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Integrated disease management of underutilized vegetables

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Abstract
People have mostly followed a vegetarian diet for centuries, yet numerous diseases in vegetables cause a person to suffer a significant loss in a variety of ways. Vegetarians make for 38% in India, which ranks highest in the world. Disease can strike at any point in the life cycle of any vegetable, whether it's before or after harvest. To enjoy a superior flavour with nutrients, vegetables should be preserved throughout their life cycle. Bacteria, fungus, virus, and nematodes are the four main pathogens that cause diseases in Underutilized vegetables. To now, isolated farmers have relied on conventional methods to prevent diseases. To protect the Underutilized vegetable, it is important to identify the disease as soon as possible before beginning treatment. Pesticides and chemicals are used to ensure that Underutilized vegetables are disease-free. To produce Underutilized vegetables disease-free without using chemicals or pesticides, an integrated technique should be used all over the world. It can be utilised for organic plants in the future to manage all pathogen-caused illness while also being cost-effective, making it suitable for all distant farmers. Sound structure and healthy plants are aided by integrated disease management. It lowers the need for pesticides and fungicides by employing a variety of management techniques, as well as the risk of pollution of the air and ground water. It solves the problem of pesticide residue. IDM's success and long-term viability are heavily reliant on their participation in developing regionally unique techniques and solutions that are appropriate for their agricultural systems, as well as combining environmentally sound and easily available control components. Farmers, disease surveying teams, agricultural extension officers, extension workers, and policymakers must all be trained and informed in order for IDM policies to be implemented successfully.

Keywords: Underutilized vegetables, IDM, disease, loss, life cycle

Introduction
Plant diseases are important to investigate because they lead to damage of plant life and yield. Various forms of losses can arise as in field, and storage, or at any point during sowing and harvesting. Direct monitory damage and material loss are caused by the diseases. Plant diseases continue to cause agony to billions upon billions of people around the world, resulting in an estimated annually crop losses of 14% and an international trade loss of $220 billion dollars. Plants were afflicted by several diseases 250 million years ago, according to fossil evidence. Plant disease has already been linked to a number of significant events throughout human history. Diseases are thought to be responsible for 30-50 percent of crop losses.
Disease is a malfunctioning activity in a plant that develops as a result of biotic and abiotic stress and can occur at any stage of the plant's life cycle, resulting in severe plant damage. Disease-causing organisms (biotic) include bacteria, viruses, fungi, nematodes, Viroid's, phytoplasma, and parasitic plants, as well as (abiotic) conditions such as a lack or excess of moisture, nutrients, light, and the presence of harmful substances in the air and soil. All crop plants are subjected to biotic and abiotic stress to varying degrees. Three conditions are required for disease development: a susceptible host plant, a live pathogen, and a favorable environment. (Farwah *et al.*, 2009) [4].
Integrated disease management {IDM} concept is successfully derived from the integrated pest management which intended to manage the plant diseases by considering divergence approaches depending on the path system, season and geographical location of the crop. IDM is an Endeavor to promote natural, economic, and biological farming ways through the most successful mix of agricultural techniques and accurate use of limited fungicide, which is a better alternative to the traditional use of chemicals. It's vital to consider a pathogen's ability to repopulate and disseminate in the crop when it comes to disease control. The initial amount of culture media, the degree of disease increase, as well as the duration the crop is cultivated are the three parameters for determination of the disease.

In many supply chains, these characteristics interact to cause rapid pathogen population growth, which is expressed as exponential growth. (T. Momal *et al.,* 2002)

The most important elements of integrated disease management (IDM) are 1.Host resistance 2.Systemic resistance induced 3. Plants with enhanced genetics 4. Cultural customs 5. Physical methods 6. Biological regulation 7. Plant nutrition 8. Utilization plant-based pesticides and 9. Appropriate application of chemicals.

Important diseases of underutilized vegetables

A. RUST (*Uromyces* sp.)

This disease is most common in cyperaceae family. Rust disease are caused by obligatory parasites of the basidiomycetes class. The disease expresses as more on the stems and leaves. Dry, rusty orange, yellow, or white color patches that break the epidermis develop in the diseased area. (Midmore *et al.*, 2004) [11] Swelling and galls may develop. Farm implements, insects, livestock, and other movable bodies spread the rust fungus widely. The main agent of long-distance spore dispersion is uredospore carried by the wind. They can survive in contaminated plant litter as teliospores (resting spores).

Fig 1: Rust disease in Chinese water Chesnutt

B. Fusarium Wilt (*Eleocharis dulcis*)

This disease is most common in cyperaceae family. Jiang *et al*. were the first to describe E. dulcis fusarium wilt. Fusarium spp. are widespread fungus that may infect a wide range of host plants, causing considerable economic losses. The disease causes yellowing of the plant stems, followed by the entire plant becoming chlorotic and stunted. White, delicate, healthy stem bases become dark and necrotic, and the roots become black. In severe situations, pink mycelia might be visible on the tops of stem bases. The disease affects production and quality from sowing through storage. So far, just a few studies on physical identification and chemical management have been conducted in China. (Zhixian Zhu *et al.*, 2014) [18].

Fig 2: Fusarium wilt

C. Chinese water chesenut – yellow crinkle disease

The causative agent of Chinese chestnut yellow crinkle disease has been identified as phytoplasma castaneae. The first report of chestnut crown yellowing given in July of 2014. In majority of the plants studied, yellowing appeared to impact the whole crown, while in others, only a portion of the crown or a single stem was affected. (Ren *et al.,* 2021) [15].

Fig 3: Yellow crinkle disease

D. bacterial leaf blight (ARACEACE)

Taro Leaf Blight (Phytophthora colocasiae) is a very contagious plant disease that causes huge brown patches mostly on leaves in affected taro plants. Lesions are caused by oomycetes draining nutrients from the leaves via haustoria, resulting in powdery white sporangia rings. This disease thrives in high-humidity, high-rainfall conditions, which provide the pathogen with a mechanism of dispersion via rain splash and a warm, moist environment that encourages hyphal development over the afflicted plant. Water droplets collect on the upper surface of leaves, forming tiny brown patches encircled by halos. These patches spread rapidly, resulting in huge brown lesions. In moist circumstances, the entire leaf can be killed in a matter of days after the first development of symptoms. Water-soaked or grey patches appear on the underside of the leaf, which grow and cause blight, which kills the leaf in a short period of time. Water-soaked regions swell throughout the night and then expand out during the day time. As a result, more water marks appear, leading to the lesions to get bigger. (GVH Jackson 1975) [6].

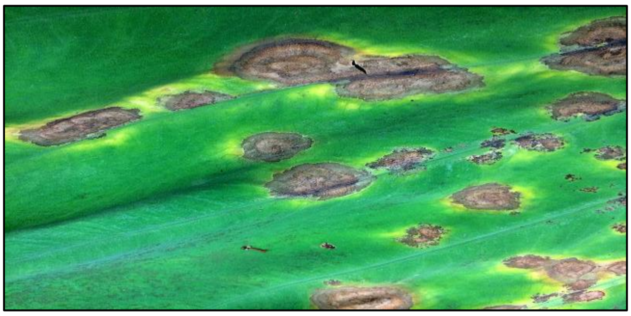

Fig 4: Bacterial leaf blight

E. Powdery mildew

Mainly occurs in cucurbitacace family brassicace family. Powdery mildew is a frequent and deadly disease of cucurbit crops. Gourds and melons are all susceptible to the disease. A powdery mildew infestation works as a sink for plant photosynthetic activity, resulting in reduced plant development, early leaf loss, and, as a result, decreased yield. Powdery mildew causes visible patches of white mycelium (similar to talc) on upper and lower leaf surfaces, petals, and stems, making it simpler to recognize than other infections. Powdery mildew shows as pale yellow patches on stems, petals, and leaves, and is first noticed on older leaves. As the whitish, fluffy mycelium spreads over plant surfaces and releases spores, the spots expand and take on a powdery look. Affected leaves turn into dull, chlorotic, and wilt in the midday heat; they finally become brownish and papery **(**HG Nuñez-Palenius 2006) [13] Powdery mildew

Fig 5: Powdery mildew

F. Downy mildew

This disease mainly occurs in Cucurbitaceae; chenopodaiceae; brassicacae family Pseudoperonospora cubensis causes Downy Mildew, which is also an oomycete but it's not a true fungus. As a water mould, it thrives in damp or humid environments. On the top leaves, pale greenish to yellow dots appear, then become brown. Leaf dots are angular, with leaf veins separating them. In excessive humidity, a dark purple grey fuzz develops on the surface of the leaf. Disease spreads quickly in moist or humid circumstances. Leaf spots clump together, turning the entire leaf dark. The leaves look s like they are destroyed by frost. (J Palti *et al.*, 1980) [14]

Fig 6: Downy mildew

G. Leaf spot in curry leaf (Rutaceae)

The symptoms of Phyllosticta leaf spot include a few circular patches or lesions. In the case of a serious infestation, it can cripple the tree by causing early leaf loss. On leaves, uneven, spherical, yellowish brown blemishes appear. The pathogen produces small black fruiting bodies, which generally form a circle, when the circumstances are favorable. The dead tissue in the middle of these patches readily peels away, creating a hole. Primary infection is transmitted by soil and rain splash, while secondary infection is transmitted by air and rain splash. (S. Joseph. *et al*.)

Fig 7: leaf spot

H. Yellow Mosiac virus (Dioscoreaceae)

This disease mainly occurs in yams. It is caused by virus and the symptoms are appeared on leaves showing yellow and green patterns (called mosaics) between the veins (called vein banding). If the infestation is severe, the leaves grow long, thin, and strap-shaped (a symptom known as the "shoe-string symptom"), and the entire plant gets stunted. Few tiny tubers with lower starch content may be produced by the plant. Some plants recover from viral infection quickly after the initial symptom, but the virus might remain in the plant and decrease its vigor. Aphids and tubers/sets are the vectors of the virus. It may result in a yield reduction of up to 40%. Yam mosaic virus is always seen in combination with yam mild mosaic virus, yam badnaviruses, and cucumber mosaic virus.
(NA Amusa *et al.*, 2003)

Fig 8: Yellow mosaic virus

I. Anthracnose (*Colletotrichum gloeosporioides)*

This disease occurs mainly in Dioscoreaceae espically in yams. A small dark brown or black lesion on the leaves, petioles, and stems is typically covered by a chlorotic halo that enlarges and fuse, culminating in widespread necrosis of the leaves and stem die-back, giving the plant as burned appearance. Primary spread occurs via dormant mycelium and ascospores from contaminated litter, with secondary spread occurring by wind-borne conidia. (NA Amusa *et al.*, 2003) [1]

Fig 9: Anthracnose

J. Root knot nematode

This disease occurs mainly in minor vegetables of solanaceous family Nematode infestations in fields, nurseries, and kitchen gardens are generally identified first in isolated regions (patches). The symptoms of an infected plant are comparable to those of a mineral shortage or drought stress, such as chlorosis, yellowing, drooping, and growth retardation, caused by a gradual decline in root activity for nutrients and water absorption and translocation. However, because of low fertility rates, poor drainage, and other disease-causing organisms exhibit similar symptoms, it's difficult to detect the presence of root-knot nematodes only based on aboveground symptoms. The formation of many "root galls" is a common sign below ground. Though root galls are a major diagnostic characteristic of the root knot nematode, the size of the gall varies by crop. (G Karssen *et al.*, 2013)

Fig 10: Root knot nematode

K. Crecospora leaf spot

This disease occurs in chenopodiaceae family. Infection and lesion development start on leaf surfaces and then spread to younger ones. At maturity, lesions are typically 1/8 inch in diameter and light grey to dark tan in hue, with a brown to purple border. Coagulating lesions cause severely damaged leaves to wither and perish. The appearance of small black specks (Pseudo stromata) within the grayish-tan lesions is a diagnostic characteristic. Conidiophores are produced in clusters by the pseudo stromata and act as conidia-bearing components. With a light microscope, Pseudo stromata may be seen, and after exposing leaves to high humidity, whole lesions become fuzzy due to the presence of many conidia.(M. Bakhshi *et al.*, 2015) [3]

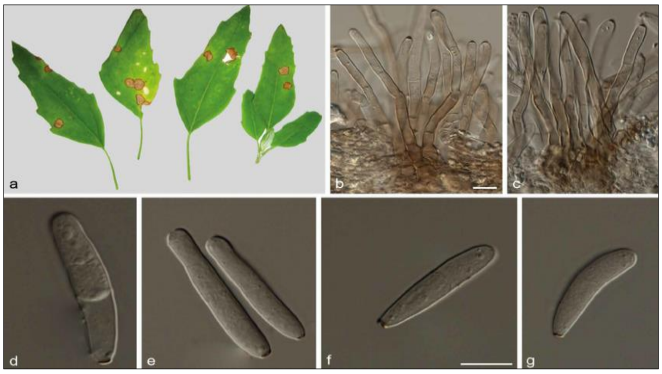

Fig 11: Cercospora leaf spot

L. Damping off

This disease occurs in brassicace family. Damping-off is a disease that kills plant seedlings. Rhizoctonia solani, Aphanomyces cochlioides, and species of Pythium, Phytophthora, Botrytis, Fusarium, Cylindrocladium, Diplodia, Phoma, and Alternaria are among the fungi and funguslike oomycetes that cause damping-off. Damping-off may damage a broad range of plant kinds and lead to losses for a lot of commercially significant food crops due to the infections' diversity. Preemergence damping-off occurs when emerging seeds decompose in the soil and early seedlings rot during emergent, while postemergence damping-off occurs when newly emerged seedlings shrivel, collapse, and die from a soft rot at the soil level. Woody seedlings wilt and wither and stay erect, resulting in root rot. The greatest losses occur in cold, damp soils with delayed germination and emergence, which are frequently seen indoors. (JR Lamichhane. *et al.*, 2017) [10].

Fig 12: Damping off

M. Bacterial Wilt

This disease occurs in convoluulacae family. Ralstonia solanacearum is the bacteria that causes this disease. Wilting, stunting, and yellowing of the leaves are all symptoms. In immature succulent plants, wilting of leaves and stem collapse can be severe. Dark, thin stripes can be seen in immature potato stems. Glistening beads of a grey to brown slimy ooze are seen when the stems are severed. Symptoms, such as a characteristic grayish-brown discoloration, may or may not appear on tubers from infected plants. When tubers are sliced in half, bacterial slime oozes out in grayish-white drops. The eyes turn a greyish brown colour and secrete a sticky material that attracts soil particles to the tuber surface. (NW Schaad *et al.*, 1997) [16]

Fig 13: (Bacterial wilt)

N. Bacterial Soft Rot (*Erwinia chrysanthemi)*

This disease occurs in convoluulacae family. A soft rot attacks roots in the field, or more often in storage, turning infected tissue pale brownish and watery. The margins of lesions on storage roots are frequently dark brown. Some storage roots seem to be in good shape on the exterior but are decaying on the inside. Infected roots develop black streaks in their vascular tissue then finally degrade softly and moistly. In plant beds, parental roots frequently rot. Brown to black, water-soaked lesions occur on branches and petioles in the field. The stem may eventually get wet and collapse, leading to the tendrils to wilt. One or two tendrils may collapse in most cases, but the entire plant may perish on rare occasions.

Fig 14: Bacterial soft rot

O. Sweet potato virus disease

This disease occurs in convoluulacae family. The whitefly-transmitted crinivirus sweet potato chlorotic stunt virus (SPCSV) and the aphid-transmitted potyvirus sweet potato feathery mottle virus produce this disease complex. SPVD is the most dangerous sweet potato disease in Africa, if not the entire globe. Plants that are afflicted lose almost all of their yield. The leaves of diseased plants are tiny and thin (strap-like or fan-like) with a deformed edge, and the plants are severely stunted. It's possible that you'll have puffiness, vein clearing, or mottling. The chlorotic mottling makes the entire plant seem pallid. The growth of storage roots is hampered, resulting in a reduction in yield. (R.B Gibsson *et al*., 1998)

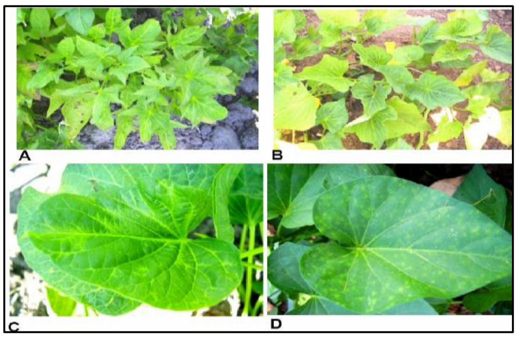

Fig 14: Sweet Potato virus disease

P. Leaf and stem scab

This disease occurs in convoluulacae family. Stem and leaf Scab is one of the most serious sweet potato diseases; it is most widespread in Asia and Australia and is most severe in areas where there is frequent fog, rain, or dew buildup. Small brown lesions on leaf veins that become corky in texture and cause veins to shrink, causing leaves to curl; lesions on stems are slightly elevated and have purple to brown cores with light brown borders; when lesions combine, scabby lesions occur on stems. (P. Kokoa *et al.*, 2001) [9]

Fig 15: Leaf and stem scab

Q. Alternaria leaf and stem blight

This disease occurs in convoluulacae family. Stem and leaf petiole blight is far more damaging than Alternaria leaf spots; stem and petiole blight is a serious sweet potato disease that has been documented from Asia, South America, and Cuba. Small gray-black oval lesions with lighter centres may appear on stems and leaf petioles, and rarely on leaves; stem and petiole lesions develop and merge, resulting in girdling of the stem; defoliation may ensue. (TJ Anginyah *et al.,* 2001) [2]

Fig 16: Alternaria leaf and stem

Integrated disease management

Disease control was largely done before the discovery of chemicals by altering cultural practises, mechanical, and physical means. The concept of integrated pest management was introduced later in the 70's century, gaining widespread attention and support among plant protection specialists. In theory, Integrated Pest Management (IPM) is a careful mix of non-chemical approaches, with pesticides used only after all other options have failed.

Important strategies for management of plant diseases are:

Cultural practices

Cultural practises as a crop management method is the oldest and most widely used environmentally friendly creative way with farmers for preventing crop losses due to diseases and other reasons. Only thorough understanding of the biology of the pathogen and its activity in various environmental, cropping system, and other circumstances can be used to successfully employ cultural practise for disease management. In crops with poor yield per unit area or for which resistant cultivars are unknown, cultural techniques are the only viable means of disease management (Singh *et al.*, 2012) [17].

Crop rotation

When a single crop is cultivated on the same plot of land year after year, viruses that attack the crop have a greater chance of spreading, frequently to the point where subsequent plantings of the same crop are economically unfeasible due to disease losses. Crop rotation can help to prevent or substantially minimise the occurrence of disease issues (Singh *et al*., 2012) [17]. Soil-borne viruses that affect plants can often be decreased in soil by growing crops which are not affected by the pathogen for three or four years.

Host eradication

Host eradication is used to stop the spread of diseases by removing diseased plants that serve as an accessible supply of inoculum inside the crop. In certain cases, eradication of the host in which the pathogen is sufficient to eradicate the inoculum 2006 (George N. Agrios)

Field sanitation

Field sanitation is another essential method for avoiding the spread of plant disease and managing it through cultural practises. Plants and plant components are some of the finest disease organism hosts. The inoculum found on a few plants in the field may proliferate in the soil or on the plant, eventually causing an epidemic the following season. As soon as the crop is harvested or the cultural process is done, destroy or remove crop leftovers, culled fruits, unused seedbed plants, and pruning's.

Mulching

Polyethylene mulch can be used to provide a physical barrier between soil and aboveground plant components, which is an important technique in the field for preventing fruit rot. Mulches that are highly UV-reflective (metalized) repel some insects that act as vectors for virus transmission.

Scouting

It is an integral part of any IPM program. Regularly monitor crops for diseases, insects, noxious weeds and nutrient deficiencies.

Spacing

Plant spacing in the field is important because it avoids excessive humidity conditions on the plant surfaces, which can lead to pathogen infection.

Physical methods

Physical agents are used in controlling plant disease such as temperature, dry air etc.

Heat treatment

Soil sterilization by heat

Steam sterilisation takes place in specific containers or on greenhouse benches, where steam is pumped into and allowed to spread through the soil. Some oomycetes as well as other water moulds are destroyed by nematodes at around 50˚c. Most of the plant harmful microorganisms are destroyed around 60 ˚& 70 ˚ c. Most weeds, as well as the remainder of plant pathogenic bacteria and viruses, are destroyed at temperatures about 82 ˚ c.

Hot water treatment

It is used to treat certain seeds bulbs to kill any pathogen with which they are infected. The temperature and duration varies with crop.

Hot air treatment

Warm air treatment of some storage organs eliminates excess moisture from their surface and speeds wound healing, reducing the risk of infection. Several virus-infected dormant plants are subjected to an 8-hour hot air treatment at temperatures ranging from 35-54 ºC.

Control by radiations

Various types of electromagnetic radiation, such as UV and X rays, are used to prevent post-harvest illnesses of vegetables by eliminating pathogens that are present on them.

Host -plant resistance

Resistance in host plants is a crucial technique for controlling diseases in key vegetable crops. Plant disease control that is the least costly, simplest, safest, and most effective. Farmers like the adoption of resistant varieties since they do not incur additional costs and are environmentally benign. Resistant varieties play an essential role in reducing agricultural plant disease losses. Genetic resistance is the only treatment for some diseases such as wilts, rusts, smuts, nematodes, and bacterial blights, leading in an increase in the cost benefit ratio. Non-toxic resistant variants are available

Chemical control

Pesticidal chemicals used to manage plant diseases can be employed in a variety of ways, depending on the parasite being controlled and the conditions required for parasitic activity.

Table 1: Diseases and its mitigation.

Disease	Chemical control
Rust	Sulphur dust
Fusarium wilt	Thiram
Powdery Mildew	Bavistin/ sulfex 0.5%
Downy Mildew	Dithane M-45 -0.2%
Leaf spot	Carbendazium@1gm/lit
Anthracnose	Bavastin
Root not nematode	Carbofuran
Cercosporaleaf spot	Tetraconozole
Collectrotrichium Leaf spot	Propioconozole

Damping off	Metalaxyl
Bacterial wilt	Bordeaux mixture 1% or COC@0.2%
Leaf scab	Hexaconozole 5%EC
Sweet potato Viral disease	Carbofuran 3G@4-5 kg/ acre
Bacterial Soft rot	TBZ+ Acetic acid +0.05% Zinc Sulphate, carbendizium 2g/ kg
Stem Blight	Captan 50% wp
Alternaria leaf Blight	Carbendizium 12%+ mancozeb 250-300gm / acre
Alternaria Leaf spot	Mancozeb- 0.25% / Copper oxy chloride-0.3%

Seed treatment

Plant diseases may be controlled by chemical seed treatments in, on, and around planted seed. Seed treatment is therapeutic when bacteria or fungus infect embryos, cotyledons, or endosperms under the seed coat, eradicative when fungi spores contaminate seed surfaces, and protective when soil-borne fungi do not penetrate seedling stems. Chemicals used in seed treatment are Chloraneb, Dichlone, Thiram, Carboxin.

Soil treatment

Soil-borne plant pathogen populations grow rapidly when soils are continually cultivated, eventually reaching levels that make contaminated soils unsuitable for crop cultivation. Chemical soil treatments that eliminate plant pathogens allow for the fast recovery of infected soils for agricultural use. To reduce nematode-induced illnesses, field soils are chemically treated prior to planting, and seedbed and greenhouse soils are fumigated (with methyl bromide, for example) to eliminate weeds, insects, and plant pathogens. Some of the chemicals used for the soil treatment Methyl bromide (general pesticide); PCNB (fungicide) SMDC [vapam] (fungicide, nematicide); MIT ["Vorlex"] (fungicide, nematicide); D-D mixture (nematicide).

Fumigation

The use of chemicals known as fumigants is the most promising technique of combating infections. Chloropicrin, Methyl bromide, and others are among them. Nematicides are available as liquids and emulsifiable concentrates for use as soil fumigants.

Biological control

The use of natural or modified organisms, genes, or gene products to decrease the impacts of pests and illnesses is referred to as biological control. Biological control occurs whenever one organism is controlled by another. Mechanisms of the biological control are antagonism, antibiosis, competition or exploitation. In this method the pathogen actively is reduced using other living organisms.

Biocontrol agents are increasingly being used in the management of crop diseases, particularly among organic producers. These compounds are used to treat soil-borne illnesses and are deemed safer for the environment and the applicator than traditional chemicals. The fungus Trichoderma harzianum and Gliocladium virens, the actinomycete Streptomyces griseoviridis, and the bacteria Bacillus subtilis are all commercially accessible biocontrol agents. Bacteriophages (phages) have been discovered to be an efficient biocontrol agent for bacterial spot on tomatoes. Phages are bacteria-infecting viruses. To properly evaluate the relevance of biocontrol to specific agricultural activities, it is best to conduct short experiments on one's own farm.

In Pythium and Fusarium diseases of spinach, Actinovate (Streptomyces lydicus) decreased the degree of root and seed rot in peas and resulted in considerably higher final emergence and significantly lowered the disease (soil-borne fungi). Powdery Mildew on pumpkin had no effect, as did Phytophthora fruit rots of pepper and pumpkin. The use of six species of Bacillus, Streptomyces griseoviridis, Trichoderma harzianum, along with the organic nutrients considerably decreased the incidence of tuber formation in Black Scurf (*Rhizoctonia solani*) and common scab (*Streptomyces scabies*) of potato. In broccoli, usage of rhizobacteria promotes plant growth, lowered the incidence of root rot (Pythium, Rhizoctonia) and wire stem (Rhizoctonia) diseases along with post-emergence diseases in spinach. But it showed no effect on foliar diseases of tomato like Septoria, Sclerotinia (white mould), and Alternaria (early blight). Contans (*Coniothyrium minitans*), as a soil treatment, dramatically minimized the lettuce loss caused by Sclerotinia species. Also, Seed treatment with Kodiak (*Bacillus subtilis*) significantly reduced Black Scurf and stem canker in potatoes and post-emergence diseases in spinach followed by seed and root rot diseases in peas. Muscador (*Muscador albus*) is a new biocontrol organism that produces gaseous chemicals and serves as a biofumigant. It has proved to be effective against storage pests in potatoes. Muscador treatment on radish resulted in reduced root and hypocotyl rot, as well as Phytophthora fruit rot in pepper. Phytophthora disease severity was considerably decreased when Muscador was combined with a resistant variety of pepper. Serenade (Bacillus subtilis) substantially increased yield and reduced the incidence of Rhizoctonia root rot on both beans and radish. It was noticed that Soil Gard (*Trichoderma virens*) decreased the incidence of Black Scurf and its severity in potatoes, as well as post-emergence disease in spinach, but showed no effect on damping-off disease caused by Pythium (Dicklow, University of Massachusetts Amherst*).*

In several studies, the use of biocontrol agents like T. viride, T. harzianum, fluorescent Pseudomonas, and B. subtilis, when applied to soil were found to be effective against root rot caused by soilborne diseases in some crops. Fungi-toxic metabolites are produced in high amounts by Trichoderma species. They also act as active mycoparasites and show a significant effect in controlling foliar and soil-borne diseases. Some pathogenic fungi, such as *Alternaria panax, Botrytis cinera, C. orbiculare, Penicillium digitatum*, *P. grisea*, and *S. sclerotiorum*, were shown to be resistant to the antifungal compound, that is produced from the bacteria *B. amyloliquefaciens.* To treat soilborne illnesses, arbuscular mycorrhizal fungi were found to be more effective. Mycorrhizal fungi envelop the plant roots, producing a fungal mat, and protect them by building a physical barrier between them and pathogens. It also provides chemical antagonists, increased plant nutrient absorption capacity, and competition (direct) with the plant pathogen. Streptomyces species acts as a biocontrol agent in controlling the diseases caused by Species of Fusarium, Rhizoctonia, Phytophthora, Pythium, Phytomatotricum, Aphanomyces, Monosprascus, Armillaria, Sclerotinia, Verticillium, Geotrichum. Incidence of some plant pathogen species like Alternaria, Botrytis, Fusarium, Gaeumannonyces, Ophistoma, Phoma, Pseudocercosporella, Pythium, Sclerotinia, and Sclerotium can be reduced by using biocontrol agent i.e Pythium oligandrum (Milan Panth, *et al*. 2020)

Newhook (1957), revealed that applying *Cladosporium herbarium* and *Penicillium spp* on dead petals of tomato flowers earlier to colonization gave complete control over the gray mold. Application of *Ampelomyces quisqualis* along with the water, to cucumber affected by *S. fuliginea*, was effective against powdery mildew and also increased the yield of the fruit

Conclusion

Plant diseases can occur at any point throughout their development. To protect the plant, it's crucial to identify the cause of the disease and treat it as soon as possible. Infectious diseases spread by biological organisms, such as microscopic organisms, may devastate a crop rapidly. From production to consumption, postharvest disease losses can occur at any phase during the postharvest management process. When estimating postharvest disease losses, it's important to consider fruit quantity and quality, because certain infections don't render produce unsellable but do lower product value. Plant diseases are caused by fungi (moulds), bacteria, viruses, and nematodes, among others. Although these pathogens are not harmful to people, they can harm plants significantly. The ability to properly identify diseases and other plant issues is crucial for the successful application of control measures. The main objective of vegetable infection control is to reduce the aesthetic and economic damage that plant disease causes. It might be utilised for organic farming in the future, with the assistance of numerous advanced technologies to monitor plant health and the spread of disease that can be physically seen. New applications and devices are being used to monitor the ideal plant development environment as well as disease-causing microorganisms.

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