plant diseases, such as tomato late blight and white rot (Sclerotium cepivorum) of Allium types. The growth of disease-resistant perennial crop cultivars that grow in organic conditions is critical (Jamieson AR. 2006). Fortunately, resistance cultivation of apple trees and grape vines has made significant strides.

Plant phenotype and physiology, specifically the nutritional content of a plant, can be controlled to some degree to mitigate pathogen and insect vector suitability (Datnoff LE. *et al.*, 2007). Through controlling the condition of the food supply for pathogens or pests, as well as the development of toxic or repellent chemicals, management practices may improve or minimize host plant resistance (Letourneau D, van Bruggen AHC. 2006). In addition, bacteria and fungi in the rhizosphere can cause systemic resistance to plant pathogens and some insect pests (Vallad GE, Goodman RM. 2004). Certain organic amendments, such as composts, can promote induced system tolerance, which can offer modest levels of resistance to a wide variety of pathogens. Pathogens and externally applied chemical compounds such as salicylic acid and potassium phosphite (Vallad GE, Goodman RM. 2004), on the other hand, can cause systemic acquired resistance, although these products are not approved for organic production (Finckh MR *et al.*, 2015).

Conclusion:

Bacteria, fungi, actenomycete, N-fixers, and Psolubilizers are all found in greater abundance in liquid organic preparations. According to the researchers, beejamrutha should be used on the day of preparation, while jeevamrutha should be used 9 to 12 days after preparation. The use of these liquid formulations will complement the use of biofertilizers, and they are simple to prepare. Increased crop diversity in time and space, as well as the use of natural vegetation, barrier and cover crops, will help to slow the spread of many plant diseases. Soil-borne diseases, including fungus- and nematode-transmitted virus diseases, are routinely suppressed in OF after a transition period of about 5 years, assuming crop rotation is sufficiently long.

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